Scheme of Instruction 2017-18

Indian Institute of Science
Bangalore - 560 012

Contents

A. Scheme of Instruction

SCHEME OF INSTRUCTION
2017-18

Preface

The “Scheme of Instruction and Student Information Handbook” contains of the courses and rules and regulations related to student life. The courses listed and the rules in the Student Handbook are primarily meant for post graduate students of the Institute. Undergraduate students are, however, allowd to credit these course.

The course listings are provided in conformance with the Divisional structure of the Institute, with the courses of each department of a Division being listed in a separate subsection within the pages allocated to the Division. For instance, all courses of the Aerospace Engineering department have the prefix AE, and are listed in the Aerospace Engineering subsection within the Mechanical Sciences Division. The only exception to this pattern is the Electrical Sciences Division, where the courses are organized under the sub-sections E0 through E9, according to the areas to which they belong. For instance, all Computer Science and Automation courses of the Electrical Sciences Division have the prefix E0, and are found in the corresponding sub-section, although the instructors come from all four departments of the division. The course codes are given in the Table of Contents.

The listing of each course consists of the course number, the title, the number of credits and the semester. The course number indicates both the department and the level of the course. For instance, MA 205 indicates that the course is offered by the Mathematics department and is at the 200 level. Such 200 level courses are either basic or second level graduate courses. The 300 level courses are advanced courses which are primarily meant for research scholars but can also be taken by course students who have the appropriate background; these courses can be taken only with the consent of the instructor. Most courses are offered only once a year, either in the August or in the January semester. A few courses are offered in the summer term.

The number of credits is given in the form m:n, where m indicates the number of lecture credits and n the number of laboratory credits. Each lecture credit corresponds to one lecture hour per week, while each laboratory credit corresponds to a 3-hour laboratory class. Thus, 2:1 credits indicates that the course would have 2 lecture hours along with one 3-hour laboratory session each week, while 3:0 credits indicates a course with 3 lecture hours and no laboratory.

The Institute offers research-based doctoral programmes as well as both course-based and research-based Master programmes. Each course-based Master programme consists of core courses, electives and a dissertation project. Details of the requirements can be found under the course listing of the departments or divisions that offer them. At the time of joining, each course student is assigned to a Faculty Advisor, who has the responsibility of helping him/her to select courses and to monitor progress through the academic program. In order to register for a course, this student needs the approval of both the faculty advisor and the course instructor. In the first semester, the normal course load of 15-16 credits should be taken; most of these courses are core courses. From the second semester onwards, students who have done well may be permitted to take an extra course, while those who have performed badly may be required to take one course less. Students are permitted to claim an exemption from core courses on the basis of having taken them earlier. Details of how to claim such an exemption are given in the later part of this book.

The Institute follows a grading system, with continuous assessment. The course instructor first aggregates the individual marks of each student from the class tests, assignments and final examination scores. These marks are then mapped to letter grades, and only the grade is announced. The point values of grades are as follows: A+ :10, A : 9, B+ : 8, B : 7, C – 6, D - 5, F – 0. While grades B+ through D are passing grades, F is a failing grade.

While all the course based programmes have a specified set of core courses, research scholars are not bound to any specific courses, although they have to take a minimum number of credits as part of their Research Training Program (RTP). For Ph.D. scholars in Science, the RTP consists of 12 credits of course work. For Ph.D. scholars in Engineering, who join with M Tech / M.Sc. (Engg.), the RTP requirement is a minimum of 12 credits. For BE/B Tech/M.Sc. graduates who join for Direct Ph.D., the RTP minimum requirement is 24 credits. Similar RTP requirements apply for Ph.D. candidates who upgrade their registration or transfer from the ME/M Tech or M.Tech (Research) programmes of the Institute. For the M.Tech (Research) degree, the RTP consists of minimum 12 credits. The Integrated Ph.D. programme has 64 credits. Research students have the option of crediting courses beyond the RTP requirement. These course come under the Non-RTP category.

Detailed information with regard to the regulations of the various programmes and the operation of different aspects of Institute activities are given in the second part of the Handbook. Students are urged to read this material carefully, so that they are adequately informed.

July 2017
Bangalore-560012

Prof. Jaywant H Arakeri
Chairman
Senate Curriculum Committee

Information on the number of credits to be registered at various levels for Different programme

M Tech/M Des/ M Mgt. programme (2 years duration)
Minimum number of credits for completion :64

Core courses	15-30	at 200 level
Dissertation Project	19-32	
Electives *	15-24	Balance to make up the minimum of 64 (at 200 level and above)

M Des programme (2 years duration)
minimum number of credits for competion : 64

Core courses	36	at 200 level
Electives*	12	at 200 level and above
Dissertation Project	16	

Research Traning Programme

(i) Ph D Science : 12 credits
(ii) Ph D in Engineering Faculty with
- (a) ME / M Tech qualification 12 credits
- (b) M Tech (Research) qualification 12 credits
- (c) BE / B Tech qualification and upgrades from M Tech (Res.) registration 24 credits
- (d) After transfer of ME / M Tech students of the institute 32 credits
- (e) BE/B Tech/M Sc qualifications 24 credits

However, the final decision regarding the additional credits to be taken with regard to (c) and (d) above rests with the committee responsible for the conversion.

(iii) For M Tech (Research) 12-21 credits (with 3 credit maths course/s)

Integrated Ph D Programme : Minimum of 64 credits

Division of Biological Sciences

Preface

This Division includes the Department of Biochemistry, Centre for Ecological Sciences, Department of Microbiology and Cell Biology, Molecular Biophysics Unit, Department of Molecular Reproduction, Development and Genetics, Centre for Neurosciences, Centre for Infectious Disease Research and the Central Animal Facility. Students from a variety of disciplines such as biology, chemistry, physics and medicine are admitted into the Division for research work leading to a PhD degree.

Each Department/Centre/Unit offers courses on specialized topics designed to provide students with the necessary theoretical background and introduction to laboratory methods. There are specific requirements for completing the Research Training Programme for students registering for research conferments at the Institute. For individual requirements, the students are advised to approach the Departmental Curriculum Committee.

The Department of Biochemistry offers a programme of study concentrating on a molecular approach towards understanding biological phenomena. The programme of instruction consists of lectures, laboratory work, and seminar assignments. In addition to formal course work, students are required to participate in group seminars, departmental seminars and colloquia.

The Center for Ecological Sciences has excellent facilities for theoretical as well as experimental research in plant and animal ecology and the social behavior of insects. The programme of instruction consists of lectures, laboratory work, seminars and special assignments.

The Department of Microbiology and Cell Biology offers courses in microbiology, infectious diseases, eukaryotic genetics, advances in immunology, plant and cell culture, and recent advances in molecular biology and genetic engineering. The students are expected to participate in seminars on recent advances in these fields.

The Molecular Biophysics Unit offers courses which cover recent developments in molecular biophysics, biopolymer conformation, structure and interactions of biomolecules and biophysical techniques.

The courses offered in the Department of Molecular Reproduction, Development and Genetics include those on endocrinology, reproduction signal transduction, genetics, gene expression and development.

The research interests in the Centre for Neuroscience spans from molecules to behavior. The courses offered would enable the students to gain fundamental knowledge in molecular and cellular neuroscience, systems and cognitive neuroscience. In addition, students will be expected to actively participate in seminars, journal clubs and lab rotations.

The Centre for Infectious Disease Research (CIDR) is involved in two primary activities: First, providing the intellectual and infrastructural support for infectious disease research. Second, enable researchers to perform studies in the Bio-safety Level-3 (BSL-3) facility, a state-of-the-art bio-containment space to perform research with high infectious organisms, e.g. Mycobacterium tuberculosis etc.

The Central Animal Facility provides standardized pathogen free, conventionally bred animals for biochemical experiments and also has facilities for research involving non-human primates.

Prof. Umesh Varshney
Chairman, Division of Biological Sciences

Integrated PhD (Biological Sciences)

Course Work

Core Courses: 19 credits

DB 201 2:0	Mathematics and Statistics for Biologists
DB 202 2:0	General Biology
DB 207 0:5	Laboratory
BC 203 3:0	General Biochemistry
MB 201 2:0	Biophysical Chemistry
MC 203 3:0	Microbiology
RD 201 2:0/	
DB 204	Genetics

Projects: 16 Credits

DB 212 0:4	Project - I
DB 225 0:6	Project - II
DB 327 0:6	Project - III

Elective Courses: 29 Credits
(For a total of 64 credits)

DB 201 (AUG) 2:0

Mathematics and Statistics for Biologists

Calculus: functions, limits and continuity, differentiation, integration, transcendental functions. Linear Algebra: vectors, matrices, determinants, linear equations. Statistics: elements of probability theory, discrete and continuous distributions, measures of central tendency, variability, confidence intervals, formulation of statistical hypotheses, tests of significance.

Joshi N V,Supratim Ray,Sekar K

Biological Instructor,Biological Instructor,Biological Instructor

DB 202 (AUG) 2:0

GENERAL BIOLOGY

Biology and the natural sciences; Growth of biological thought; Matter and life; Origin of life; History of life on earth; Bacteria and Protists; Fungi and other primitive plants; Seed bearing plants; Animals without back-bones; Insects, Vertebrates, Phylogeny and Systematics; Mechanisms of Evolution; Chemical basis of life; Cellular basis of life; Selected topics in plant and animal physiology; Selected topics in plant and animal ecology; Introduction To Neurophysiology with Topics In General Physiology; Behavioral ecology and sociobiology; Biological diversity on earth; Complexity; Molecular versus Organismal approaches to solving problems in Science.

Renee M Borges

• Maynard Smith, J. The Theory of Evolution, Penguin Books (1993 edition), 1958. • Bonner, J. T. Why Size Matters: From Bacteria to Blue Whales, Princeton University Press, 2007. • Sigmund, K. Games of Life, Penguin Books, 1993. • Medawar, P. Pluto's Republic (incorporating The Art of The Soluble and Induction and Intuition in Scientific Thought). Oxford University Press, 1982.,• Maynard Smith, J. The Theory of Evolution, Penguin Books (1993 edition), 1958. • Bonner, J. T. Why Size

Matters: From Bacteria to Blue Whales, Princeton University Press, 2007. • Sigmund, K. Games of Life, Penguin Books, 1993. • Medawar, P. Pluto's Republic (incorporating The Art of The Soluble and Induction and Intuition in Scientific Thought). Oxford University Press, 1982.,• Maynard Smith, J. The Theory of Evolution, Penguin Books (1993 edition), 1958. • Bonner, J. T. Why Size Matters: From Bacteria to Blue Whales, Princeton University Press, 2007. • Sigmund, K. Games of Life, Penguin Books, 1993. • Medawar, P. Pluto's Republic (incorporating The Art of The Soluble and Induction and Intuition in Scientific Thought). Oxford University Press, 1982.

DB 203 (AUG) 3:0

General Biochemistry

Biochemistry of carbohydrates and lipids. Cell membrane: structure and function. Metabolism: basic concepts and design, glycolysis and citric acid cycle, oxidative phosphorylation, bioenergetics, fatty-acid metabolism, integration and regulation of metabolism, pentose phosphate pathways and gluconeogenesis. Photosynthesis. Protein translation and regulation, cellular protein transport and protein turnover, biosynthesis and catabolism of amino acids and nucleotides, signal transduction. DNA structure, replication and repair. Transcription, regulation of gene expression in prokaryotes and eukaryotes. Recombinant DNA technology.

Sathees C. Raghavan,Patrick D Silva,Ganesh Nagaraj

Stryer L.,Biochemistry (4th Edn),David L Nelson and Michael M Cox, Lehninger Principles of Biochemistry, 3rd Edn, Worth Publishers, 2000.,W. H. Freeman and Company,1995.

MB 201 (AUG) 2:0

Introduction to Biophysical Chemistry

Basic thermodynamics, ligand binding and co-operativity in biological systems, kinetics, diffusion and sedimentation.

Raghavan Varadarajan

Tinoco, I., Sauer, K., Wang, J.C., Physical Chemistry, Principles and Applications in Biological Sciences, Prentice Hall, NJ, 1978. Cantor, C.R., and Schimmel, P.R., Biophysical Chemistry, Vols. I-III, W H Freeman and Co., San Francisco, 1980.,Tinoco, I., Sauer, K., Wang, J.C., Physical Chemistry, Principles and Applications in Biological Sciences, Prentice Hall, NJ, 1978. Cantor, C.R., and Schimmel, P.R., Biophysical Chemistry, Vols. I-III, W H Freeman and Co., San Francisco, 1980.,Tinoco, I., Sauer, K., Wang, J.C., Physical Chemistry, Principles and Applications in Biological Sciences, Prentice Hall, NJ, 1978. Cantor, C.R., and Schimmel, P.R., Biophysical Chemistry, Vols. I-III, W H Freeman and Co., San Francisco, 1980.

MC 203 (AUG) 3:0

Essentials in Microbiology

Fascinating world of microbes; Principles of microscopy; Microbial taxonomy, Microbial diversity, evolution and genomics; Mechanisms of horizontal gene transfer including genome transplantation, Microbes as model systems of development, Microbes as bioreactors and sensors; bioremediation; bacterial cell structure and function; Bacterial physiology and nutrition; Bacteriophages, Plasmids and Transposons; Understanding and combating bacterial pathogenesis; Antibiotics- mechanisms of drug resistance and mode of action; Quorum sensing and biofilms; Host-pathogen interactions and mechanisms of immune surveillance; PRR and their role in pathogenesis; TH subsets and modulation by pathogens; Diagnostics and vaccine development.

Amit Singh,Balaji Kithiganahalli,Dipshikha Chakrav

Stanier, R.V., Adelberg E.A and Ingraham J.L., General Microbiology, Macmillan Press, Fourth edition; Westriech, G.A. and Lechmann M.D., Microbiology, Macmillan Press, Fifth Edition; Atlas R.M., Microbiology:,FundamentalsandApplications, Macmillan Press Second Edition; Goldsby, R. A., Kindt T. J., Osborne B. A., Kuby J., Immunology, W. H. Freeman & Company, New York; Travers,,J., Shlomchik, W., Immunobiology, Garland Science publishing, New York.

RD 201 (AUG) 2:0

Genetics

Transmission and distribution of genetic materials, dominance relations and multiple alleles, gene interaction and lethality. Sex linkage, maternal effects and cytoplasmic heredity, cytogenetics and quantitative inheritance. Elements of developmental and population genetics.

Mahadevan S,Arun Kumar

DB212 (JAN) 0:6

Project I

Faculty

DB225 (JAN) 0:6

Project II

An independent research project to be conducted in the laboratory of a faculty member in the Division of Biology, preferably in the laboratory where the PhD research will be carried out. Students will have to make a presentation, providing an overview of earlier information available in their research area, and present the proposed objectives and preliminary experiments that have been carried out.

Faculty

DB327 (JAN) 0:6

Project III

An independent research project to be conducted in the laboratory of a faculty member in the Division of Biology. It is desirable that the project be carried out in the laboratory where Project II was conducted.

Faculty

Faculty,

Biochemistry

BC 201 (AUG) 2:0

Cell Biology

Biogenesis of proteins in eucaryotes: targeting to intracellular organelles, post-translational modifications, cellular redox. Intracellular protein degradation: lysosomal and non-lysosomal. Nuclear organization and function, chromosome structure, function and inheritance. Regulation of the Cell cycle, dynamic molecular events during mitosis, cell-cell communication.

Shikha Laloraya,Patrick D Silva,Utpal Tatu,Dipanka

Alberts et al., Molecular Biology of the Cell, Third edition, Garland Publ. Inc. 1994,,Darnell et al., Molecular Cell Biology, Scientific American Books, 1995.,Annual Reviews of Biochemistry. Annual Reviews of Cell Biology.

BC 202 (AUG) 2:0

Proteins: Structure and Function

Purification and characterization of enzymes/proteins. Determination of primary/ secondary/ tertiary/quaternary structures. conformational properties of polypeptide chains; Mechanism of Protein folding;. Enzyme catalysis – steady state kinetics, allosteric enzymes, kinetics of interactions of ligands, protein engineering, enzyme mechanisms.

Utpal Tatu,Narasimha Rao D,Nagasuma R Chandra

Creighton, T.G., Proteins, W.H.Freeman, 1993.,Segel, I.H., Biochemical Calculations, Wiley, 1976,Athel Cornish-Bowden, Fundamentals of Enzyme Kinetics, Portland Press, 2004. Branden, Carl, and Tooze, J., Introduction to protein structure, Garland Publishing, Inc., 1999.

BC 203 (AUG) 3:0

General Biochemistry

Biochemistry of carbohydrates and lipids. Cell membrane: structure and function. Metabolism: basic concepts and design, glycolysis and citric acid cycle, oxidative phosphorylation, bioenergetics, fatty-acid metabolism, integration and regulation of metabolism, pentose phosphate pathways and gluconeogenesis. Photosynthesis. Protein translation and regulation, cellular protein transport and protein turnover, biosynthesis and catabolism of amino acids and nucleotides, signal transduction. DNA structure, replication and repair. Transcription, regulation of gene expression in prokaryotes and eukaryotes. Recombinant DNA technology.

Purusharth Rajyaguru,Sathees C. Raghavan,Patrick D

Stryer L., Biochemistry (4th Edn), W. H. Freeman and Company, 1995,David L Nelson and Michael M Cox, Lehninger Principles of Biochemistry,,3rd Edn, Worth Publishers, 2000.

BC 206 (AUG) 2:0

Essentials in Immunology

Adaptive and innate immunity, inflammation, antibody structure and function, the complement system, antigen - antibody interaction, cells and organs of the immune system, B cell activation, immunoglobulin genes, molecular basis of antibody diversity, T cell receptors, T cell activation, major histocompatibility complex, antigen processing and presentation, lymphokines, transcription factors,

hypersensitivity, autoimmunity, immunological techniques. Immunological disorders and therapy

Dipankar Nandi,Anjali Anoop Karande,Sandeepa M Esw

Goldsby, R.A., Kindt, T.J., Osborne, B.A., and Kuby, J., Immunology, Fourth edition, W.H. Freeman and Company, 2000.,Roitt, I., Essential immunology, Third Edition, Blackwell Scientific Publications, 1994.,Paul, W., Fundamental Immunology, Third Edition, Raven Press, 1994.

BC 205 (JAN) 2:0

Fundamentals of Physiology and Medicine

Introduction to human embryology and congenital anomalies (RB), Cardiovasculr system; Respiratory system; Endocrine system; Digestive system; Renal Physiology; Physiology and common Pathologies/disorders associated with these systems; Medical and surgical interventions (SME).

Ramray Bhat,Sandeepa M Eswarappa

1. Ganong's Review of Medical Physiology, 25th Edition (McGraw-Hill Education).,2. Guyton and Hall Textbook of Medical Physiology (Saunders Publication).,3. Harrison's Principles of Internal Medicine (McGraw -Hill Education).,4. Davidson's Principles and Practice of Medicine, 22nd Edition (Churchill Livingstone).

BC 207 (JAN) 2:0

Proteomics in Practice

Course offers introduction to proteomics, 2D gel electrophoresis techniques for resolution of proteins, mass spectrometry principles and applications in proteomics. Study of post translational modifications, Databases (NCBI, Swiss-prot and MSDB) and their uses, software (protein pilot, cascot and gpm) uses for proteomic analysis. Introduction to quantitative proteomics and techniques (i-TRAQ and SILAC).

Utpal Tatu

Reiner Westermeier,Tom Nave,Proteomics :,Tools for the New Biology,by Daniel C Liebler,2002

BC 209 (JAN) 2:0

Dessertation Project

The dissertation project is aimed at training students to review recent literature in specialized areas of research.students to review recent lit

Jayabaskaran C

Only BC Students,Biochemistry students,Biochemistry students

BC 210 (JAN) 3:0

Molecular Basis of Ageing and Regeneration

A. Mechanisms of Ageing and Regenration; Model systems for studying Ageing and Regenration; Role of cellular processes such as transcription, translation, posttranslational modifications; Signalling mechanisms.Cellular Senescnece; Genetic basis of Ageing and longevity; Ageing and diseases; Organ Senescence; Obesity/Diabetes/Cardiovascular diseases/Muscle degenration; Interventions to delay ageing and/or enhance life span

Purusharth Rajyaguru,Nagalingam Ravi Sundaresan,Varsha Singh

Principles of Regenerative Biology by Bruce Carlson.,Regeneration - Developmental Biology by Scott F Gilbert (6th Edition). Handbook of the Biology of Ageing, Seventh Edition, by Edward J Masoro (Editor), Steven N. Austad (Editor) 2010.,Molecular Biology of Aging (Cold Spring Harbor Monograph Series), by Leonard Guarente, 2007.,Biology of Aging : Observations and Principles by Robert Arking, 2006. Aging and age- related diseases : the basics by Karasek, M 2006. Molecular Biology of the Cell by Alberts B et al., 2008.

BC 302 (JAN) 3:0

Current Trends in Drug Discovery

Introduction to the process of Drug discovery, Principles of drug action, Biochemical pharmacology, drug absorption, distribution, metabolism and elimination, bioavailability. Drug receptors and their interactions, dose-response relationships, pharmacokinetics & pharmacodynamics. Use of genomics and proteomics for understanding diseases at the molecular level. Brief introduction to Systems biology, Strategies for target discovery, high throughput screening using genomics, proteomics and bioinformatics for target and lead identification. Molecular recognition, drug and target structures and chemoinformatics. Druggability, protein-ligand interactions, structure-based ligand design. Lead Identification, Lead optimization and design, Binding site characterization, docking and clustering. Pharmacophore-based approaches, QSAR. Pharmacogenomics & Variability in Drug Response, biochemical mechanisms of drug resistance, examples from current literature

Nagasuma R Chandra

Basic Principles of Drug Discovery and Development by Benjamin E Blass 2015,Structure Based Drug Discovery - An Overview by Roderick E. Hubbard (RSC Publication) 2006,Molecular Pharmacology from DNA to Drug Discovery by John Dickenson, Fiona Freeman, Chris Lloyd Mills, Shiva Sivasubramaniam and Christian Thode, Wiley-Blackwell, 2013

Ecological Sciences

EC 301 (AUG) 2:1

Animal Behaviour: Mechanisms and Evolution

History, classical ethology; Neuroethology: sensory processing and neural maps; learning and memory; hormones and behavior; ontogeny of behaviour; sensory ecology; sociobiology; behavioral genetics; optimality approaches and evolutionary models to understand strategies for foraging, competition, group living, sexual selection and mate choice, parental care and family conflicts, predator-prey interactions; theoretical, integrative and computational approaches to studying animal behaviour.

Maria Thaker,Rohini Balakrishnan

Alcock, J., Animal Behaviour - An Evolutionary Approach (Sixth Edition), Sinauer Associates, 1998.,Camhi, J.M., Neuroethology, Sinauer Associates, 1984.,Dugatkin, L.A., Principles of Animal Behaviour (2nd Edition), W.W. Norton and Company, 2009.,Davies, N.B., Krebs, J.R. and Stuart, A. W. An Introduction to Behavioural Ecology. (Fourth Edition), Wiley-Blackwell, 2012.

EC 302 (AUG) 2:1

Plant-Animal Interactions (Ecology, Behaviour and Evolution)

The sensory biology of the interaction between plants, their animal mutualists and parasites: vision, chemoreception, olfaction and multimodal signalling; energetics of plant–animal interactions; nectar, floral and vegetative scents and pollen chemistry; stable isotopes in the study of plant–animal interactions; mate choice in plants; evolution of floral and fruit traits; phenotypic plasticity and inducible defenses in plants; behavioural and physiological processes in generalist and specialist herbivores, pollinators and seed dispersers; co-evolutionary dynamics of symbiosis, mutualisms and arms races

Renee M Borges

Chittka, L. and Thompson, J. D. (Eds.), Cognitive Ecology of Pollination — Animal Behaviour and Floral Evolution. Cambridge University Press, 2001.,Herrera, C. M. and Pellmyr, O. (Eds.), Plant– Animal Interactions: An Evolutionary Approach. Blackwell Publishing, 2002.,Baluska, F., and Ninkovic, V. (Eds.), Plant Communication from an Ecological Perspective. Springer, 2010.,Schaeffer, H.M., and Ruxton, G.D. (Eds). Plant– Animal Communication. Oxford University Press, 2011.

EC 305 (AUG) 2:1

Quantitative Ecology: Research Design and Inference

The scientific process in ecology; framing ecological questions; elements of study design; confronting ecological models with data; understanding the nature of data; frequentist, likelihood, and Bayesian frameworks for statistical inference; statistical modeling strategies; model selection and multimodel inference; model validation

Kavita Isvaran

Hilborn, R. and Mangel, M., The Ecological Detective: Confronting Models with Data. Princeton University Press, Princeton, 1997.,Bolker, B., Ecological Models and Data in R, Princeton University Press, Princeton, 2009,Crawley, M.J., The R Book, Wiley, Chichester, 2007

DB 209 (JAN) 2:1

Evolutionary Biology

Natural selection; units of selection; adaptation; speciation; population genetics; drift and the neutral theory; quantitative genetics; molecular phylogenetics; molecular evolution; estimating nucleotide substitutions; homologous sequences; gene trees vs. species trees; Darwinian selection at the molecular level; gene families; applications of molecular phylogenetics

Praveen Karanth

Futuyma, D. J., Evolutionary Biology (Third Edition), Sinauer Associates, 1998.
Li, W.-H. and Graur, D., Fundamentals of Molecular Evolution, Sinauer Associates, 1991.
Hartl, D. L. and Clark, A. G., Principles of Population Genetics, Sinauer Associates, 1997.

EC 201 (JAN) 2:1

Theoretical and Mathematical Ecology

Basic elements of theoretical ecology, building and analyzing mathematical models of ecological systems, generating new ecological insights and hypotheses. Discrete and continuous population models; nonlinear dynamics and bifurcations in ecological models; incorporating stochasticity and space; random walks in ecology and evolution; game theory and ESS; Price equation and levels of selection.

Vishwesha Guttal

Hastings,A.,Population Biology: Concepts and Models,Springer,Turchin

EC 203 (JAN) 2:0

Ecology: Principles and Applications

Earth (geology, geography, climate); ecology and society; evolutionary underpinnings to the ecology of organisms; natural selection and sexual selection; population dynamics; plant–herbivore interactions; predator–prey interactions; competition and coexistence; succession; trophic interactions and trophic cascades; ecosystems; biogeochemical cycles; global change; ecological applications; biodiversity and conservation; quantitative tools (ecological modeling and an introduction to statistics)

Sumanta Bagchi

Begon,M.,C.R. Townsend,and J.L. Harper. Ecology: From Individuals to Ecosystems,(Fourth Edition) Wiley-Blackwell

EC 204 (JAN) 2:1

Evolutionary Biology

Natural selection; units of selection; adaptation; speciation; population genetics; drift and the neutral theory; quantitative genetics; molecular phylogenetics; molecular evolution; estimating nucleotide substitutions; homologous sequences; gene trees vs. species trees; Darwinian selection at the molecular level; gene families; applications of molecular phylogenetics

Praveen Karanth

Futuyma, D. J., Evolutionary Biology (Third Edition), Sinauer Associates, 1998.
Li, W.-H. and Graur, D., Fundamentals of Molecular Evolution, Sinauer Associates, 1991.
Hartl, D. L. and Clark, A. G., Principles of Population Genetics, Sinauer Associates, 1997.

EC 209 (JAN) 2:1

Evolutionary Biology

Natural selection; units of selection; adaptation; speciation; population genetics; drift and the neutral theory; quantitative genetics; molecular phylogenetics; molecular evolution; estimating nucleotide substitutions; homologous sequences; gene trees vs. species trees; Darwinian selection at the molecular level; gene families; applications of molecular phylogenetics

Praveen Karanth K

Futuyma,D. J.,Evolutionary Biology (Third Edition),Sinauer Associates,1998.

Microbiology and Cell Biology

MC 203 (AUG) 3:0

Essentials in Microbiology

Fascinating world of microbes; Principles of microscopy; Microbial taxonomy, Microbial diversity, evolution and genomics; Mechanisms of horizontal gene transfer including genome transplantation, Microbes as model systems of development, Microbes as bioreactors and sensors; bioremediation; bacterial cell structure and function; Bacterial physiology and nutrition; Bacteriophages, Plasmids and Transposons; Understanding and combating bacterial pathogenesis; Antibiotics- mechanisms of drug resistance and mode of action; Quorum sensing and biofilms; Host-pathogen interactions and mechanisms of immune surveillance; PRR and their role in pathogenesis; TH subsets and modulation by pathogens; Diagnostics and vaccine development.

Amit Singh,Balaji Kithiganahalli,Dipshikha Chakrav

Current Opinion in Genetics and Development/ Cell Biology/ Plant Biology; Trends in Genetics / Cell Biology / Biochemistry; Principles of Development by Wolpert and co-authors; Mechanisms in Plant Development by Leyser and Day; Plant Physiology by Taiz and Zeiger; Ecological Developmental Biology by Gilbert and Epel,Current Opinion in Genetics and Development/ Cell Biology/ Plant Biology; Trends in Genetics / Cell Biology / Biochemistry; Principles of Development by Wolpert and co-authors; Mechanisms in Plant Development by Leyser and Day; Plant Physiology by Taiz and Zeiger; Ecological Developmental Biology by Gilbert and Epel,Current Opinion in Genetics and Development/ Cell Biology/ Plant Biology; Trends in Genetics / Cell Biology / Biochemistry; Principles of Development by Wolpert and co-authors; Mechanisms in Plant Development by Leyser and Day; Plant Physiology by Taiz and Zeiger; Ecological Developmental Biology by Gilbert and Epel

MC 205 (AUG) 2:0

Host-Pathogen interactions - Bacteria, Viruses and Protozoan Parasites

Secretion systems of bacteria: Type I, II, III, IV, V. Overview of ABC exporters and importers, plant pathogen interactions, virulence gene expression, intracellular pathogenesis. Pathogen persistence, signaling by bacterial and viral components. Innate and adaptive immunity to bacterial pathogens. Quorum sensing, biofilm formation, and its role in pathogenesis. Viral immune evasion mechanisms such as functional mimicry of host complement proteins, secretion of chemokine and cytokine-like molecules, inhibition of NF-?B and apoptosis, inhibition of serine proteases of the host antigen presenting cells to suppress antigen presentation, inhibition of MHC class I presentation of viral antigens, inhibition of host secretory pathway, prevention of phagosome acidification, antigenic variation and suppression of TH1 responses by protozoan pathogens, role of host TRIM5 family proteins in controlling HIV by mutation of viral RNA, ds-RNA and non-capped 5’ end mediated recognition of pathogens by the host. Viral vectors, vaccines and drugs.

Dipshikha Chakravortty,Vijaya S

David G. Russell and Siamon Gordon, Phagocyte-Pathogen Interactions: Macrophages and the Host Response to Infection, ASM Press, 2009. Knipe, D.M., and Howley, M. (Eds), Fundamental Virology, Lippincott Williams and Wilkins, Fourth Edn. 2001.,David G. Russell and Siamon Gordon, Phagocyte-Pathogen Interactions: Macrophages and the Host Response to Infection, ASM Press, 2009. Knipe, D.M., and Howley, M. (Eds), Fundamental Virology, Lippincott Williams and Wilkins, Fourth Edn. 2001.,David G. Russell and Siamon Gordon, Phagocyte-Pathogen Interactions: Macrophages and the Host Response to Infection, ASM Press, 2009. Knipe, D.M., and Howley, M. (Eds), Fundamental Virology, Lippincott Williams and Wilkins, Fourth Edn. 2001.

MC 206 (AUG) 2:0

RNA BIOLOGY

Biology of RNA, with primary emphasis on eukaryotic systems. Concept of RNA world, chemical aspects of RNAses and their specificities. Types of RNA, transcription mechanisms, coupled transcription and post transcriptional processing, splicing and polyadenylation, post-transcriptional

control mechanisms and mRNA stability, RNA structure and prediction, evolution of RNA sequences, RNA editing, ribozymes, RNA binding proteins, ribonucleoprotein – complexes and functions, RNA-protein recognition and interactions. Techniquesin RNA research. Non-coding RNAs: structure and function. RNA interference: siRNA and miRNAs, role of RNA in protein biosynthesis, translational control of gene expression. RNA viruses: regulation of gene expression. RNA in pathogenesis: its potential use as a drug and as a drug target.

Saibal Chatterjee,Saumitra Das

Gestland, R. F, Cech, T. R, & Atkins J. F., The RNA World. Cold Spring Harbor Press, New York. 3rdEdn, 2006.,Gestland, R. F, Cech, T. R, & Atkins J. F., The RNA World. Cold Spring Harbor Press, New York. 3rdEdn, 2006.,Gestland, R. F, Cech, T. R, & Atkins J. F., The RNA World. Cold Spring Harbor Press, New York. 3rdEdn, 2006.

MC 207 (AUG) 3:0

Molecular Biology

Genome organisation, structure and complexity.Chromatinstructure and remodelling.Protein nucleic acids interactions. DNA replication in prokaryotes and eukaryotes: general rules, mechanisms, andregulation. DNA modifications in epigenetic control of biologicalprocesses.DNA repair and recombination.Mechanisms and machinery of transcription in prokaryotes and eukaryotes.RNA splicing and editing.Catalytic RNAs.Transcriptional and translational regulation of geneexpression.Protein splicing and repair.Small RNAs: biogenesis, and theirmodes of action in regulation of gene expression and chromatin architecture. Group discussions and seminars on current topics in MolecularBiology

Saibal Chatterjee,Umesh Varshney

Lewin's GenesX, Lewin, B., Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. Molecular Biology of The Cell, Fifth edition, Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P.,Lewin's GenesX, Lewin, B., Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. Molecular Biology of The Cell, Fifth edition, Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P.,Lewin's GenesX, Lewin, B., Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. Molecular Biology of The Cell, Fifth edition, Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P.

MC 208 (AUG) 3:0

Principles of Genetic Engineering

Growth and maintenance of bacterio-phages and bacterial strains containing plasmids.Enzymes used in genetic engineering.Vectors used in molecular cloning and expression of genes, promoter analyses, and gene targeting in bacterial, mammalian, human, and plant systems.DNA, RNA, and protein isolation, purification, and fractionation methods. Radioactive and nonradioactive labelling of nucleic acids and proteins, and detection. Nucleic acids hybridisationmethods. Transformation and transfection methods.Geneand cDNA cloning methods.In vitro genome packaging systems and construction of genomic DNA and cDNA libraries.Detection and characterisationmethods for genes and chromosomes.Nucleic acidssequencing methods.Methods for protein analysis, protein-nucleic acid,and protein-protein interactions.Site-specific mutagenesisin vitro and in vivo.Random mutagenesis methods in vitro and in vivo. Genome engineering methods. Polymerase chain reaction (qualitative and quantitative), methods, and applications.Antisense technology and RNA silencing techniques.DNA and Protein microarrays. Methods to generate transgenic animals. Applications of Genetic Engineering Methods in Medicine and Agriculture.

Nagalingam Ravi Sundaresan,Ajit Kumar P

J. Sambrook and D. W. Russell, Molecular Cloning: A Laboratory Manual, 3rdEdn: Vol. I, II, & III, Cold Spring Harbor Laboratory Press. J. J. Greene and V. B. Rao. Recombinant DNA Principles and Methodologies. CRC Press. S. B. Primrose and R. M. Twyman.Principles of Gene Manipulation and Genomics, 7thEdn, Blackwell Publishing. Fred Ausubel and Others. Current Protocols in Molecular Biology. Wiley. Original papers describing the principles and methods.,J. Sambrook and D. W. Russell, Molecular Cloning: A Laboratory Manual, 3rdEdn: Vol. I, II, & III, Cold Spring Harbor Laboratory Press. J. J. Greene and V. B. Rao. Recombinant DNA Principles and Methodologies. CRC Press. S. B. Primrose and R. M. Twyman.Principles of

Gene Manipulation and Genomics, 7thEdn, Blackwell Publishing. Fred Ausubel and Others. Current Protocols in Molecular Biology. Wiley. Original papers describing the principles and methods.,J. Sambrook and D. W. Russell, Molecular Cloning: A Laboratory Manual, 3rdEdn: Vol. I, II, & III, Cold Spring Harbor Laboratory Press. J. J. Greene and V. B. Rao. Recombinant DNA Principles and Methodologies. CRC Press. S. B. Primrose and R. M. Twyman.Principles of Gene Manipulation and Genomics, 7thEdn, Blackwell Publishing. Fred Ausubel and Others. Current Protocols in Molecular Biology. Wiley. Original papers describing the principles and methods.

MC 212 (AUG) 2:0

Advances in Cell Biology

Concepts: Prokaryotic and eukaryotic membrane structure, composition, organization and transport; Organelle structure, function and their biogenesis includes nucleus, endoplasmicreticulum, Golgi, endosomes, lysosomes and lysosome-related organelles,autophagosomes,peroxisomes, mitochondria and chloroplasts; Protein trafficking in-and-out of the organelles; Cytoskeletal elements and organization; Cell adhesion and junctions; Intra and extra cellular signaling;Cell cycle, cell division (asymmetric and symmetric) and stem cells; Cell death and protein homeostasis pathways andCellular diseases. Methods: Introduction and evolution of light microscopy; Electron microscopy; Cytohistochemistry; Flow cytometry; Pulse-chase and subcellular fractionation; Proteomics and Protein-protein interaction approaches and genome-wide RNAi or small molecular screens to study the various cellularpathways

Subba Rao Gangi Setty,Sachin Kotak

Molecular Biology of The Cell, Fifth edition, Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. Physical Biology of the Cell, Second edition, Phillips R., Kondev, J., Theriot, J. and Garcia, H. G. Lewin'sGenesX, Lewin, B., Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T.,Molecular Biology of The Cell, Fifth edition, Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. Physical Biology of the Cell, Second edition, Phillips R., Kondev, J., Theriot, J. and Garcia, H. G. Lewin'sGenesX, Lewin, B., Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T.,Molecular Biology of The Cell, Fifth edition, Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. Physical Biology of the Cell, Second edition, Phillips R., Kondev, J., Theriot, J. and Garcia, H. G. Lewin'sGenesX, Lewin, B., Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T.

MOLECULAR BIOPHYSICS

MB 201 (AUG) 2:0

Introduction to Biophysical Chemistry

Basic thermodynamics, ligand binding and co-operativity in biological systems, kinetics, diffusion and sedimentation.

Raghavan Varadarajan

Tinoco, I., Sauer, K., Wang, J.C., Physical Chemistry, Principles and Applications in Biological Sciences,, Prentice Hall, NJ, 1978. Cantor, C.R., and Schimmel, P.R., Biophysical Chemistry, Vols. I-III, W H Freeman and Co.,,San Francisco, 1980.

MB 204 (AUG) 3:0

Molecular Spectroscopy and its Biological Applications

Principles and biological applications of UV-Vis, fluorescence, vibrational and circular dichroism spectroscopy. Mass spectrometry and basics of one- and two-dimensional NMR spectroscopy with applications to peptide and protein structure determination.

Siddhartha P Sarma

Horst Friebolin, Basic One-and Two-Dimensional NMR Spectroscopy (Fourth Edition), Wiley-VCH. Claridge, T.D., W, High,Resolution NMR Techniques in Organic Chemistry, Volume 27, Second Edition (Tetrahedron Organic Chemistry),(Paperback – Dec 5, 2008).

MB 205 (AUG) 2:0

Introduction to X-ray Crystallography

Crystal symmetry. Symmetry elements and symmetry operations, point groups, lattice space groups. Production and properties of X-rays, diffraction of X-rays by crystals, Laue equations, Bragg's Law, Fourier transformation and structure factor, reciprocal lattice, experimental techniques, rotating crystals and moving film methods. Basic ideas of structure determination, Patterson and Fourier methods, chemical crystallography, structures of organic, inorganic compounds and minerals, powder diffraction.

Kaza Suguna,Aravind Penmatsa

Buerger, M.J., Elementary Crystallography,Woolfson, M.M., An Introduction to X-ray Crystallography,,Stout, H., and Jenson, L.H., X-ray Structure Determination, Macmillian, 1968

MB 206 (AUG) 3:0

Conformational and Structural aspects of biopolymers

Basic ideas on structure and conformation of simple molecules – structural features of proteins and nucleic acids, aspects of biomolecular forces. Higher order structural organization of proteins and nucleic acid.

Srinivasan N,Manju Bansal,Anand Srivastava

Ramachandran, G.N., and Sasisekharan, V., Advances in Protein Chemistry, Vol. 23, Academic Press, p 283, 1968,Leach, A.R., Molecular Modelling: Principles and Applications, Prentice Hall, 2001.,Schulz and Schirmer, Principles of Protein Structure, Springer Verlag, 1979.

MB 209 (AUG) 3:1

Molecular & Cellular Neurophysiology

Membrane components and structures, membrane transport, passive and active electrical properties of the membrane-ionic mechanisms of membrane and action potential, quantifying ionic hypothesis by voltage-clamp technique, Hodgkin Huxley formalism, structure-function aspects of voltage and chemically gated ionic channels, excitatory and inhibitory postsynaptic potentials, patch-clamp technique, recording and analysis of electrophysiological data, measurement of Ca concentrations in single cells, cell membrane capacitance and exocytosis, application of confocal microscopy. Synaptic plasticity, short term and long term potentiation and depression,mechanisms underlying synaptic plasticity, dendritic structure, dendritic ion channels, active properties of dendrites, dendritic spikes and backpropogating action potentials, Intrinsic plasticity, mechanisms underlying intrinsic plasticity.

Rishikesh Narayanan,Sikdar S K

Hille, B., Ionic channels of excitable membranes, Second Edin, Sinauer Associates, Massachussets.,Rudy, B., and Iverson, L.E. (Eds), Methods in Enzymology, 207, 1992.,Kandel, E.R., Schwartz, J.H., and Jessel, T.M., Essentials of Neural Science and Behaviour, Prentice Hall International, 1995.,Cowan,W. M., Sudhof, T.C, Stevens, C.F., Synapses, The John Hopkins University Press, First edition, 2003,Stuart G. Spruston N, Hausser M Dendrities, Oxford University Press, Second Edition, 2008.

MB 208 (JAN) 3:1

Theoretical and Computational Neuroscience

Need for and role of theory and computation in neuroscience, various scales of modelling, ion channel models, single neuron models, network and multi-scale models, models of neural plasticity. Oscillations in neural systems, central pattern generators, single neuron oscillators, network oscillators information representation, neural encoding and decoding, population codes, hierarchy and organization of sensory systems, receptive field and map modelling. Case studies, computational laboratory and projects

Rishikesh Narayanan,Arun P Sripati

Prerequisites: MB209, basic knowledge of linear algebra, probability, statistics and ordinary differential equations, and some programming knowledge.,Dayan, P., and Abbott, L.F., Theoretical Neuroscience: Computational and Mathematical Modeling of Neural Systems, The MIT press, 2005.,Koch, C., and Segev, I. (Eds), Methods in Neuronal Modeling: From Ions to Networks, The MIT press, Second Edn, 1998. Eric De Schutter (ed.), Computational modeling methods for neuroscientists, The MIT press, 2009. Eugene Izhikevich, Dynamical systems in neuroscience: The geometry of excitability and bursting, The MIT press, 2006. Doya, K., Ishii, S., Pouget, A., Rao, R.P.N. (Eds), Bayesian Brain: Probabilistic Approaches to Neural Coding, The MIT press, 2007.

MB 210 (JAN) 2:0

Peptides and Drug-Design

Organic reaction mechanisms; acids and bases; synthesis and properties of alpha, beta and gamma amino acids; conventional and contemporary ways of peptide and protein synthesis; synthesis and properties of cell-penetrating peptides; design of peptide mimics for drug-discovery,

chemical genetics screening.

Jayanta Chatterjee

a. Norbert Sewald and Hans-Dieter Jakubke, Peptides: Chemistry and Biology, Second Edition, Wiley-VCH Verlag GmbH & Co. KGaA,2009.,Miguel Castanho and Nuno C. Santos (Eds), Peptide Drug Discovery and Development: Translational Research in Academia and Industry, Wiley-VCH Verlag GmbH & Co. KGaA,2009,Selected review articles.

MB 211 (JAN) 3:1

Multiscale Theory and Simulations of Biomolecular Systems

Theoretical and computational aspects of various advance sampling and free energy calculation methods (maximum work theorem, Jarzinsky equality, umbrella sampling, replica exchange, metadynamics, markov state model, etc).Continuum representation of solvent and calculation of electrostatic and non-electrostatic component of solvation free energy. Method development and application of multiscale coarse-graining methods such as force-matching, elastic network models, Inverse-Boltzmaan's method and relative entropy methods.

Anand Srivastava

Basic knowledge in statistical mechanics, thermodynamics and molecular simulation (and/or basic exposure to biomolecule conformations) Working knowledge of any one molecular dynamics tool. Books and references a. Michael P. Allen and Dominic J. Tidesley, Computer Simulation of Liquids (Oxford Science Publications), 1981 b. Andrew Leach, Molecular Modeling: Principles and Application(Princet Hall), 2001.,c. Christophe Chipot (Ed.) and Andrew Pohorille (Ed.), Free Energy Calculations (Springer), 2008 d. Gregory A. Voth (Ed.), Coarse-Graining of Condensed Phase and Biomolecular Systems (CRC Press), 2008 e. Mark Tuckerman, Statistical Mechanics: Theory and Molecular Simulation (Oxford Graduate Texts), 2010,f. Ken Dill and Sarina Bromberg, Molecular Driving Forces: Statistical Thermodynamics in Biology, Chemistry, Physics, and Nanoscience (Taylor and Francis), 2010 g. Gregory R. Bowman (Ed.), Vijay S. Pande (Ed.) and Frank Noé (Ed.), An Introduction to Markov State Models and Their Application to Long Timescale Molecular Simulation: Advances in Experimental Medicine and Biology (Springer),2013

MB 212 (JAN) 2:0

Electron microscopy and 3D image processing for Life Sciences

Objectives and basic working principles of different types of microscopes. Different types of electron microscopies and their applications.Basic introduction of electron microscopy physics and optics. Principles of image formation, Fourier analysis, Contrast Transfer Function and point spread function (electron scattering, phase contrast, electron–specimen interactions, electron diffraction). Characteristics of various advanced sample preparation, imaging, data collection techniques of bio-molecules for negative staining and cryo-electron microscopy. Theoretical, computational and practical aspects of various advanced 3D image processing techniques for all kinds of EM data (Random Conical Tilt Pair, Orthogonal Tilt pair, Single Particle Analysis, Subtomogram averaging). Cryo-EM map interpretation and data analysis, validation, molecular docking (use of Chimera, VMD) and application of Molecular Dynamics Flexible Fitting (MDFF)

Somnath Dutta

Basic knowledge in differential calculus, matrix, probability theory, basic physics like optics, light, modern physics, wave nature of electrons, electron physics, some programming knowledge and familiarity with Linux.,1. John J. Bozzola and Lonnie D. Russell (1992). Electron Microscopy (Jones & Bartlett Publishers). 2. Ray F. Egerton (2005). Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM (Springer). 3. Elaine Evelyn Hunter and Malcolm Silver (1993). Practical Electron Microscopy: A Beginner's Illustrated Guide (Cambridge University). 4. Ludwig Reimer and Helmut Kohl (2008). Transmission Electron Microscopy: Physics of Image Formation (Springer).,5. John Kuo (2007). Electron Microscopy: Methods and Protocols (Methods in Molecular Biology) (Humana). 6. Earl J. Kirkland (2014). Advanced Computing in Electron Microscopy (Springer). 7. Gabor T. Herman and Joachim Frank (2014). Computational Methods for Three-Dimensional Microscopy Reconstruction (Birkhäuser Basel). 8. Joachim Frank (2006). Electron Tomography, (New York, Springer). 9. Joachim Frank (2006).,Three-Dimensional Electron Microscopy of Macromolecular Assemblies (New York, Oxford U. Press). 10. Joachim Frank (1996). Three-dimensional Electron Microscopy of Macromolecular Assemblies (San Diego, Academic Press).

MB 303 (JAN) 3:0

Elements of Structural Biology

Methods for determining the three dimensional structures of biological macromolecules by X-Ray Crystallography. Biophysical methods to understand structures of proteins and protein-DNAcomplexes.

Balasubramanian Gopal

Kensal, E. Van Holde et al., Principles of Physical Biochemistry, Second Edn, Pearson Education Intl.,Cantor, C.R., and Schimmel, P.R., Biophysical Chemistry, Vols. I-III, W H Freeman and Co., San Francisco, 1980.,Research papers and reviews

MB 305 (JAN) 3:0

Biomolecular NMR Spectroscopy

Basic theory of NMR spectroscopy. Classical and theoretical descriptions of NMR spectroscopy. Product operator formalism for description of multi-pulse homo-nuclear and hetero-nuclear NMR experiments. Multidimensional NMR spectroscopy, description of basic homo-nuclear 2D NMR experiments useful for structure determination of biological macro-molecules. Experimental aspects of homo-nuclear NMR spectroscopy: data acquisition, processing and interpretation of 2D homo-nuclear spectra. Principles of hetero-nuclear NMR spectroscopy. Analysis of 3D and 4D hetero-nuclear isotope edited NMR pulse sequences. Introduction to relaxation and dynamic processes (chemical and conformational processes) that affect NMR experiments.

Siddhartha P Sarma

Cavanaugh, J., Fairbrother, W.J., Palmer, III, A.G., and Skelton, N.J., Protein NMR Spectroscopy – Principles and Practice, Academic Press, 1995.,Levitt, M., Spin Dynamics, John Wiley, 2000,Wuthrich, K., NMR of Proteins & Nucleic Acids, John Wiley, 1986.

Molecular Reproduction Development and Genetics

RD 201 (AUG) 2:0

Genetics

Transmission and distribution of genetic material, dominance relations and multiple alleles, gene interaction and lethality, linkage and recombination, sex linkage, gene mapping, introduction to molecular genetics, genetics of regulation, maternal effects and cytoplasmic heredity, elements of developmental and population genetics.

Mahadevan S

Genetics 3rd edition by M. Strickberger,Molecular Genetics 2nd edition by G. Stent and R. Calendar,Genetic Switch 2nd edition by M. Ptashne

RD 204 (AUG) 2:0

Principles of Signal Transduction in Biological Systems

The course will cover principles of signal transduction and aspects of systemic evaluation of signaling pathways. Detailed analysis of receptors, second messengers and ion channels in various organisms; Methods and techniques of studying signal transduction pathways; signal transduction in bacterial systems and in higher mammalian systems; Mammalian signal transduction mechanisms i GPCRs signaling, MAP kinases, protein kinases, second messenger generating systems, ion channels and other signaling cascades; proteins scaffolding and cellular context will be covered. The course will also cover aspects of studying signal transduction events in living systems using modern microscopic techniques and hos spatio-temporal dynamics of signaling pathways regulate cellular physiology. Genetic analysis of signalling pathways in model organisms.

Deepak Kumar Saini,Ramray Bhat

Molecular Biology of the Cell by Alberts B et al., 5th Edition,Biochemistry of Signal Transduction and Regulation, Krauss G, 5th Edition,Cell Signaling, Lim W et al, 1st Edition

RD 205 (JAN) 2:0

Human Molecular Genetics

Human chromosomes, clinical cytogenetics, tools of human molecular genetics, organization of human genome, pattern of Mendelian inheritance, genomic imprinting, uniparental disomy and human genetic disorders, X-inactivation, genetic variation, polymorphism and mutation, gene mapping and linkage analysis, biochemical basis of genetic diseases, genetics of cancer, genetic counseling, prenatal diagnosis

Arun Kumar

Human Molecular Genetics by Tom Strachan & Andrew P Read,Thompson & Thompson Genetics in Medicine by RL Nussbaum, RR McInnes & HF Willard,Human Genetics: Problems & Approaches by F Vogel & AG Motulsky

RD 206 (JAN) 2:0

Molecular Oncology

Introduction to cancer biology. Immortalization, transformation, metastasis. Causes of cancer,

initiators and promoters, carcinogens, tumor viruses, sporadic and familial cancer. Genetic alterations in cancer. Molecular mechanisms of carcinogenesis: cell culture and animal models. Cancer as a tissue: angiogenesis, role of stroma. Cell cycle and cancer: cell cycle checkpoints, cyclins and cyclin dependent kinases, CDK inhibitors. Oncogenes: growth factors, growth factor receptors, G protein/signal transduction, tyrosine and serine/threonine kinases and transcription factors. Tumor suppressor genes. Mismatch repair, telomerase, DNA methylation, protein phosphorylation/dephosphorylation and degradation events. Transformation by RNA and DNA tumor viruses: adenovirus, simian virus 40 and human papilloma virus, oncogene-tumor suppressor interactions. Apoptosis and cancer. Cancer and stem cells

Annapoorni Rangarajan,Kumaravel Somasundaram

Weinberg, R., 2013. The biology of cancer. Garland science. (Book),Hanahan, D. and Weinberg, R.A., 2011. Hallmarks of cancer: the next generation. Cell, 144(5), pp.646-674. (review article),Pecorino, L., 2012. Molecular biology of cancer: mechanisms, targets, and therapeutics. Oxford university press.

RD 209 (JAN) 2:0

Molecular basis of ageing and regeneration

Mechanisms of Ageing and Regeneration, Model systems for Regeneration; Role of cellular process such as transcription, translation, posttranslational modifications, Signalling mechanisms; neurogenesis, Cellular senescence; Model systems for studying Ageing; Genetic basis if Ageing and longevity; Ageing and diseases; immunosenescence and inflammation, Organ Senescence; Obesity/Diabetes/Cardiovascular diseases/Muscle degeneration; Interventions to delay ageing and/or enhance life span (caloric restriction)

Purusharth Rajyaguru,Nagalingam Ravi Sundaresan,Varsha Singh

Principles of Regenerative Biology by Bruce Carlson.,Regeneration - Developmental Biology by Scott F Gilbert (6th Edition).,Handbook of the Biology of Ageing, Seventh Edition, by Edward J Masoro (Editor), Steven N. Austad (Editor) 2010.,Molecular Biology of Ageing (Cold Spring Harbor Monograph Series), by Leonard Guarente, 2007.,Biology of Ageing: Observations and Principles of Robert Arking, 2006.

RD 210 (JAN) 2:0

Fundamentals of Physiology and Medicine

Introduction to anatomy, histology, evolutionary medicine and clinical examinations, general human embryology, physiological and pathological aspects of cardiovascular system, respiratory system, renal system, alimentary system, Endocrine system.

Ramray Bhat,Sandeepa M Eswarappa

Ganong's Medical Physiology, 23rd Edition,Junqueira's Basic Histology, 13th Edition,Robbins Basic Pathology, 9th Edition

Neuroscience

NS 201 (AUG) 3:0

Fundamentals of Systems and Cognitive Neuroscience

Biophysics of action potentials, brain imaging, sensation and perception, attention, motor systems and executive control, insect and animal behavior

Aditya Murthy,Arun P Sripati,Supratim Ray,Sridhar

None,None,None

NS 202 (AUG) 3:0

Fundamentals of Molecular and Cellular Neuroscience

Molecular basis of neuronal development, neuronal transmission, synaptic organisation and its relationship to synaptic physiology, small animal behavior, learning and memory and neurological disorders.

Balaji J,Deepak Kumaran Nair

None,None,None

NS 204 (AUG) 0:1

Neuroscience Practicum 1

Laboratory experience to enable the student gain exposure to research....

Deepak Kumaran Nair,Sridharan Devarajan

Registration open to CNS First Year graduate students only,None,None

NS 203 (JAN) 3:0

Optical Spectroscopy and Microscopy

Transition probabilities; Time dependent perturbation theory; Interaction with strong fields, Second Quantization; Origin of Spontaneous emission; characteristics of stimulated emission; Absorption and emission. Emergence of biophysical methods such as CD, Fluorescence spectroscopy, Energy transfer and other such methods from the above principles. Non-linear optics ; Lasers; Pulsed and CW lasers; Multi photon excitation; optical microscopy; diffraction limit; principles of laser scanning microscopes; photo detection; optical microscope in bits and pieces.

Balaji J

None,None,None

NS 301 (JAN) 2:0

Topics in Systems and Cognitive Neuroscience

Sensory encoding, perception and object recognition, attention, decision making. Movement planning, cognitive control.

Aditya Murthy,Arun P Sripati,Supratim Ray,Sridhar

NS201,None,None

NS 302 (JAN) 2:0

Topics in Molecular and Cellular Neuroscience

Cell fate specification, axonal path-finding, signaling in the nervous system, synaptic transmission, learning and memory and neurobiology of psychiatric and neurological disorders.

Balaji J,Narendrakumar Ramanan,Deepak Kumaran Nair

NS202,None,None

Division of Chemical Sciences

Preface

The division of Chemical Sciences comprises of the departments of Inorganic and Physical Chemistry (IPC), Materials Research Centre (MRC), NMR Research Centre (NRC), Organic Chemistry (OC) and Solid State and Structural Chemistry Unit (SSCU). Students with a basic/advanced degree in Chemistry, Physics or several branches of engineering are eligible for admission to the doctoral program in the division. In addition, the division also admits B.Sc. graduates to the Integrated PhD program. Since 2011, the division is also actively engaged in the four-year Bachelor of Science (Research) program and has introduced several courses at the undergraduate level.

The courses offered by various departments carry a two-letter departmental code that is followed by a three digit number; of which, the first digit refers to the course level. In addition, courses offered to the Integrated PhD students are listed separately with another code. The courses offered by the different departments have been grouped as follows:

CD	Integrated Ph D
IP	Inorganic and Physical Chemistry
MR	Materials Research Centre
OC	Organic Chemistry
SS	Solid State and Structural Chemistry

Each department/centre/unit offers courses on several basic as well as specialized topics designed to provide students with a sound foundation in both theoretical and experimental aspects. There are specified requirements for completing the research training programme (RTP) for students registering under different streams at the Institute. For details concerning these requirements, students are advised to approach the department Chairman or the Departmental Curriculum Committee.

The Department of Inorganic and Physical Chemistry provides training in several contemporary areas of theoretical and experimental research covering all aspects of modern Inorganic and Physical Chemistry. The programme of instruction consists of class lectures, laboratory work and student seminars.

The Materials Research Centre provides students opportunity to learn and train on several modern sophisticated instrumental facilities for the materials preparation, device fabrication and materials and device characterization. The Centre offers courses in various aspects of theoretical and experimental Material Science and on modern materials characterization techniques.

The Department of Organic Chemistry offers courses at both the fundamental and advanced levels in Organic Chemistry, in addition to courses on advanced special topics. The students also undergo training in advanced laboratory methods and are expected to give seminars on contemporary research topics.

The Solid State and Structural Chemistry unit offers several courses in frontier areas of Solid State Chemistry and Surface Sciences, besides basic and advanced courses in Chemical Physics; students of the department will have an opportunity to work in all major topics in solid state chemistry and physics.

The NMR Research Centre houses several modern NMR spectrometers; courses are offered at various levels, both on basic and advanced topics. In addition, the center also organizes workshops and symposia in the area of Nuclear Magnetic Resonance. In addition, it provides research facilities in the area of NMR to scientists from all over the country.

Prof. P K Das,
Chairman
Division of Chemical Sciences

Integrated PhD (Chemical Sciences)

Course Work

Core Courses

I Semester

CD 204 3:0	Chemistry of Materials
CD 211 3:0	Physical Chemistry-I
CD 212 3:0	Inorganic Chemistry
OC 213 3:0	Organic Chemistry
CD 214 3:0	Basic Mathematics
CD 215 0:4	General Chemistry Lab. (Organic & Inorganic)

II Semester

CD 221 3:0	Physical Chemistry II
CD 222 3:0	Material Chemistry
CD 223 3:0	Organic Synthesis
CD 224 2:1	Computers in Chemistry
CD 225 0:4	Physical and Analytical Chemistry Lab

III Semester (optional)
16 Credits of optional courses to be taken from any of the five Departments in consultation with the Ph. D. Supervisor.

IV Semester
CD 241 : 0:14 Research Project Six credits of optional courses in consultation with Ph. D. Supervisor.

CD 204 (AUG) 3:0

Chemistry of Materials

Aspects of crystal chemistry (lattices, unit cells, symmetry, point groups and space groups etc), packing, bonding and description of crystal structures, Pauling rules, crystallographic methods, defects in solids, electronic structure, magnetism, phase transitions, framework solids, ionic solids and synthesis of solids.

Natarajan S,Vasudevan S

C.N.R. Rao and J. Gopalakrishnan, New directions in solid state chemistry,A.R. West, Solid State Chemistry and its applications,A.F. Wells, Structural Inorganic Chemistry,L. Smart and E. Moore, Solid state chemistry : An introduction

CD 211 (AUG) 3:0

Physical Chemistry – I Quantum Chemistry and Group Theory

Postulates of Quantum Mechanics and introduction to operators; Wave Packets, Exactly solvable problems Perturbational, Variational, and WKB Methods; Angular Momentum and Rotations, Hydrogen Atom, Zeeman and Stark effects, Many electron Atoms, Slater determinants, Hartree-Fock Variational Method for atoms; Symmetry and Group theory, Point Groups, Reducible and Irreducible Representations (IR), Great Orthogonality theorem, Projection operators, Applications to molecular orbitals and normal modes of vibration and selection rules in spectroscopy

Upendra Harbola,Aninda Jiban Bhattacharyya

I. Levine, Quantum Chemistry,D. Griffiths, Introduction to Quantum Mechanics.,F. A. Cotton, Chemical Applications of Group Theory

CD 212 (AUG) 3:0

Inorganic Chemistry – Main group and coordination chemistry

Main group: hydrogen and its compounds – ionic, covalent, and metallic hydrides, hydrogen bonding; chemistry of lithium, beryllium, boron, nitrogen, oxygen and halogen groups; chains, rings, and cage compounds; Coordination chemistry: bonding theories (revision and extension), spectral and magnetic properties; inorganic reactions and mechanisms: hydrolysis reactions, substitution reactions trans-effect; isomerization reactions, redox reactions; metal-metal bonding and clusters; mixed valence systems; chemistry of lanthanides and actinide elements

Jemmis E.D,Chakravarty A R

Shriver D.F, Atkins P.W. and Langford C.H., Inorganic Chemistry, Freeman, NY, 1990.,Cotton F.A. and Wilkinson G. Advanced Inorganic Chemistry, 5th edition, John Wiley, NY, 1987.,Huheey J.E., Inorganic Chemistry, Principles of Structure and Reactivity, Harper International, 3rd edition. 1983.

CD 213 (AUG) 3:0

Organic Chemistry – Structure and Reactivity

Stereochemistry and conformational analysis. Methods of deducing organic reaction mechanisms, Hammond postulate, Curtin-Hammett principle, linear free energy relationships; Hammett equation; kinetic isotope effects. Electronic effects in organic compounds, aromaticity, frontier orbital theory, steric effects;organic transformations and molecular rearrangements; reactive intermediates, classical and nonclassical carbocations, carbanions, free radicals, carbenes, nitrenes, arynes, radical ions, diradicals, concerted reactions, Woodward-Hoffman rules.

Uday Maitra,Sosale Chandrasekhar

Anslyn, E.V., and Dougherty, D.A., Modern Physical Organic Chemistry, University Science Books, 2006.,Smith, M. B., March J., March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, 6th ed. Wiley, 2007.,Carey F.A., and Sundberg R.J., Advanced Organic Chemistry, Part A. 5th ed. Plenum, 2007.,Lowry T.M. and Richardson K.S., Mechanism and Theory in Organic Chemistry, 3rd ed, Addison-Wesley-Longman, 1998.,Current literature.

CD 214 (AUG) 3:0

Basic Mathematics

Differentiation and integration: different methods of evaluating integrals, multi-dimensional integrals, numerical integration. Vectors: gradient, divergence, dash and curl and their physical significance. Matrices: eigen values and eigen vectors. Complex variables: Cauchy-Reimann conditions, Cauchy's theorem, Cauchy's integral formula. Differential equations: differential equations of quantum chemistry and chemical kinetics, numerical solutions of differential equations. The Dirac delta function, the gamma and error function. Function spaces, orthonormal functions, Fourier series, Fourier and Laplace transforms, fast Fourier transforms.

Hanudatta S Atreya,Upendra Harbola

Thomas, G. B., Finney, R.L., Calculus and Analytical Geometry, Narosa Publishing. 1984.,Arfken, G. B. and Weber, H.J., Mathematical Methods for Physicists, Prism Indian Edition, 1995.,Keryszig, E., Advanced Engineering Mathematics, Wiley Eastern Limited, 1983

CD 215 (AUG) 0:4

Organic & Inorganic Chemistry Laboratory

Common organic transformations such as esterification, Diels-Alder reaction, oxidation-reduction, Grignard reaction, etc. Isolation and purification of products by chromatographic techniques, characterization of purified products by IR and NMR spectroscopy. Synthesis of coordination complexes, preparation of compounds of main group elements, synthesis of organo-metallic complexes. Physico-chemical characterization of these compounds by analytical and spectroscopic techniques.

Jayaraman N,Geetharani K,Natarajan S

...,...,....

CD 221 (JAN) 3:0

Physical Chemistry II: Statistical Mechanics

Review of thermodynamics, postulates of statistical mechanics, ensembles, classical and quantum statistics. Application to ideal gas, rotational and vibrational problems, black body radiation, electron conduction in metals, specific heats of solids, classical fluids, and phase transitions.

Govardhan P Reddy

E. Fermi, Thermodynamics,H.B. Callen, Thermodynamics and Introduction to Thermostatistics,D.A. MacQuarrie, Statistical Mechanics,D. Chandler, Introduction to Modern Statistical Mechanics

CD 222 (JAN) 3:0

Material Chemistry

Structure of solids, symmetry concepts, crystal structure. Preparative methods and characterization of inorganic solids. Crystal defects and non-stoichiometry. Interpretation of phase diagrams, phase transitions. Kinetics of phase transformations, structure property correlations in ceramics, glasses, polymers. Composites and nano-materials. Basics of magnetic, electrical, optical, thermal and mechanical properties of solids.

Karuna Kar Nanda,Prabeer Barpanda

A.R. West, Solid State Chemistry and its Applications John Wiley and Sons, 1984.,J.F. Shackelford, Introduction to Materials Science for Engineers, MacMillan, 1988.,....

CD 223 (JAN) 3:0

Organic synthesis

Principles of selectivity and reactivity in the use of reagents for oxidation, reduction and bond forming reaction. Planning a synthesis, antithetic analysis, synthons, linear and convergent synthesis.

Jayaraman N,Tushar Kanti Chakraborty

Warren S., Designing Organic Synthesis, 1978,Carruthers W. S., Some Modern Methods of Organic Synthesis 3rd edition, Cambridge University Press, 1986.,Carery, F. A. and Sundberg, R. J., Advanced organic chemistry, Part B, 2nd ed., Plenum, 1984,House, Modern Synthetic Reactions, 1972.,Fuhrhop J. and Penzilin G., Organic Synthesis - Concepts, Methods, Starting Materials, Verlog Chemie 1983.

CD 224 (JAN) 2:1

Computers in Chemistry

Basic programming in Python using simple examples. Numerical methods: interpolation, numerical integration and differentiation, Gaussian quadrature, basic linear algebra, eigensolutions, linear and non-linear data fitting, solutions of ODEs.

Sai G Ramesh

Any accessible book on numerical methods.

CD 225 (JAN) 0:4

Physical and Analytical Chemistry Laboratory

Langmuir adsorption, chemical analysis by potentiometry, conductometry and iodometry methods, pH-metry, cyclic voltammetry, flame photometry, electronic states by uv-visible spectroscopy, IR spectroscopy, solid state chemistry – synthesis of solids and chemical analysis, X-ray diffraction.

Aninda Jiban Bhattacharyya,Shivakumara C,Sampath S

(a) Vogel, A.I, Vogel's text book of quantitative chemical analysis Longman 1989.,(b) David R Shoemaker, Carl W. Garland and Nibler J.W., Experiments in Physical Chemistry, McGraw-Hill International Edition, 1989.,(c) Relevant literature from Chemical Education (ACS Publications) and other pedagogic Chemistry Journals

CD 301 (JAN) 3:0

Advanced NMR Spectroscopy

Basic principles of two-dimensional (2D) NMR spectroscopy, 2D line shapes, phases and filtering. Resolved 2D spectroscopy. Correlated 2D experiments (COSY, TOCSY, etc.) involving homo-nuclear and hetero-nuclear correlations. 2D multiple-quantum spectroscopy, 2D relaxation experiments (NOESY, ROESY). Multinuclear 2D and 3D experiments such as HSQC, HMQC, HNCA and HNCA (CO) etc. Introduction to coherence level diagram, product operator formalism, phase cycling and gradient-enhanced spectroscopy. Two-dimensional NMR of solids. NMR imaging. Applications of two and three-dimensional NMR experiments for structure determination of large molecules.

Hanudatta S Atreya,Suryaprakash N,Raghothama S

W. R. Croasmun and R. M. K. Carlson, Two -Dimensional NMR Spectroscopy - Applications for Chemists and Biochemists, VCH, 1987.,.....,.....

Inorganic and Physical Chemistry

IP 203 (AUG) 3:0

Group Theory and Molecular Spectroscopy

Group theory: Symmetry elements, point groups, representation theory, great orthogonality theorem, SALCs. Time-dependent perturbation theory, light-matter interaction. H-like atoms, angular momenta and selection rules of transitions, multi-electon atoms, term symbols, spin-orbit coupling, Zeeman and linear Stark effects. Rotations and vibrations of diatoms, anharmonic effects, selection rules, electronic structure. Rotations and vibrations of polyatomic molecules, various tops and their properties, normal modes of vibration, selection rules, electronic states and transitions

Atanu Bhattacharya

Levine, I, Molecular Spectroscopy Struve, W. S. Fundamentals of molecular spectroscopy Bernath, P. F. Spectra of atoms and molecules (2nd Ed.) Cotton, F. A. Chemical applications of group theory,-,-

IP 214 (AUG) 2:1

Crystallography for Chemists

Crystal symmetry. Generation and properties of X-rays. Diffraction theory, reciprocal lattice. Experimental aspects. Rotation, Weissenberg precession and diffractometer techniques. Structure factor equation. Electron density function. Phase problem. Structure solution. Introduction to direct methods. Refinement. Absolute configuration, molecular interactions, solid state reactions. Chemical reaction paths. Electron density studies. Experiments on structure solution related problems. Crystal symmetry. Generation and properties of X-rays. Diffraction theory, reciprocal lattice. Experimental aspects. Rotation, Weissenberg precession and diffractometer techniques. Structure factor equation. Electron density function. Phase problem. Structure solution. Introduction to direct methods. Refinement. Absolute configuration, molecular interactions, solid state reactions. Chemical reaction paths. Electron density studies. Experiments on structure solution related problems.

Nethaji M

Taylor C.A. A nonmathematical introduction to X-ray diffraction. Stout G. and Jensen L.H., X-ray structures determination. Buerger M.J., X-ray Crystallography.,-,-

IP 311 (AUG) 3:0

Bio and Medicinal Inorganic Chemistry

Principles of biochemistry and molecular biology, role of metal ions in biology, principles of coordination chemistry, amino acids and other bioligands, proteins – secondary and tertiary structure, nucleic acids, iron proteins, iron transport, role of zinc in biology – zinc enzymes, biological importance of nickel, copper proteins, redox reactions involving manganese, biological roles of vanadium, cobalt and molybdenum, basic concepts in drug design, metals and health - metal-based drugs and mechanism of their action, metalloproteins as drug targets.

Mugesh G

Lippard S.J. and Berg, J.M., Principles of Bioinorganic Chemistry, University Science Books, California, 1994. Kaim, W.; Schwederski, B. Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life, Wiley, 1991 Gielen, M.; Tiekink, E. R. T. Eds. Metallotherapeutic Drugs and Metal-Based Diagnostic Agents: The Use of Metals in Medicine, Wiley, 2005,-,-

IP 312 (AUG) 3:0

Advanced Organometallic Chemistry

Structure and bonding in organometallic compounds – isolobal analogies, metal carbonyls, carbenes and NHC complexes, olefin and acetylene complexes, alkyls and allyl complexes, metallocenes. Major reaction types – oxidative addition, reductive elimination, insertion, isomerization and rearrangement reactions. Catalytic reactions: metathesis, hydrogenation, allylic activation, C-C coupling reactions, C-X coupling etc.

Balaji R Jagirdar

Elschenbroich, Ch. Organometallics, 3rd edition, Wiley-VCH, Weinheim, 2005. Gupta, B. D.; Elias, A. J. Basic Organometallic Chemistry: Concepts, Syntheses and Applications (Second Edition), 2013.,-,-

IP 313 (JAN) 3:0

Electrochemical Energy Conversion and Storage

Electrochemical energy systems. Batteries, fuel cells and electrochemical capacitors. Fundamentals and applied aspects. Primary and secondary batteries. Polymer electrolyte membrane fuel cells, solid oxide fuel cells etc. Double layer- and pseudo- capacitors. Integration of electrochemical energy storage systems with other devices.

Sampath S,Prabeer Barpanda

B E Conway, Electrochemical Supercapacitors: Fundamentals and Applications, Kluwer, 1999. C A Vincent and B Scrosati, Modern Batteries, Butterworth-Heinemann 1997. T J Crompton, Battery Reference Book, Elsevier, 2000. Sammes Nigel, Fuel Cell Technology, Springer, 2006.,-,-,-,-

IP 314 (JAN) 3:0

Ultrafast Optics and Spectroscopy in Physical Chemistry

Plane wave and phase velocity, Representation of short pulses in time and frequency domain, General construction of laser, Ultrafast Laser System: Oscillator and Amplifier, Gaussian Beam characteristics, Polarization and Birefringence in ultrafast optics, Pulse Measurements in frequency and time domains, Nonlinear Ultrafast Optics: second order, third order, higher order, Dispersion in Ultrafast Optics, Ultrafast Spectroscopy, Ultrafast Dynamics through Conical Intersections, Ultrafast Processes in gas, liquid, and solids.

Atanu Bhattacharya

Ultrafast Optics by Andrew Weiner, Wiley. • Ultrafast Optics Online Book by Rick Trebino (Georgia Institute of Technology) • Modern Optics by Robert Guenther, John Wiley and Sons • Introduction to Modern Optics, Grant R. Fowles, Dover Publications.,-,-,-,-

IP 322 (JAN) 3:0

Polymer Chemistry

Concepts and terminology. Principles of polymerization – chain versus step growth process. Kinetics of chain polymerization process, estimation of various rate constants. Determination of molecular weight of polymers and their distribution.Solution properties and chain dimension. Characteristics and mechanisms of various chain polymerizations – radical, cationic, anionic, Ziegler-Natta and ring

opening metathesis polymerizations. Living polymerizations – criteria for livingness, newer methods for living polymerizations – GTP, ATRP and TEMPO-mediated radical polymerizations. Copolymerization – random, alternating and block copolymers and kinetic schemes for analysis of copolymerization. Micro-structural analysis of polymers by NMR – estimation of regio- and stereo-regularity in polymers, sequence distribution in copolymers etc., and mechanisms for stereo-regulation.

Ramakrishnan S

Flory P.J., Principles of Polymer Chemistry Odian G., Principles of Polymerization. Paul C Hiemenz and Timothy P Lodge, Polymer Chemistry,-,-,-,-

IP 323 (JAN) 3:0

Topics in Basic and Applied Electrochemistry

Electrode kinetics and electrochemical techniques: polarizable and non-polarizable interfaces; current-potential relationship; methods of measurement of kinetic parameters; over potential; symmetry factor and transfer coefficient; mechanistic criteria; diffusion, activation phenomena. Steady state and potential step techniques; polarography; cyclic voltammetry; chrono- methods; convective diffusion systems: rotating disc and ring disc electrodes; microelectrodes; AC impedance techniques - concepts and applications. Applied topics: fundamentals of batteries: primary, secondary, reserve batteries; solid state and molten solvent-batteries; fuel cells. Photo-electrochemical solar cells and conversion of solar energy. Corrosion – fundamentals and applications.

Sampath S

Bard A.J. and Faulkner L.R., Electrochemical methods: Principles and Applications, Wiley 1990. Greef R., Peat R., Peter L.M., Pletcher D. and Robinson J. (Southampton Electrochemistry Group), Instrumental Methods in Electrochemistry, Ellis Harwood Ltd., 1985. Gileadi E., Electrode Kinetics for Chemists, Chemical Engineers and Material Scientists, VCH 1993. Vincent C.A., Modern Batteries, Edward Arnold, UK 1984. Nozik A.J., Photoeffects at semiconductor-electrolyte interfaces, ACS, Washington 1981.,-,-

IP 324 (JAN) 3:0

Photophysics and Photochemistry: Fundamentals and Applications

Fundamental concepts in Photophysics and photochemistry, time dependent processes (milli seconds to femtoseconds), excited states, energy transfer, relaxation phenomena, time resolved experimental methods such as absorption, fluorescence, infrared and Raman, examples with applications in chemistry and biology.

Siva Umapathy

N.J.Turro, Modern Molecular Photochemsitry J.N.Demas, Excited State Lifetime Measurements,-,-

Materials Research

MR 203 (AUG) 3:0

Introduction to Biometerials

Basic concepts in biomaterials science. Salient properties of important material classes; concept of biocompatibility, host response, structure-property of biological cell; structure and properties of cells, protein and cellular adaptation process; various cell fate processes, cell-material interaction, Assessment of biocompatibility of biomaterials, Structure and properties of bone as well as in vivo testing and histocompatibility assessment, examples of some important metallic biomaterials, bio-ceramics and bio-composites

Bikramjit Basu

Basu B,Katti D and Kumar A,: Advanced Biomaterials: Fundamentals,Processing and Applications; John Wiley & Sons,Inc.

MR 301 (AUG) 3:0

Quantum Mechanical Principles in Materials

Basics of quantum mechanics (atoms to materials). Classification of materials based on quantum mechanical principles. Classical and quantum mechanical treatment of lattice vibrations. Quantum mechanical treatment of electrical, optical and thermal properties of materials. Semiconductors, superconductors, foundations of magnetism, magnetic phenomena and their interpretation (classical and quantum mechanical approach).

Abhishek Kumar Singh

Claude Cohen-Tannoudji, Bernard Diu, Frank Laloe. Quantum Mechanics (2 vol. set), John Wiley & Sons,Charles Kittel., Introduction to Solid State Physics, John Wiley and Sons,Neil W. Ashcroft, and David Mermin N., Solid State Physics, Brooks/Cole,Brandt and Dahmen. The Picture Book of Quantum Mechanics,Stephen Elliott, The Physics and Chemistry of Solids

MR 303 (AUG) 3:0

Nanomaterials Synthesis and Devices

Introduction to nanoscience and nanotechnology. Surfaces, interfaces and characterization techniques. Chemical and physical methods of synthesizing nanomaterials (0D, 1D & 2D), Growth mechanisms and growth kinetics, Size-dependent properties of nanomaterials, Applications in catalysis, gas sensing, photodetection and white light emission, Applications in Devices such as linear, rectifier, FET, etc.

Balaram Sahoo,Karuna Kar Nanda

Markov I. V., Crystal Growth for Beginners, Fundamentals of Nucleation, Crystal Growth and Epiaxy, World Scientific, 1998..,Milton Ohring., Materials Science of Thin Films, Academic Press, 2002,Surface Physics, M. Prutton, Clarendon Press, Oxford, 1975,Cao G, Nanostructures and Nanomaterials, Synthesis Properties and Applications, Imperial College Press, 2004.

MR 304 (AUG) 1:2

Characterization Techniques in Materials Science

Preparation of fine particles, growth of single crystals and thin films, thermal analysis, magnetic measurement, X-ray diffraction, SEM and TEM analyses, electrical and dielectric measurements.

Arun M Umarji

Faculty,of,MRC

MR 222 (JAN) 3:0

Chemistry of Materials

Structure of solids, symmetry concepts, crystal structure. Preparative methods and characterization of inorganic solids. Crystal defects and non-stoichiometry. Interpretation of phase diagrams, phase transitions. Kinetics of phase transformations, structure property correlations in ceramics, glasses, polymers. Composites and nano-materials. Basics of magnetic, electrical, optical, thermal and mechanical properties of solids.

Prabeer Barpanda,Karuna Kar Nanda

faculty,faculty,faculty,J.F. Shackelford,Introduction to Materials Science for Engineers

MR 302 (JAN) 3:0

Crystal Defects and Properties

Descriptive crystal chemistry for ionic crystals, Pauling's rules, thermodynamics of point defects, point defects in ionic crystals, defect reactions and Kroger-Vink diagrams. Introduction to dislocations, slip, slip systems, perfect and partial dislocations. Thompson tetrahedron and dislocation reactions, planar defects, surfaces and interfaces, direct observation of defects on material. Thermal energy, heat capacity, thermal expansion, thermal conductivity. Negative expansion effects in solids. Thermal shock resistant materials. Thermoelectric effects and materials for thermal energy harvesting.

Bikramjit Basu,Arun M Umarji

Chiang,Y-M.,Birnie IIi,D.P and Kingery W.D.,Physical Ceramics – Principles for Ceramic Science and Engineering

MR 305 (JAN) 3:0

Functional Dielectrics

Physical and mathematical basis of dielectric polarization, polarization in static/alternating electric fields. Conductivity and loss. piezoelectric, pyroelectric and ferroelectric concepts. Ferroic materials, primary and secondary ferroics, Optical materials. Birefringence and crystal structure, electro-optic materials and light modulators

Balaram Sahoo

Azaroff and Brophy, Electronic processes in Materials, McGraw-Hill, New York 1963,Von Hippel Arthur R, Dielectric Materials and Applications, MIT, Cambridge,Lines M.E. and Glass A.M., Principles and Applications of Ferroelectrics and related Materials, Clarendon Press, Oxford,Amnon Yariv ., Quantum Electronics

MR 306 (JAN) 3:0

Electron Microscopy in Materials Characterization

Resolution and Rayleigh criterion, electron optics, electron guns and lenses, probe diameter and probe current, electron-specimen interactions, interaction volume. Principles of scanning electron microscopy, imaging modes and detectors. Transmission electron microscopy – elastic and inelastic scattering, modes of operation, diffraction theory, Bragg's law and Laue conditions. Reciprocal space and Ewald sphere construction, Kikuchi lines, convergent beam electron diffraction, diffraction contrast imaging – Howie-Whelan dynamical theory, Thickness and bend contours, imaging defects and strain fields, weak-beam dark field microscopy, phase contrast imaging – Moire fringes, Fresnel fringes and high-resolution imaging.

Ravishankar Narayanan

Goldstein J.I , Romig A.D. Newbury D.E,Goldstein J.I , Romig A.D. Newbury D.E,Goldstein J.I , Romig A.D. Newbury D.E

MR 307 (JAN) 3:0

Thin Films, Nano Materials and Devices: Science and Engineering

Thin films of functional materials including non-linear dielectrics, III-V and Nitride semiconductors. Processing, structure, and properties of materials at the nanometer length scale. Specific nanofabrication topics include epitaxy, beam lithography, self-assembly, bio-catalytic synthesis, atom optics, and scanning probe lithography. The unique size- dependent properties (electronic, ferroelectric and magnetic) and charge carrier transport in insulating and semiconducting materials and semi-conductor devices. Structure – property correlations with reference to computation, magnetic and ferroelectric storage, sensors and actuators and photo-voltaics

Krupanidhi S B

"Advanced Semiconductors and Organic Nano-Techniques", edited by Morkoc H., Academic Press, 2003,Rainer Waser, Editor., Nanoelectronics and Information Technology, Wiley-VCH Verlag GmbH, Weinheim (2003,Tester, J. W, Drake E. M, Golay M. W, Driscoll M. J., and Peters W. A.. Sustainable Energy - Choosing Among Options.,Cambridge, MA: MIT Press, 2005,Scott J.F., Ferroelectric Memories. Springer. ISBN 3540663878 (2000

MR 308 (JAN) 2:1

Computational Modeling of Materials

Introduction to computational modeling of materials, description of atomic interaction, tight binding approximation, Hartree-Fock, molecular orbital method, density functional theory. Applications of these methods in modeling of mechanical, electronic, magnetic, optical, and dielectric properties of materials, design principles of novel materials

Abhishek Kumar Singh

Richard Martin., Electronic Structure: Basic Theory and Practical Methods Cambridge,Richard Martin., Electronic Structure: Basic Theory and Practical Methods Cambridge,Richard Martin., Electronic Structure: Basic Theory and Practical Methods Cambridge

Organic Chemistry

OC 203 (AUG) 3:0

Organic Chemistry-I

Stereochemistry and conformational analysis. Methods of deducing organic reaction mechanisms, Hammond postulate, Curtin-Hammett principle, linear free energy relationships; Hammett equation; kinetic isotope effects. Electronic effects in organic compounds, aromaticity, frontier orbital theory, steric effects;organic transformations and molecular rearrangements; reactive intermediates, classical and nonclassical carbocations, carbanions, free radicals, carbenes, nitrenes, arynes, radical ions, diradicals, concerted reactions, Woodward-Hoffman rules.

Mrinmoy De,Uday Maitra

Anslyn, E.V., and Dougherty, D.A., Modern,Physical Organic Chemistry, University Science Books, 2006.,Physical Organic Chemistry, University Science Books, 2006.,Chemistry: Reactions, Mechanisms and Structure, 6th ed. Wiley, 2007.,Carey F.A., and Sundberg R.J., Advanced Organic

OC 231 (AUG) 3:0

Chemistry of Proteins and Peptides

Amino acids, peptide synthesis, geometry and oligopeptide conformations. Non-covalent interactions, dynamism in peptides, molecular recognition, Ramachandran plot, Foldamers. Protein architecture, protein-protein interactions, protein stability. Peptide conformational analysis. Protein solubility, pKa, protein aggregates, isofolding, unfolded proteins, membrane proteins. Peptidomimetics, isosteres, folding peptides. Enzymes: mechanisms of selected enzymes, enzyme inhibitors. Important developments in current literature.

Erode N Prabhakaran

Voet D and Voet J.G. Biochemistry 2nd Edition John Wiley Cysons NY, 1995.,Stryer L. Biochemistry 4th Edition , WH. Freeman & Co., NY.,Contemporary literature

OC 301 (AUG) 3:0

Organic Synthesis II

Organic synthesis and total synthesis of complex natural products: Advances in C-C bond forming reactions; Olefination reactions; Olefin metathesis including alkyne metathesis; Synthesis of alkynes; Asymmetric addition of Grignard reagents, organozinc and lithium reagents to carbonyl compounds; Directed lithiation, chiral lithium reagents; alkylation of carbonyl compounds including asymmetric alkylation. Addition of organometallinc reagents to imines, Asymmetric acetate/ propionate aldol reaction. Asymmetric allylation of carbonyl compounds; Ring forming reactions, Baldwin rules; cyclopentannulations with specific application to triquinanes. Advances in carbocation rearrangements. Inverse electron demand Diels Alder reaction/ Hetero Diels Alder reaction: Application of the above in the total synthesis of natural products including natural products of contemporary interest in current literature.

Kavirayani R Prasad

Wyatt P. and Warren S, Organic Synthesis, Strategy and Control,; Wiley 2007,Nicolaou, K.C., Sorensen, E.J., Classics in Total Synthesis, Wiley VCH, NY 1996,Warren S. Organic Synthesis: The Disconnection Approach, Wiley, NY, 1982.,Nicolaou, K. C., Classics in Total synthesis I and II; Wiley-VCH, Weinheim 2003; Current literature,Pre-requisites: For students registered for regular PhD programme, including those coming to regular PhD programme through Int PhD and UG streams and recommendation by research supervisor

OC 303 (AUG) 3:0

Carbohydrate Chemistry

Structures and conformational itineraries of monosaccharides; Reactions of monosaccharides: reactivity profiles at each carbon center; ring expansions and contractions; reactions at anomeric carbon and epimeric carbons; deoxy sugars; anhydrosugars; protecting group methods; chemical and enzymatic glycosylations to oligosaccharides; glycosidic bond stabilities; naturally-occurring oligo- and polysaccharides and their conformations; chiral auxiliaries and modifications of sugars to carbocycles and heterocycles; aspects of animal and plant polysaccharides, glycoproteins, proteoglycans and glycosaminoglycans; selected natural product synthesis originating from a sugar scaffold

Jayaraman N

Monosaccharides: Their chemistry and their roles in natural products, P. Collins and R. Ferrier, John Wiley & Sons Ltd., Chichester, 1998,2. Carbohydrates: The essential molecules of life, R. V. Stick, S. J. Williams, Elsevier, Oxford, 2001,3. Organic synthesis with carbohydrates, G.-J. Boons, K. J. Hale, Blackwell Science, Inc., Malden, 2000,Pre-requisites: Regular PhD students; Int PhD students: Completion of CD213 and CD223 courses; UG students: Completion of UC205, CD213 and CD223

OC 232 (JAN) 3:0

Graduate Colloquium

Students will present a short seminar on a selected contemporary topic which would be extremely useful for educating the students beyond their immediate area of interest. This course will be treated as a departmental requirement for all students registered at the Department of Organic Chemistry during the first year.

Santanu Mukherjee,Prabhu K R

colloquium,colloquium,colloquium

OC 234 (JAN) 3:0

Organic Synthesis

Principles of selectivity and reactivity in the use of reagents for oxidation, reduction and bond forming reaction. Planning a synthesis, antithetic analysis, synthons, linear and convergent synthesis

Tushar Kanti Chakraborty,Jayaraman N

Warren S., Designing Organic Synthesis, 1978,Carruthers W. S., Some Modern Methods of Organic Synthesis 3rd edition, Cambridge University Press, 1986,Carery, F. A. and Sundberg, R. J., Advanced organic chemistry, Part B, 2nd ed., Plenum, 1984,House, Modern Synthetic Reactions, 1972.,Fuhrhop J. and Penzilin G., Organic Synthesis - Concepts, Methods, Starting Materials, Verlog Chemie 1983.

OC 303 (JAN) 3:3

Physical Methods of Structure Elucidation

Structural elucidation of organic compounds using physical methods. Principles underlying the following techniques and their applications in organic chemistry will be discussed: Ultraviolet, Visible,

Infrared, NMR (1H and 13C) Spectroscopy, and Mass Spectrometry; Circular dichroism and fluorescence spectroscopy, 2D NMR spectroscopy Other physical methods like, microscopy, light scattering etc.

Prabhu K R

Stothers, J.B. Carbon-13 NMR spectroscopy, Vol.XXIV, Academic Press, 1972,Jackmann, L and Stembel, Applications NMR Spectroscopy in Organic Chemistry,Pergamon Press 1969,Current Literature,Pre-requisites: BS (Chemistry Major) or MS

Solid State and Structural Chemistry Unit

CD 204 (AUG) 3:0

Chemistry of Materials

Aspects of crystal chemistry (lattices, unit cells, symmetry, point groups and space groups etc), packing, bonding and description of crystal structures, Pauling rules, crystallographic methods, defects in solids, electronic structure, magnetism, phase transitions, framework solids, ionic solids and synthesis of solids

Natarajan S,Vasudevan S

C.N.R. Rao and J. Gopalakrishnan, New directions in solid state chemistry,A.R. West, Solid State Chemistry and its applications,A.F. Wells, Structural Inorganic Chemistry,L. Smart and E. Moore, Solid state chemistry : An introduction

SS 201 (AUG) 3:0

Thermodynamics and Statistical Mechanics

Formal principles; conditions for equilibrium, Legendre transformation, Maxwell relations. Phase transitions; classification, Landau theory, universality. Irreversible thermodynamics; thermodynamic forces and fluxes. Onsager relations; illustrative applications to electrochemistry; thermo-electric and thermo-magnetic effects. Introduction to far from equilibrium systems. Basic formulations of statistical mechanics; ensembles, partition functions, relations to thermodynamic functions. Ideal systems; quantum statistics, non-ideal gases, Einstein and Debye Solids. Introduction to statistical mechanics of liquids. Computer simulations; basics of Monte Carlo and molecular dynamics techniques.

Govardhan P Reddy

H.B. Callen, Thermodynamics and an Introduction to Thermo Statistics,D.A. Mcquarrie, Introduction to Statistical Mechanics,D. Chandler, Introduction to Statistical Mechanics

SS 202 (AUG) 3:0

Introductory Quantum Chemistry

Basic postulates of quantum mechanics. Exact solutions: harmonic oscillator (ladder operator approach), particle on a ring and a sphere. Linear operators and matrices. Angular momentum, raising and lowering operators and matrices for spin angular momentum. Hydrogenic atoms (without explicit solution of radial equation), many electron atoms and Slater determinants. Approximate methods - perturbation methods, application to many-electron atoms and term symbols. Variational method - Hartree-Fock method for atoms. Hartree-Fock-Roothan method for molecules. Time-dependent perturbation method - absorption and emission.

Anshu Pandey

Ira Levine, Quantum Chemistry,P.W. Atkins, Molecular Quantum Mechanics,A. Szabo and N. Ostlund, Modern Quantum Chemistry

SS 205 (AUG) 3:0

Symmetry and Structure in the Solid State

Symmetry, point groups and space groups, crystal lattices. Scattering, diffraction, reciprocal lattice. powder diffraction. Single crystal methods. Data collection and processing synchrotron radiation, phase problem in crystallography. Patterson and direct methods, Rietveld refinement, intermolecular interactions electron density analysis. Basics of neutron diffraction, electron diffraction.

Guru Row T N

C. Giacavazzo (Ed.) Fundamentals of crystallography,J. D. Dunitz, X-ray analysis and the structure of organic molecules,,G.H. Stout and L.H. Jensen, X-ray structure determination: A practical guide

SS 304 (AUG) 3:0

Solar Energy: Advanced Materials and Devices

Important Parameters in Photovoltaics, Shockely-Queisser limit, thermodynamic aspects, photon management. Mechanisms of charge separation and transport: junctions, energy transfer, electron transfer. Advanced Photovoltaic Materials (Perovskite, DSSC, Polymer and Colloidal Nanocrystal), Factors affecting photovoltaic performance-exciton diffusion length, charge transport and band-gap. Organic photovoltaic cells-Schottky, Donor-acceptor, heterojunction and bilayer. Methods of photovoltaic Fabrication and photophysics of molecular sensitizers.

Anshu Pandey,Satish Amrutrao Patil

The Physics of Solar Cell-Jenny Nelson, Imperial College Press,Organic Photovoltaics Mechanisms, Materials and Devices-Niyazi Serdar Sariciftci,Physics of Semiconductor Devices-Sze and Ng.

SS 208 (JAN) 3:0

Principles of Solid State Physics

a) Crystal Lattices and Reciprocal Space b) Drude Theory, Sommerfeld Theory, Electrons in a periodic potential c) Free Electron Approximation, Tight Binding Approach, Energy Bands and Dispersion Relations d) Phonon Dispersion and Thermal Transport e) Magnetism f) Superconductivity and Quantum Hall Effect

Ramasesha S,Naga Phani B Aetukuri

Undergrad level Quantum Mechanics and Mathematics,Undergrad level Quantum Mechanics and Mathematics,Undergrad level Quantum Mechanics and Mathematics

SS 303 (JAN) 3:0

Polymeric Materials: Synthesis and Physical Properties

Synthesis of polymers; Reaction Mechanism and Kinetics, Characterization methods; Concepts of soft matter physics and solid-state chemistry relevant to polymers; Specific concepts and physical properties of polymers: chemical structure, morphology, rheology, glass transition; Mechanisms of electron and ion transport; Applications in electrical and optical devices

Satish Amrutrao Patil,Aninda Jiban Bhattacharyya

Handbook of Organic Conductive Molecules and Polymers, H. S. Nalwa, John Wiley & Sons, 2nd Ed, 1997,Solid State Electrochemistry ed. P.G. Bruce, Cambridge University Press, Cambridge, UK, 1995.,Principles of Polymer Chemistry, Paul J. Flory,Kosuke Izutsu, Electrochemistry in Nonaqueous Solutions, Wiley-VCH, Weinheim, 2002.,Solid State Chemistry and its Applications, Anthony R. West, John Wiley and Sons (Asia), Singapore, 2005.

Division of Physical and Mathematical Sciences

Preface

The Division of Physical and Mathematical Sciences comprises the Department of Mathematics, Department of Instrumentation and Applied Physics, Department of Physics, Centre for Cryogenic Technology and Centre for High Energy Physics (formerly Theoretical Studies). The Joint Astronomy and Astrophysics Programme also comes under its purview.

The courses offered in the Division have been grouped into six broad areas. These areas have been identified by code letters as follows:

IN	Instrumentation and Applied Physics
MA	Mathematics
PH	Physics
AA	Astronomy & Astrophysics
HE	High Energy Physics

The course numbers have the prefix of the code letter followed by the numbers. The first digit indicates the level of the course.

There are specific requirements for completing a Research Training Programme for students registering for research conferments at the Institute. For specific individual requirements, the students are advised to approach the Departmental Curriculum Committee.

The Department of Physics and the Centre for High Energy Physics offer an Integrated PhD Programme to which BSc graduates with an adequate background of Physics and Mathematics are admitted.

The Integrated PhD programme in the Mathematical Sciences is offered by the Department of Mathematics to which BSc graduates with an adequate knowledge of Mathematics are admitted.

An M Tech programme in Instrument Technology is offered in the Department of Instrumentation and Applied Physics. For all these programmes, most of the courses are offered by the faculty members of the Division, but in certain special areas, courses offered in other Divisions may also be chosen.

Prof Rahul Pandit
Chairman
Division of Physical &
Mathematical Sciences

Instrumentation and Applied Physics

IN 201 (AUG) 3:0

Analytical Instrumentation

Principles, instrumentation, design and application of UV, visible and IR spectroscopy, mass spectrometry, Mossbauer and NMR spectroscopy, X-ray methods of analysis including powder diffraction, wavelength and energy dispersive x-ray fluorescence. Electron microscopy and microprobe. ESCA and AUGer techniques, photo electron spectroscopic methods, scanning tunneling and atomic force microscopy. Chromatography, thermal analysis including DTA, DSC and TGA. Thermal wave spectroscopic techniques such as photo-acoustic, photo-thermal deflection and photopyro-electric methods.

Asokan S,Siva Umapathy

Willard, H.W., Merritt, L.L., Dean, J.A., and Settle, F.A., Instrument Methods of Analysis Sixth Edn, East West Publishers, 1992.,Strong, D.A., Holler, F.J., and Nieman, T.A., Principles of Instrumental Analysis (Fifth Edn,) Saunders, 1998.,Apar Wiston, C., X Ray Methods, John Wiley and Sons, 1991

IN 210 (AUG) 3:0

Wave propagation in periodic media

Theory of one, two and three dimensional lattices, energy velocity, energy flow, characteristics impedance, Kronig-Penny and tight binding models of crystals, wave propagation in nonlinearstructures. Transmission and reflection of electromagnetic waves on an interface, grating theory, multi-dimensional phononic and photonic crystals, materials and techniques of fabrication, nature inspired periodic structures, device applications

Abha Misra

C. Kittel,Introduction to Solid State Physics,John Wiley & Sons 1953.,A. P. French,Vibrations and WavesW. W. Norton & company 1971.

IN 229 (AUG) 3:0

Advanced Instrumentation Electronics

Instrumentation building blocks: operational amplifiers, RC timers, waveform generators, programmable analog circuits, analog filter design, switched capacitor circuits, CAD for analog circuits. RF circuits: basic transmission line theory, impedance matching, Smith chart, stability of RF amplifiers, VCO, mixer, PLL. Measurement and characterization of noise.

Atanu Kumar Mohanty

Horowitz, P., and Hill, W., Art of Electronics, Second Edn, Cambridge Univ. Press, 1980.,Ryder, J.D., Networks, Lines and Fields, Second Edn, Prentice Hall of India, 1955.,Millman, J., and Halkias, C.C., Integrated Electronics, McGraw Hill, Auckland, 1972.

IN 232 (AUG) 3:0

Concepts in solid state physics

Vibrations in solids; Electrons in Metals; Phonons; Tight binding chain; Chemical bonding in solids;

Crystal structure; Real and Reciprocal Space; Scattering experiments; Waves in reciprocal space; Band structure and optical properties; Fermi surfaces; Introduction to semiconductors; Magnetism; Practical examples and review.

H. Ibach and H. Luth, Solid State Physics: An Introduction to Principles of Materials Science, Springer, 4th Edition 2009.,Steven H. Simon, The Oxford solid state basics, Oxford University Press, 2013.,Charles Kittel, Introduction to Solid State Physics, Wiley.

IN 234 (AUG) 3:0

High Vacuum Technology and Applications

Kinetic theory of gases in closed systems, production and measurement of high vacuum, materials for vacuum environment, vacuum system design and fabrication, leak detection. Applications of high vacuum in thin film technology, metallurgy and space technology. Concepts of ultra high vacuum techniques.

Mohan Rao G

Roth, A., Vacuum technology, Elsevier Science, 1996.,O'Hanlon, I., A User Guide to Vacuum Technology, Wiley-Interscience, 2003.,Lafferty, J.M., Foundations of Vacuum Science and Technology, John Wiley and Sons, 1998.

IN 244 (AUG) 2:1

Optical Metrology

Dimensional Metrology: Pinhole Camera Model, Camera Calibration, Laser Triangulation, Structured Illumination Techniques, Fringe Analysis, Phase Unwrapping, System Calibration. Interferometry: Various Interferometric Techniques such as Michelson, Mach-Zehnder, Fabry-Pérot, Holographic, Speckle, Moiré, VISAR and Common-Path Interferometry. Metrology with Optical Microscopy: Basics of Microscopy, 2-D and 3-Dmeasurements, Optical Sectioning, Super-resolution, Surface Profiling and Quantitative Phase Imaging. This course also aims at providing hands-on experience for important representative experimental techniques such as Michelson Interferometry, 4-f System, digital holography, fringe projection profilometry and quantitative phase imaging in microscopy.

Sai Siva Gorthi

Fundamentals of Photonics by B.E.A. Saleh and M.C.Teich,Wily 2nd edition,2013,Optical Metrolog by Kjell J.Gasvik,Wily 3rd edition, 2002,Quantitative Phase Imaging of Cells and Tissues by Gabriel Popescue,M.C.Graw Hill Professional 1st edition, 2011.

IN 267 (AUG) 3:0

Fluorescence Microscopy and Imaging

Light Sources, Monochromators, Optical Filters, Photomultiplier tubes, polarizers, Beer-Lambart Law, Paraxial ray Optics and System Designing, Wave Optics, electromagnetic theory, fluorescence microscopy systems, molecular physics, photo-physics and Stern-Volmer equation, Jablonski diagram, emission spectra, fluorescence lifetime and quantum yield, time-domain lifetime measurements, fluorescence correlation spectroscopy, total internal reflection fluorescence microscopy, electric field effects, point spread function, single-and multi-photon fluorescence microscopy, advanced super resolution microscopy, aperture engineering techniques, 3D image reconstruction, Markov random field, maximum likelihood algorithm, Bayes theorem.

Partha Pratim Mondal

Prerequisites: Knowledge of C and MATLAB Programming.,James Pawley, Handbook of Biological Confocal Microscopy, Springer, Springer Science + Business Media, 3rd Edition, 2006. J. R. Lakowicz, Principles of Fluorescence Spectroscopy, 3rd Edition, Springer, 2006.,M. Born and E. Wolf, Principles of Optics, 7th Edition, Cambridge University Press, 2001.,Alberto Diaspro, Nanoscopy and Multidimensional Optical Fluorescence Microscopy, CRC, 1st Edition, 2010.,C. Gonzalez and R. E. Woods, Digital Image Processing, 3rd Edition

IN 270 (AUG) 3:0

Digital Signal Processing

Fourier analysis, Fourier Integral, Discrete Fourier transform multiplications of two signals, Z transform, convolution, correlation Digital filtering, Discrete transformation modulation, FIR, IIR filters, Analog I/O interphase for real time DSP system, application of TMS320 C6713DSK to evaluate convolution, IIR and FIR filter.

Mondal T K

Ervin Kreszic - Advanced engineering mathematics,Robert F Coughlin.,Frederick F driscoll, opreational amplifier and linear integrated circuits.,Emmanual c Ifeachar, Barrie w Jervis - Digital signal processing

IN 302 (AUG) 3:0

Advanced Topics in Fluorescence Imaging

Ray Optics, Wave Optics, Electromagnetic Optics, Polarization Optics, Waves and Particles, Wave Particle Duality / Heisenbergs Uncertainty Principle, Mathematical Tools of Quantum Mechanics, Postulates of Quantum Mechanics, Quantum Harmonic Oscillator, Quantum Theory of Radiation, Quantum States of Light, Quantum Distribution Theory (Coherent State Distribution, Wigner Distribution and others), Atom Field Interaction.

Partha Pratim Mondal

Knowledge of C and MATLAB Programming. Any Course in Optics / Optical Engineering Classical Mechanics M. Born and E. Wolf, Principles of Optics, 7th Edition, Cambridge University Press, 2001.,Joseph W. Goodman, Introduction to Fourier Optics, 3rd Indian Edition, Viva Books Pvt Ltd., 2007.,C. Cohen-Tannoudji, B. Diu and F. Laloe, Quantum Mechanics, Wiley-VCH, 1977.

IN 212 (JAN) 3:0

Advanced Nano/Micro Systems

Fundamentals of MEMS & NEMS fabrication, Physical properties of MEMS and NEMS devices, doping, pattern generation, tools for nanoscale characterizations, CMOS based devices, Advanced sensing systems such as image sensor, touch sensors, accelerometer, gyroscope, flow sensors, actuators, transducers, thermal sensor, electrostatic, piezoelectric piezoreristive sensors, chemical sensors, biological sensors, strain gauges, load cells, pressure sensors, optical sensors, signal conditioning circuits for sensors, control units etc., electrons and ions optics, single electron tunneling, quantization of electrical conduction, electronic and photonic band gap crystals.

Abha Misra

M. J. Madou, Fundamentals of microfabrication, CRC Press 1997.,H. J, Levinson, Principles of lithography, SPIE 2004.,B. Bhushan, Hand book of Nanotechnology, Springer, 2nd edition 2007.,H. J. De Los Santos, Principles and Applications of Nano MEMS Physics, Springer 2008.

IN 214 (JAN) 3:0

Semiconductor Devices and Circuits

Quantum Mechanics Fundamentals, Schrodinger Equation, Particle ina Box, Harmonic Oscillator, Bonding, Crystals, Winger Seitz Cell, Bragg?s Law, Lattice Waves and Phonons, Reciprocal Lattice Brillouin Zones, Kronig Penny Model, Formation of Energy Bands, Metals, Semiconductors- Density of States, Fermi Function, Carrier Concentrations and Mass Action Law, Doping, Recombination and Generation, Continuity Equation, Metal Semiconductor Junctions, PN Junctions, BJT, JFET, MESFET, MOS Capacitor, MOSFETs, Small Signal Models, Single Stage Amplifiers Basics, Organic Semiconductors, amorphous silicon, metal oxides.

Sanjiv Sambandan

Advanced Semiconductor Fundamentals, Robert F Pierret,Modular series on Solid State Devices, Robert F Pierret and Gerold W Neudeck Pearson Education Inc,Semiconductor Devices: Physics and Technology, 2nd ED, SM Sze,Hydrogenated Amorphous Silicon: R.A. Street, Cambridge University Press.

IN 222 (JAN) 3:0

Microcontrollers and Applications

Architecture of Microcontrollers and hardware interfacing techniques. Introduction to Integrated development environment for application software development. A/D – D/A interfaces. Stepper and DC Motor controls. Finite state Machine Models for applications. Case studies of applications controlled via local keyboard or by using serial Interfaces. Use of I2C bus in applications.

Ramgopal S

Ayala, The 8051 Microcontroller, Third Edn, Thomson, 2007. Mazidi, M.A., Mazidi, J.G., and Mckinlay, R.D.,The 8-51 Microcontroller and Embedded Systems using Assembly and C,Second Edn, Pearson Education,Mazidi M.A, Mazidi J.G amd J G and Mckinlay R D,Microcontroller: Internal Instructions, Programming and Interfacing Subrata Ghoshal, Pearson Education : 2010

IN 223 (JAN) 3:0

Plasma Processes

Glow discharge plasmas, ion surface interactions, magnetron discharges, ion sources, DC, RF and ECR plasmas, surface modification using ion sources, ion beam mixing and ion implantation, ion beam etching for microelectronic devices, plasma diagnostics, Langmuir probe, glow discharge mass spectrometry and optical emission spectrometry, plasma surface modification.

Mohan Rao G

Chapman, B.N., Glow Discharge Processes, John Wiely and Sons, 1979.,Vossen, J.L., and Kern, W. (Eds), Thin Film Processes, Academic Press, 1979.,Cuomo, J.J., Rossnagel, S.M., and Kauffman, H.R. (Eds), Handbook of Ion beam Processing Techniques, Noyes Publications, 1989.

IN 224 (JAN) 3:0

Nanoscience and Device fabrication

Nanoscience: Introduction, classification, Summary of electronic properties of atoms and solids, Effects of the nanometer length scale, General methodologies for nanomaterial characterization, semiconductor physics - semiconductor nanostructures, Quantum confinement in semiconductor nanostructures, Modulation doping, Interband/Intraband absorption in semiconductor

nanostructures, Phonon bottleneck, thermodynamics and kinetics of phase transformations, Applications of semiconductor nanostructures Device fabrication: Growth techniques and properties, thin film phenomena, PVD and CVD techniques, MBE-growth of self assembled InAs quantum dots, Heterostructures grown inside MBE, FIB for ion implantation and insulation writing, lithography.

Engines of Creation: The Coming Era of Nanotechnology, K. Eric Drexler, Marvin Minsky 1987,Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience, E. Wolf, John Wiley & Sons, 2004,Nanoscale science and Technology, R. W. Kelsall, I. W. Hamley, M. Geoghegan 2005,Advanced Nanotechnology (Encyclopaedia Of Nanoscience-1), S. K. Prasad 2008,Concepts of Modern Physics, Arthur Beiser 2015

IN 227 (JAN) 3:0

Control Systems Design

Dynamics of linear systems, Laplace transforms, analysis of feedback control systems using Nyquist plots, Bode plots and Root Locus, design of control systems in single-degree of-freedom configuration using direct design, proportional-integral-derivative control, lead-lag ompensation, design of control systems in two-degree of-freedom configuration to achieve robustness, Quantitative feedback theory control of non-minimum phase systems, Bode sensitivity integrals, use of describing functions to analyze and compensate nonlinearities.

Jayanth G R

Horowitz I.M., Synthesis of Feedback Systems, Academic Press, 1963.,Goodwin G. C., Graebe S. E.,. Salgado M. E, Control System Design, PHI Learning, 2001.,Sidi, marcel, design of Robust Control Systems, Kriegar, 2001.

IN 228 (JAN) 3:0

Automatic System Control Engineering

Digital interfacing, A/D conversion by 8 bit, 12 bit and 16 bit, system calibration, compensation. Application of proportional control and PID control to systems and comparison, case studies. Stability analysis and performance modeling. Advantages of microcomputer based industrial process control systems. Remote control methods. Introduction of fuzzy logic and Application. Linux infrared remote control.

Mondal T K

Hall, D.V., Microprocessors and interfacing, McGraw Hill, 1986.,John Van De Vegte, Feedback control system, Prentice Hall Intl, Inc.,Terano, T., Asai, K., Sugeno, M. (Eds), (Translated by Charles Aschmann), Applied Fuzzy Systems, Professional, Boston, 1994.

IN 268 (JAN) 2:1

Microfluidic Devices and Applications

Basic principles in microfluidics, design principles for microfluidic devices, device fabrication techniques, components of microfluidic devices (micro-pump, mixers, lenses, valves, heaters, sensors, etc.), utility of microfluidic devices in various biological, chemical and optical sensing applications, opto-fluidics, Inertial-microfluidics, droplet-microfluidics, microfluidics based-flow cytometry. This course also provides hands on-experience in the design, fabrication and characterization of Lab-on-chips or point-of care testing devices.

Sai Siva Gorthi

Introduction to Microfluidics by Patric tabeling. 2005,Wereley,Biological Applications of Microfluidics edited by Frank A. Gomez,2006,Fundamentals and Applications of Micro-fluidicsBy Nam-Trung nguyen and Stev

IN 271 (JAN) 3:0

Cryogenic Instrumentation and Applications

Introduction and fundamentals of cryogenic technology, Properties of cryogenic fluids, Properties of materials at low temperatures, Cryogenic refrigeration systems and gas liquefaction systems, Measurement of temperature, pressure, flow and liquid level, Cryogenic fluid storage and transfer systems, Design of cryostats and cryogenic systems, Cryocoolers, Cryogenic safety, Applications of cryogenics.

Upendra Behera,Shivaprakash N C

Randall F. Barron, Cryogenic Systems, Second Edition, Oxford University Press, 1985.,Randall F. Barron, Cryogenic Systems, Second Edition, Oxford University Press, 1985. Thomas M. Flynn, Cryogenic Engineering, Marcel Dekker Inc, 1997.,J. G. Weisend II, Handbook of Cryogenic Engineering, Taylor & Francis, 1998.

Mathematics

Course No. Credits Course title

Core Courses (these are compulsory)

ESSENTIAL COURSES			
Course No.	**Credits**	**Course Title**	**Instructor**
MA 212	3:0	Algebra I	Abhishek Banerjee
MA 219	3:1	Linear algebra	Soumya Das
MA 221	3:0	Analysis I	Gadadhar Misra
MA 223	3:0	Functional analysis	T. Bhattacharya
MA 231	3:1	Topology I	Harish Seshadri
MA 242	3:0	Partial differential equations	S Thangevelu
MA 261	3:0	Probability models	Manjunath Krishnapur
MA 232	3:0	Introduction to algebraic topology	Subhojoy Gupta
MA 361	3:0	Probability theory	Srikanth K Iyer
MA 220	3.0	Representation theory	Pooja Single
ELECTIVES COURSES			
Course No.	**Credits**	**Course Title**	**Instructor**
MA 338	3:0	Differential manifolds & Lie Group	Vamsi Pingali
MA 360	3:0	Random Martix theory	Manjunath Krishnapur
MA 312	3.0	Commutative Algebra	D. P Patil
UG COURSES			
Course No.	**Credits**	**Course Title**	**Instructor**
UM 101	3:0	Analysis and linear algebra I	Gautam Bharali
UM 201	3:0	Probability and statistics	M K Ghosh
MA 200	3.0	Multivariable Calculus	Thirupathi Gudi

MA 212 (AUG) 3:0

Algebra I

Part A 1. Groups: definitions & basic examples; 2. Normal subgroups, quotients; 3. Three isomorphism theorems; 4. Centralizer and normalizer of a subset, centre of a group; 5. Permutations, symmetric groups and Cayley's Theorem; 6. Group actions and their applications, Sylow's theorems. Part B 1. Rings and ideals: basic definitions, quotient rings; 2. The Chinese Remainder Theorem; 3. Maximal and prime ideals; 4. Unique factorization, unique factorization domains, principal ideal domains, Euclidean domains, polynomial rings; 5. Modules: basic definitions and examples, Hom and tensor products, the Structure Theorem for finitely generated modules over PIDs; 6. Fields: basic definitions and examples, algebraic & transcendental numbers; 7. Finite fields, characteristic, the order of a finite field.

Abhishek Banerjee

none,none,none

MA 219 (AUG) 3:1

Linear algebra

Sector spaces: definition, basis and dimension, direct sums. Linear transformations: definition, the Rank-Nullity Theorem, the algebra of linear transformations. Dual spaces. Matrices. Systems of linear equations: elementary theory of determinants, Cramer's rule. Eigenvalues and eigenvectors, the characteristic polynomial, the Cayley-Hamilton Theorem, the minimal polynomial, algebraic and geometric multiplicities. Diagonalization. The Jordan canonical form. Symmetry: group of motions of the plane, discrete groups of motion, finite subgroups of SO(3). Bilinear forms: symmetric, skew-symmetric and Hermitian forms, Sylvester's law of inertia, Spectral theorem for Hermitian and normal operators on finite-dimensional vector spaces.

Soumya Das

MA 220 (AUG) 3:0

Representation theory of Finite groups

Representation of finite groups, irreducible representations, complete reducibility, Schur's lemma, characters, orthogonality, class functions, regular representations and induced representation, the group algebra.

Linear groups: Representation of the group SU2

Pooja Singla

Aritin, M., Algebra, Prentice Hall of India, 1994.
Fulton W., and Harris, J., Representation Theory, Spinger-Verlag, 1991.
Serre, J. P., Linear Representations of Finite Groups, Springer-Verlag, 1977.

MA 221 (AUG) 3:0

Analysis I

Construction of the field of real numbers and the least upper-bound property. Review of sets, countable & uncountable sets. Metric spaces: topological properties, the topology of Euclidean space. Sequences and series. Continuity: definition and basic theorems, uniform continuity, the Intermediate Value Theorem. Differentiability on the real line: definition, the Mean Value Theorem. The Riemann-Stieltjes integral: definition and examples, the Fundamental Theorem of Calculus. Sequences and series of functions, uniform convergence, the Weierstrass Approximation Theorem. Differentiability in higher dimensions: motivations, the total derivative, and basic theorems. Partial derivatives, characterization of continuously-differentiable functions. Higher-order derivatives.

Gadadhar Misra

MA 223 (AUG) 3:0

Functional Analysis

Basic topological concepts, Metric spaces, Normed linear spaces, Banach spaces, Bounded linear functionals and dual spaces, Hahn-Banach Theorem, Bounded linear operators, Open mapping theorem, Closed graph theorem, Banach-Steinhaus theorem, Hilbert spaces, Riesz Representation Theorem, Orthonormal sets, Orthogonal complements, Bounded operators on a Hilbert space up to (and including) the spectral theorem for compact, self–adjoint operators.

Bhattacharyya T

MA 231 (AUG) 3:1

Topology

Point-set topology: Open and closed sets, Continuous functions, Metric topology, Product topology, Connectedness and path-connectedness, Compactness, Countability axioms, Separation axioms, Complete metric spaces, Quotient topology, Topological groups, Orbit spaces. The fundamental group: Homotopic maps, Construction of the fundamental group, Fundamental group of the circle, Homotopy type, Brouwer's fixed-point theorem, Separation of the plane.

Harish Seshadri

MA 232 (AUG) 3:0

Introduction to algebraic topology

The fundamental group: Homotopy of maps, multiplication of paths, the fundamental group, induced homomorphisms, the fundamental group of the circle, covering spaces, lifting theorems, the universal covering space, Seifert-van Kampen theorem, applications. Simplicial and singular hololog: Simplicial complexes, chain complexes, definitions of the simplicial and singular homology groups, properties of homology groups, applications.

Subhojoy Gupta

MA 242 (AUG) 3:0

Partial differential equations

First-order partial differential equations: Method of characteristics, Cauchy problem, Hamilton-Jacobi equations (including either the Hopf-Lax formula or introduction to viscosity solutions, as per audience interest). Second-order partial differential equations: The Cauchy problem and classification of second-order equations, Holmgren’s uniqueness theorem, Laplace equation, Heat equation, Wave equation, Some methods of solutions, Variable separable method. Brief introduction to the weak formulation (time permitting): Motivations, Dirichlet Functional.

Thangavelu S

MA 261 (AUG) 3:0

Probability Models

Sample spaces, events, probability, discrete and continuous random variables, conditioning and independence, Bayes' formula, moments and moment generating function, characteristic function, laws of large numbers, central limit theorem, Markov chains, Poisson processes.

Manjunath Krishnapur

MA 312 (AUG) 3:0

Commutative Algebra

Noetherian rings and Modules, Localisations, Exact Sequences, Hom, Tensor Products, Hilbert's Null-stellensatz,

Integral dependence, Going-up and Going down theorems, Noether's normalization lemma , Discrete valuation

rings and Dedekind domains.

Dilip P Patil

Atiyah, M. F. and Macdonald, I.G., Introduction to Commutative Algebra, Addison-Wesley, 1969.
Raghavan.,S. B.., Singh and Sridharan, R., Homological Methods in Commutative Algebra, TIFR Mathematical Pamphlet Number 5, Oxford University Press, 1977.
Serre, J. P., Local Algebra (translated from French), Springer Monographs in Mathematics, Springer-Verlag, 2000.
Zariski, O and Samuel, P., Commutative Algebra, Vols.I and II, Van Nostrand, 1958 and 1960.

MA 338 (AUG) 3:0

Differential Manifolds and Lie Group

Syllabus: Differentiable manifolds, differentiable maps and tangent spaces, regular values and Sard's theorem, submersions and immersions, vector fields and flows, exponential map, Frobenius theorem, Lie groups and Lie algebras, exponential map , Homogenous spaces, tensors and differential forms, exterior algebra, Lie derivative, Orientable manifolds, integration on manifolds and Stokes Theorem . Covariant differentiation, Riemannian metrics, Levi-Civita connection, Curvature and parallel transport, spaces of constant curvature.

Vamsi Pritham Pingali

S. Kumaresan: A course in differential geometry and Lie groups, Texts and Readings in Mathematics, 22. *Hindustan Book Agency, New Delhi,* 2002
F. Warner: Foundations of differentiable manifolds and Lie groups , Graduate Texts in Mathematics, 94.
Springer-Verlag, New York-Berlin, 1983
J. Lee: Introduction to smooth manifolds , Graduate Texts in Mathematics, 218.
Springer, New York, 2013

MA 360 (AUG) 3:0

Random Matix Theory

Wigner's semicircle law: (a) combinatorial method, (b) Stieltjes' transform method, (c) Chatterjee's invariance principle method. Gaussian unitary and orthogonal ensembles: (a) Exact density of eigenvalues. (b) Orthogonal polynomials and determinantal formulas leading to another proof of Wigner's semicircle law. Tridiagonal reduction for GUE and GOE: (a) Another derivation of eigenvalue density. (b) Another proof of Wigner's semicircle law. (c) Matrix models for Beta ensembles. (c) Selberg's integral. Other models of random matrices - Wishart and Jacobi ensembles. Free probability: (a) Noncommutative probability space and free independence. (b) Combinatorial approach to freeness. (c) Limiting spectra of sums of random matrices. Non-hemitian random matrices: (a) Ginibre ensemble. (b) Circular law for matrices with i.i.d entries. Fluctuation behaviour of eigenvalues (if time permits).

Manjunath Krishnapur

S. Kumaresan: A course in differential geometry and Lie groups, Texts and Readings in Mathematics, 22. *Hindustan Book Agency, New Delhi,* 2002
F. Warner: Foundations of differentiable manifolds and Lie groups , Graduate Texts in Mathematics, 94.
Springer-Verlag, New York-Berlin, 1983
J. Lee: Introduction to smooth manifolds , Graduate Texts in Mathematics, 218.
Springer, New York, 2013

MA 361 (AUG) 3:0

Probability theory

Probability measures and random variables, pi and lambda systems, expectation, the moment generating function, the characteristic function, laws of large numbers, limit theorems, conditional contribution and expectation, martingales, infinitely divisible laws and stable laws.

Srikanth Krishnan Iyer

MA 213 (JAN) 3:1

Algebra II

Part A 1. Introduction to categories and functors, direct and inverse limits; 2. Field of fractions of an integral domain, localization of rings; 3. i-adic completion of rings; 4. Tensor products, short exact sequences of modules; 5. Noetherian rings and modules, Hilbert Basis Theorem, Jordan-Holder Theorem; 6. Artinian rings, Artinian implies Noetherian, Krull-Schmidt Theorem. Part B 1. Splitting fields, normal and separable extensions; 2. Application to finite fields; 3. The Fundamental Theorem of Galois Theory; 4. The Primitive Element Theorem.

Abhishek Banerjee

MA 222 (JAN) 3:1

Analysis II

Sigma-algebras, outer measures and measures. Construction of Lebesgue measure. Measurable functions.

Lebesgue integration and integration with abstract measures. Monotone convergence theorem, Fatou's lemma and the dominated convergence theorem. Comparison of Riemann integration and Lebesgue integration. Product sigma-algebras, product measures, Fubini's theorem. Signed measures and the Radon-Nikodym theorem. L^p spaces, characterization of continuous linear functionals on L^p spaces. Complex measures, the Riesz representation theorem.

Manjunath Krishnapur

MA 224 (JAN) 3:1

Complex Analysis

Complex numbers, complex-analytic functions, and the Cauchy-Riemann condition. Cauchy's integral integral formula, power series. Liouville's theorem and applications. The maximum-modulus principle. Morera's theorem, Schwartz reflection principle. Isolated singularities and the residue theorem. Contour integration. Möbius transformations, conformal mappings. Normal families and Montel's theorem. The Riemann Mapping Theorem. The Schwarz Lemma: proof, applications, automorphisms of the unit disc. Basics of analytic continuation (time permitting).

Harish Seshadri

MA 229 (JAN) 3:0

Calculus on manifolds

Basics: The inverse function and implicit function theorems. The Riemann integral in higher dimensions, partitions of unity, the change of variables formula. Stokes' Theorem: Introductory multilinear algebra, differential forms, the exterior derivative. Integration of differential forms, differentiable simplices and chains, Stokes' Theorem for differentiable chains. Stokes' Theorem for embedded submanifolds in Euclidean space: motivations and statement, examples and special cases. Differentiable manifolds: Definitions and examples. Smooth functions on manifolds. The tangent bundle. Immersions, embeddings and submersions. The implicit function theorem on manifolds.

Basudeb Datta

MA 241 (JAN) 3:1

Ordinary differential equations

Basic concepts: Introduction and examples through physical models, first and second order equations, general and particular solutions, linear and nonlinear systems, linear independence, solution techniques. Existence and uniqueness theorems: Peano and Picard theorems, Grownwall's inequality, dependence on initial conditions and associated flows. Linear systems: Fundamental matrix, stability of equilibrium points, phase-plane analysis, Sturm-Liouville theory. Nonlinear systems and stability: Lyapunov's method, non-linear perturbation of linear systems, periodic solutions and the Poincare-Bendixson theorem.

Nandakumaran A K

MA 278 (JAN) 3:0

Introduction to Dynamical Systems Theory

Linear Stability analysis, attracters, limits cycles, Poincare-Bendixson theorem, relaxation oscillations.Elements of Bifurcation theory, saddle-node, transcritical, pitchfork and Hopf bifurcations. Integrability, Hamiltonian systems, Lotka-Volterra equations. Lyapunov functions and dirct methods for stability, dissipative systems, Lorenz systems, chaos and its measures, Lyapunov exponents, strange attractors, simple maps, period-doubling bifurcations, Feigenbaum constants, fractals.

Janaki Balakrishnan

MA 315 (JAN) 3:0

Lie Algebra and their representation

Finite dimensional Lie algebras, Ideals, Homomorphisms, Solvable and Nilpotent Lie algebras, Semisimple Lie algebras, Jordan decomposition, Kiling form, root space decomposition, root systems, classification of complex semisimple Lie algebras
Representations Complete reducibility, weight spaces, Weyl character formula, Kostant, steinberg and Freudenthal formulas

Gadadhar Misra

J E Humphreys Introduction to Lie algebras and Representation theory Springer-Verlag, 1972.
J P Serre Complex Semisimple Lie Algebras, Springer, 2001
Fulton. W., and Harris J. Representation theory, Springer-Verlag. 1991.

MA 340 (JAN) 3:0

Advanced functional Analysis

Banach algebras, Gelfand theory, C* - algebras the GNSconstruction, spectral theorem for normal operators, Fredholm operators. The L- infinity functional calculus for normal operators.

Bhattacharyya T

MA 392 (JAN) 3:0

Random Graphs and interacting particle systems

Erdos - Renyi random graphs, graphs with power law degree distributions, Ising Potts and contact process, voter model, epidemic models. Books Bollobas Bela, Random graphs, Cambridge University Press, Second Edition, 2006. Janson, S., Luczak, T and Rucinski, A, Random Graphs, Wiley, 2000. Durrct, R: Random Graph Dynamics, Cambridge, 2011.

Srikanth Krishnan Iyer

Physics

Integrated Ph D Programme
Physical Sciences

Departmental Core Courses

PH 201 3:0 Classical Mechanics
PH 202 3:0 Statistical Mechanics
PH 203 3:0 Quantum Mechanics I
PH 204 3:0 Quantum Mechanics II
PH 205 3:0 Mathematical Methods of Physics
PH 206 3:0 Electromagnetic Theory
PH 207 1:2 Analog Digital and Microprocessor Electronics
PH 208 3:0 Condensed Matter Physics-I
PH 209 2:1 Analog and Digital Electronics Lab
PH 211 0:3 General Physics Laboratory
PH 212 0:3 Experiments in Condensed Matter Physics
PH 213 0:4 Advanced Experiments in Condensed Matter Physics
HE 215 3:0 Nuclear and Particle Physics
PH 217 3:0 Fundamentals of Astrophysics
PH 231 0:1 Workshop practice
PH 300 1:0 Seminar Course

Project:
PH 250A 0:6 Project
PH 250B 0:6 Project

Elective Courses:
HE 316 3:0 Advanced Mathematical Methods
PH 320 3:0 Condensed Matter Physics II
PH 325 3:0 Advanced Statistical Physics
PH 330 0:3 Advanced Independent Project
PH 340 4:0 Quantum Statistical Field Theory
PH 347 2:0 Bioinformatics
PH 350 3:0 Physics of Soft Condensed Matter
PH 351 3:0 Crystal Growth, Thin Films and Characterization
PH 352 3:0 Semiconductor Physics and Technology
PH 359 3:0 Physics at the Nanoscale
PH 362 3:0 Matter at Low Temperatures
HE 392 3:0 Standard Model of Particle Physics
HE 395 3:0 Quantum Mechanics III
HE 396 3:0 Gauge Field Theories

PH 201 (AUG) 3:0

Classical Mechanics

Newton's laws, generalized co-ordinates. Lagrange's principle of least action and equations. Conservation laws and symmetry. Integrable problems, elastic collisions and scattering. Small oscillations including systems with many degrees of freedom, rigid body motion. Hamilton's equations. Poisson brackets. Hamilton Jacobi theory. Canonical perturbation theory, chaos, elements of special relativity. Lorentz transformations, relativistic mechanics.

Faculty PH

Goldstein, H., Classical Mechanics, Second Edn, Narosa, New Delhi, 1989,Landau, L.D., and Lifshitz, E.M., Mechanics, Pergamon, UK, 1976,Rana, N.C., and Jog, P.S., Classical Mechanics Tata McGraw-Hill, New Delhi, 1991

PH 203 (AUG) 3:0

Quantum Mechanics-I

Historical foundations. Wave function for a single particle. Hamiltonian. Schrodinger equation. Probability current. Wave packets. One-dimensional problems: step, barrier and delta-function

potentials. Tunnelling, scattering and bound states. Harmonic oscillator, operator approach. Matrix formulation of quantum mechanics. Hermitian and unitary operators. Orthonormal basis. Momentum representation. Uncertainty relations. Postulates of quantum mechanics. Heisenberg representation. Ehrenfest's theorem. Threedimensional problems. Rotations, angular momentum operators, commutation relations. Spherical harmonics. Hydrogen atom, its spectrum and wave functions. Symmetries and degeneracies. Spin angular momentum. Spin-1/2 and two-levelsystems. Addition of angular momentum. Spin-orbit and hyperfine interactions. Time-independent perturbation theory. Stark and Zeeman effects. Variational methods, ground state of helium atom.

Diptiman Sen

Cohen-Tannoudji, C., Diu, B., and Laloe, F., Quantum Mechanics Vol.1, JohnWiley, 1977,Landau, L.D., and Lifshitz E.M., Quantum Mechanics, Pergamon, NY, 1974.,R. Shankar, Principles of Quantum Mechanics, Springer, 2010

PH 205 (AUG) 3:0

Math Methods of Physics

Linear vector spaces, linear operators and matrices, systems of linear equations. Eigen values and eigen vectors, classical orthogonal polynomials. Linear ordinary differential equations, exact and series methods of solution, special functions. Linear partial differential equations of physics, separation of variables method of solution. Complex variable theory; analytic functions. Taylor and Laurent expansions, classification of singularities, analytic continuation, contour integration, dispersion relations. Fourier and Laplace transforms

Ananthanarayan B

Mathews, J., and Walker, R.L., Mathematical Methods of Physics, Benjamin, Menlo Park, California, 1973,Dennery, P., and Krzywicki, A., Mathematics for Physicists, Harper and Row, NY, 1967,Wyld, H.W., Mathematical Methods for Physics, Benjamin, Reading, Massachusetts, 1976.

PH 209 (AUG) 2:1

Electronics II

Introduction to microprocessors, Intel 80x86 architecture and instruction set. Assembly and C level programming, memory and IO interfacing. Mini projects using integrated circuits, data acquisition systems. PC add-on boards. Introduction to virtual instrumentation

Rajan K

Hall, D.V., Digital circuits and systems, McGraw Hill International Electronic Engineering Series.,Hall, D.V., Microprocessors and Interfacing, Second Edn, Tata McGraw Hill.,Robert Bishop, Learning with LabView Express, Pearson Edn.

PH 211 (AUG) 0:3

General Physics Laboratory

Diffraction of light by high frequency sound waves, Michelson interferometer, Hall effect, band gap of semiconductors, diode as a temperature sensor, thermal conductivity of a gas using Pirani gauge, normal modes of vibration in a box, Newton’s laws of cooling, dielectric constant measurements of triglycine selenate, random walk in porous medium

Vasant Natarajan,Victor Suvisesha Muthu D,Koteswar

practical course,practical course,practicals

PH 213 (AUG) 0:4

Advanced Experiments in Condensed matter physics

This lab course has two components: In the first part, the students will do the following five experiments in the Central Instruments Facility of the department to learn about the basic preparation
characterization tools.
1. Laue diffraction
2. Powder diffraction
3. Differential Scanning calorimetry
4. Optical absorption spectra
5. RF sputtering
In the second part the students will do an 8-week project in a designated lab under the supervision of a faculty member.

Ganesan R,Anil Kumar P S

practical course,practical course,practical course

PH 215 (AUG) 3:0

Nuclear and Particle Physics

Yukawa potential. Isospin, neutron and proton. Deuteron. Shell model, magic numbers. Nuclear transitions, selection rules. Liquid drop model, collective excitations. Nuclear fission and fusion. Beta decay. Neutrinos. Fermi theory, parity violation, V-A theory. Mesons and baryons. Lifetimes and decay processes. Discrete symmetries, C, P, T and G. Weak interaction transition rules. Strangeness, K mesons and hyperons. Hadron multiplets, composition of mesons and baryons. Quark model and quantum chromodynamics

Jyothsna Rani Komaragiri

An Introduction to Physical Concepts (Second edition),Springer,1999. Krane K.S.,Introductory Nuclear Physics,John Wiley & Sons

PH 217 (AUG) 3:0

Fundamentals of Astrophysics

Overview of the major contents of the universe. Basics of radiative transfer and radiative processes. Stellar interiors. HR diagram. Nuclear energy generation. White dwarfs and neutron stars. Shape, size and contents of our galaxy. Basics of stellar dynamics. Normal and active galaxies. High energy and plasma processes. Newtonian cosmology. Microwave background. Early universe.

Prerna Sharma

Choudhuri, A.R., Astrophysics for Physicists,Shu, F., The Physical Universe,Carroll, B.W., and Ostlie, D.A., Introduction to Modern Astrophysics

PH 231 (AUG) 0:1

Workshop Practice

Use of lathe, milling machine, drilling machine, and elementary carpentry. Working with metals such as brass, aluminium and steel

Vasant Natarajan

practical course,practical course,practical course

PH 300 (AUG) 0:1

Seminar Course

The course aims to help the fresh research student in seminar preparation, presentation and participation. The seminars will be given by the course registrants, after proper guidance by the instructors.

Aveek Bid,Ramesh K

Seminar course,Seminar Course,Seminar Course

PH 320 (AUG) 3:0

Condensed Matter Physics II

Review of one-electron band theory. Effects of electron-electron interaction: Hartree – Fock approximation, exchange and correlation effects, density functional theory, Fermi liquid theory, elementary excitations, quasiparticles. Dielectric function of electron systems, screening, plasma oscillation. Optical properties of metals and insulators, excitons. The Hubbard model, spin-and charge-density wave states, metal-insulator transition. Review of harmonic theory of lattice vibrations. Anharmonic effects. Electron-phonon interaction – phonons in metals, mass renormalization, effective interaction between electrons, polarons. Transport phenomena, Boltzmann equation, electrical and thermal conductivities, thermo-electric effects. Superconductivity–phenomenology, Cooper instability, BCS theory, Ginzburg-Landau theory

Faculty PH

Ashcroft, N.W., and Mermin, N.D., Solid State Physics, Saunders College, Philadelphia.,Madelung, O., Introduction to Solid State Theory, Springer-Verlag, Berlin.,Jones, W., and March, N.H., Theoretical Solid State Physics, Dover Publications, New York

PH 325 (AUG) 3:0

Advanced Statistical Physics

Systems and phenomena. Equilibrium and non-equilibrium models. Techniques for equilibrium statistical mechanics with examples, exact solution, mean field theory, perturbation expansion, Ginzburg Landau theory, scaling, numerical methods. Critical phenomena, classical and quantum. Disordered systems including percolation and spin glasses. A brief survey of non-equilibrium phenomena including transport, hydrodynamics and non-equilibrium steady states.

Rahul Pandit,Sriram Ramaswamy

Chaikin, P.M., and Lubensky, T.C., Principles of Condensed Matter Physics, Cambridge University Press, 1995,Plischke, M., and Bergersen, B., Equilibrium Statistical Physics, Second Edn, World Scientific, 1994.,Sethna, J.P., Statistical Mechanics: Entropy, Order Parameters and Complexity, Oxford Univ. Press, 2006.

PH 330 (AUG) 0:3

Advanced Independent Project

Open to research students only

Faculty PH

Project Course,Project Course,Project Course

PH 351 (AUG) 3:0

Crystal Growth, Thin films

Basic concepts and experimental methods of crystal growth: nucleation phenomena, mechanisms of growth, dislocations and crystal growth, crystal dissolutions, phase equilibria, phase diagrams and material preparation, growth from liquid-solid equilibria, vapour- solid equilibria, monocomponent and multi-component techniques. Thin film growth and characterization: concepts of ultra high vacuum, nucleation and growth mechanisms, deposition techniques such as sputtering, evaporation, LPE,MOCVD, MBE, PLD, etc., thick ness measurements and characterization such as RHEED, LEED thin-film XRD, etc.

Suja Elizabeth,Anil Kumar P S

Laudise, R. A. ; Growth of Crystals, Prentice-Hall, 1970,Hurle, D.T.J.,(ed.), Hand Book of Crystal Growth, Ed., North Holland,1994 Chopra , K.L., Thin Film Phenomena, McGrow Hill, USA, 1969

PH 362 (AUG) 2:0

Radiative Processess in Astrophysics

Elements of radiative transfer and stellar atmospheres. Theory of grey atmospheres. Covariant formulation of classical electrodynamics. Radiation from accelerated charges. Cyclotron and synchrotron radiation. Bremsstrahlung. Thomson and Compton scattering. Plasma effects. Atomic and molecular spectra. Transition rates and selection rules. Opacity calculations. Line formation in stellar atmospheres.

Rybicki, G.B. and Lightman, A.P.,Radiative Processes in Astrophysics,Mihalas, D.: Stellar Atmospheres

PH 363 (AUG) 2:0

Introduction to Fluid Mechanics and Plasma Physics

Boltzmann equation. Derivation of fluid equations. An introduction to stellar dynamics. Important properties of ideal and viscous fluid flows. Gas dynamics. Waves in fluids. Hydrodynamics stability. Turbulence. Plasma orbit theory. Debye shielding and collective behaviour. Waves and oscillations inplasmas. From the Vlasov equation to MHD equations. Flux freezing. MHD waves. Reconnection andrelaxation. Dynamo theory.

Choudhuri, A.R.: The Physics of Fluids and Plasmas.,Landau, L.D. and Lifshitz, E.M.: Fluid Mechanics. Chen, F.F.: Introduction to Plasma Physics,V.Krishan, Atrophysical Plasmas and Fluids, Kluwer

PH 202 (JAN) 3:0

Statistical Mechanics

Basic principles of statistical mechanics and its application to simple systems. Probability theory, fundamental postulate, phase space, Liouville's theorem, ergodicity, micro-canonical ensemble, connection with thermodynamics, canonical ensemble, classical ideal gas, harmonic oscillators, paramagnetism, Ising model, physical applications to polymers, biophysics. Grand canonical ensemble, thermodynamic potentials, Maxwell relations, Legendre transformation. Introduction to quantum statistical mechanics, Fermi, Bose and Boltzmann distribution, Bose condensation, photons and phonons, Fermi gas, classical gases with internal degrees of freedom, fluctuation, dissipation and linear response, Monte Carlo and molecular dynamics methods.

Justin Raj David

Pathria, R.K., Statistical Mechanics, Butterworth Heinemann, Second Edn, 1996,Reif, F., Fundamentals of Statistical and Thermal Physics, McGraw Hill, 1965.,Landau, L.D., and Lifshitz E.M., Statistical Physics, Pergamon, 1980.

PH 204 (JAN) 3:0

Quantum Mechanics II

Time dependent perturbation theory. Fermi golden rule. Transitions caused by a periodic external field. Dipole transitions and selection rules. Decay of an unstable state. Born cross section for weak potential scattering. Adiabatic and sudden approximations. WKB method for bound states and tunneling. Scattering theory: partial wave analysis, low energy scattering, scattering length, Born approximation, optical theorem, Levinson's theorem, resonances, elements of formal scattering theory. Minimal coupling between radiation and matter, diamagnetism and paramagnetism of atoms, Landau levels and Aharonov- Bohm effect. Addition of angular momenta, Clebsch Gordon series, Wigner Eckart theorem, Lande's g factor. Many particle systems: identity of particles, Pauli principle, exchange interaction, bosons and fermions. Second quantization, multielectron atoms, Hund's rules. Binding of diatomic molecules. Introduction to Klein Gordon and Dirac equations, and their nonrelativistic reduction, g factor of the electron.

Biplob Bhattacherjee

Landau, L.D., and Lifshitz E.M., Quantum Mechanics, Pergamon, NY, 1974.,Cohen-Tannoudji, C., Diu, B., and Laloe, F., Quantum Mechanics (2 Vols.),,John Wiley, 1977

PH 206 (JAN) 3:0

Electromagnetic Theory

Laws of electrostatics and methods of solving boundary value problems. Multi-pole expansion of electrostatic potentials, spherical harmonics. Electrostatics in material media, dielectrics. BiotSavart Law, magnetic field and the vector potential. Faraday's Law and time varying fields. Maxwell's equations, energy and momentum of the electromagnetic field, Poynting vector, conservation laws. Propagation of plane electromagnetic waves. Radiation from an accelerated charge, retarded and advanced potentials, Lienard-Wiechert potentials, radiation multi-poles. Special theory of relativity and its application in electromagnetic theory. Maxwell's equations in covariant form: four – potentials, electromagnetic field tensor, field Lagrangian. Elements of classical field theory, gauge invariance in electromagnetic theory.

Arnab Roy Choudhury

Jackson, J.D., Classical Electrodynamics, Third Edn, John Wiley.,Panofsky, W.K.H., and Phillips, M., Classical Electricity and Magnetism, Second Edn, Dover,Jackson, J.D., Classical Electrodynamics, Third Edn, John Wiley

PH 207 (JAN) 1:2

Electronics I

Basic diode and transistor circuits, operational amplifier and applications, active filters, voltage regulators, oscillators, digital electronics, logic gates, Boolean algebra, flip-flops, multiplexers, counters, displays, decoders, D/A, A/D. Introduction to microprocessors.

Rajan K

Horowitz and Hill, The Art of Electronics, Second Edn.,Millman and Halkias, Integrated Electronics, McGraw Hill.,Horowitz and Hill, The Art of Electronics, Second Edn.

PH 208 (JAN) 3:0

Condensed Matter Physics-I

Drude model, Sommerfeld model, crystal lattices, reciprocal lattice, X-ray diffraction, Brillouin zones and Fermi surfaces, Bloch's theorem, nearly free electrons, tight binding model, selected band structures, semi-classical dynamics of electrons, measuring Fermi surfaces, cohesive energy, classical harmonic crystal, quantum harmonic crystal, phonons in metals, semiconductors, diamagnetism and paramagnetism, magnetic interactions.

Anindya Das

Ashcroft, N.W., and Mermin, N.D., Solid State Physics, Holt-Saunders International, NY, 1976.,Kittel, C., Introduction to Solid State Physics, 5th/6th/7th editions, Wiley International, Singapore.,Ashcroft, N.W., and Mermin, N.D., Solid State Physics, Holt-Saunders International, NY, 1976.

PH 212 (JAN) 0:3

Experiments in Condensed.

Hall coefficient carrier mobility and life-time in semiconductors, resistivity measurement in anisotropic materials, crystal growth, crystal optics, light scattering, electron tunneling, resonance spectroscopy, coexistence curve for binary liquid mixtures, magnetic susceptibility, dielectric loss and dispersion. Meissner fraction of a high temperature superconductor, specific heat of a glass, microwave and rf absorption in high Tc materials, surface studies by STM in air, electron tunneling/STM magnetic susceptibility, calibration of a cryogenic temperature sensor (oxide/Ge sensor), resistivity vs temperature of a superconductor.

Victor Suvisesha Muthu D,Koteswara Rao K S R

Weider, Lab. notes of electrical measurements.,Smith and Richardson, Experimental methods in low temperature physics.,Weider, Lab. notes of electrical measurements.

PH 250 (JAN) 0:6

Project I

This two part project starts in the fourth semester of the Integrated Ph.D Programme (PH 250 A) and ends in the summer before the beginning of the 5th semester (PH 250B).

Faculty PH

Project Course,Project Course,Project Course

PH 316 (JAN) 3:0

Advanced Mathematical Methods

Symmetries and group theory. Finite and continuous groups with examples. Group operations and representations. Homomorphism, isomorphism and automorphism. Reducibility, equivalence, Schur's lemma. Permutation groups,Young diagrams. Lie groups and Lie algebras. SU(2), SU(3) and applications. Roots and weights. Dynkin diagrams. Classification of compact simple Lie algebras. Exceptional groups. Elements of topology and homotopy.

Chethan Krishnan

Georgi H., Lie Algebras in Particle Physics (Second edition), Perseus Books, 1999.,Mukhi S. and Mukunda N., Introduction to Topology, Differential Geometry and Group Theory for Physicists, Wiley Eastern, 1990,Hamermesh M., Group Theory and its Applications to Physical Problems, Addison-Wesley, 1962.

PH 322 (JAN) 3:0

Molecular Simulation

Introduction to molecular dynamics, various schemes for integration, inter- and intra-molecular forces, introduction to various force fields, methods for partial atomic charges, various ensembles (NVE, NVT, NPT, NPH), hard sphere simulations, water imulations, computing long-range interactions. Various schemes for minimization: conjugate radient, steepest descents. Monte Carlo simulations, the Ising model, various sampling methods, particle-based MC simulations, biased Monte Carlo. Density functional theory, free energy calculations, umbrella sampling, smart Monte Carlo, liquid crystal simulations, introduction to biomolecule simulations

Prabal Kumar Maiti

Prerequisites: Basic courses in statistical physics, quantum mechanics,Prerequisites: Basic courses in statistical physics, quantum mechanics,Prerequisites: Basic courses in statistical physics, quantum mechanics

PH 350 (JAN) 3:0

Physics of Soft Condensed Matter

Phases of soft condensed matter, colloidal fluids and crystals, polymer solutions, gels and meltsMicelles, vesicles, surfactant mesophaes, polymer colloids, microgels and star polymers-particles
with tunable soft repulsive interaction, surfactant and phospolipid membranes. Lyotropic liquid crystals. Structure and dynamics of soft matter, electrostatics in soft matter, dynamics at equilibrium. Glass formation and jamming, dynamical heterogeneity. Soft glassy rheology. Shear flow, linear and nonlinear rheology, visco-elastic models, Introductory biological physics. Active matter. Experimental methods, Small angle scattering and diffraction, Dynamic light scattering and diffusive wave spectroscopy, dynamics of soft matter using synchrotron X-ray and neutron scattering, rheometry. Conforcal microscopy.

Jaydeep Kumar Basu

Prerequisite: Knowledge of basic statistical mechanics Jones, R.A.L. Soft Condensed Matter, Oxford University Press, 2002,Rubinstein, M., and Colby, R.H. Polymer Physics, Oxford, 2003,Doi and Edwards, Theory of Polymer Dynamics, Clarendon, Oxford, 1988

PH 352 (JAN) 3:0

Semiconductor Physics

Semiconductor fundamentals: band structure, electron and hole statistics, intrinsic and extrinsic semiconductors, energy band diagrams, drift-diffusion transport, generation - recombination, optical absorption and emission. Basic semiconductor devices: on junctions, bipolar transistors, MOS capacitors, field-effect devices, optical detectors and emitters. Semiconductor technology: fundamentals of semiconductor processing techniques; introduction to planar technology for integrated circuits

Venkataraman V

Seeger, K., Semiconductor Physics, Springer-Verlag, 1990.,Sze, S.M., Physics of Semiconductor Devices, Wiley, 1980.,Muller, K., and Kamins, T., Device Electronics for Integrated Circuits, John Wiley, 1977.

PH 354 (JAN) 3:0

Computational physics

Introduction to computational physics; Machine representation, precision and errors; Roots of equations; Quadrature; Random numbers and Monte-Carlo Fourier methods Ordinary differential equations Numerical Linear algebra

Manish Jain

Mark Newman, Computational Physics, Createspace Independent Publishing (2015).,Rubin H. Landau, Manuel J. Paez and Cristian Bordeianu, Computational Physics, 3rd Ed Problem Solving with Python, Wiley (2015).,A. Klein and A. Godunov, Introductory Computational Physics, Cambridge University Press (2006),Forman Acton, Real computing made real: Preventing Errors in Scientific and Engineering Calculations, Dover Publications. Lloyd N. Trefethen and David Bau, Numerical Linear Algebra, SIAM.

PH 359 (JAN) 3:0

Physics at the Nanoscale

Introduction to different nanosystems and their realization, electronic properties of quantum confined systems: quantum wells, wires, nanotubes and dots. Optical properties of nanosystems: excitons and plasmons, photoluminescence, absorption spectra, vibrational and thermal properties of nanosystems, Zone folding. Raman characterization

Arindam Ghosh,Ambarish Ghosh

Delerue,C and Lannoo, M., Nanostructures: Theory and Modelling, Springer, 2006.,Saito, R., Dresselhaus, G., and Dresselhaus, M.S., Physical Properties of Carbon Nanotubes, Imperial College Press.,Delerue,C and Lannoo, M., Nanostructures: Theory and Modelling, Springer, 2006.

PH 364 (JAN) 3:0

Topological Phases of Matter (Theory and experiment)

The course is designed to teach the concepts and methods of various forms of topological phases of matter to mainly physics students. Some related concepts and their extensions such as Aharonov-Bohm effect, Berry phase, graphene, Majorana, Weyl fermions will also be taught. This is a combined theory and experimental course (no experiment will however be performed). Students are expected to have taken condensed matter I, but no prior knowledge of group theory is required.

Aveek Bid,Tanmoy Das

"Topological insulators", Shun-Qing Shen, Springer "Topological insulators and topological superconductors" B. Andrei Bernevig, and T. L. Hughes, Princeton University Press,"Topological insulators- The physics of spin helicity in quantum transport" G. Tkachov, Pan Stanford publishing,"Topological insulators" Marcel Franz, and L. Molenkamp, Elsevier "Colloquium: Topological band theory", A. Bansil. H. Lin and T. Das, Rev. Mod. Phys. 88, 021004 (2016).,"Colloquium: Topological insulators", M. Z. Hasan, C. L Kane, Rev. Mod. Phys. 82, 3045 (2010).,"Topological insulators and superconductor", X.-L. Si, S.-C. Zhang, Rev. Mod. Phys. 83, 1057 (2011).

PH 365 (JAN) 3:0

Galaxies and Interstellar Medium

Galactic structure: local and large scale distribution of stars and interstellar matter, the spiral structure, the galactic centre. Galactic dynamics, stellar relaxation, dynamical friction, star clusters, density wave theory of galactic spiral structure, chemical evolution in the galaxy, stellar populations. Galaxies, morphological classification of galaxies, active galaxies, clusters of galaxies, interactions of galaxies, dark matter, evolution of galaxies.

Nirupam Roy

Mihalas, D. and Binney, J.: Galactic Astronomy.,Binney, J. and Tremaine, S.: Galactic Dynamics,Spitzer, L.: Physical Process in the Interstellar Medium

PH 371 (JAN) 3:0

General Relativity & Cosmology

Foundations of general relativity. Elements of tensor analysis. Schwarzschild and Kerr spacetimes. Black hole physics. Gravitational radiation. Cosmological models. Observational tests. The early universe. The microwave background. Formation of structures.

Banibrata Mukhopadhyay

Landau, L.D., and Lifshitz, E.M.: The Classical Theory of Fields.,Weinberg, S.: Gravitation and Cosmology.,Peebles, P.J.E.: Physical Cosmology.

PH 377 (JAN) 0:2

Astronomical Techniques (Seminar Course)

Radio: coordinate system, detection principles, resolution and sensitivity, interferometry and aperturesynthesis. IR/Optical/UV: CCD fundamentals, imaging systems, point-spread-function, sensitivity, photometry and spectroscopy, speckle techniques, adaptive optics. X-ray/Gamma-ray astrophysics: detection principles, detectors and imaging systems, resolution and sensitivity, detector response, data analysis methods for spectroscopic and timing studies. Coordinated laboratory / data analysis exercises in each of the three areas.

Faculty PH

Christianson, W.N., & Hogbohm, J.A.: Radio Telescopes Roy, A.E., & Clarke, D.: Astronomy Principles and Practice.,Kitchin, C.R.: Astrophysical Techniques.,G.F.Knoll;, Radiation Detection and Measurement (2nd ed), Wiley, NY N.Tsoulfanidis, Measurement and Detection of Radiation (2nd ed), Taylor & Francis, Washington DC

PH 396 (JAN) 3:0

Quantum Field Theory 2

Abelian gauge theories. QED processes and symmetries. Loop diagrams and 1-loop renormalization. Lamb shift and anomalous magnetic moments. Nonabelian gauge theories. Faddeev-Popov ghosts. BRST quantization. QCD beta function, asymptotic freedom. Spinor helicity formalism for gauge theories. Composite operators, operator product expansion. Anomalies. Lattice gauge theory, strong coupling expansion. Confinement and chiral symmetry breaking.

Sudhir Kumar Vempati

Schwartz M.D., Quantum field theory and the standard model, Cambridge University Press, 2014.,Srednicki M., Quantum Field Theory, Cambridge University Press, 2007.,Peskin M.E. and Schroeder D.V., An Introduction to Quantum Field Theory, Addison Wesley, 1995.,Weinberg S., The Quantum Theory of Fields, Vol. I: Foundations, Vol. II: Modern Applications, Cambridge University Press, 1996.

PH 398 (JAN) 3:0

General Relativity

Review of tensor calculus and properties of the Riemann tensor. Killing vectors, symmetric spaces. Geodesics. Equivalence principle and its applications. Scalars, fermions and gauge fields in curved space-time. Einstein's equations and black hole solutions. Schwarzschild solution, Motion of a particle in the Schwarzschild metric. Kruskal extension and Penrose diagrams. ReissnerNordstrom solution, Kerr solution. Laws of black hole physics. Gravitational collapse. Oppenheimer-Volkoff and Oppenheimer-Synder solutions, Chandrasekhar limit. Csomological models, Friedmann-Robertson-Walker metric. Open, closed and flat universes. Introduction to quantizing fields in curved spaces and Hawking radiation.

Aninda Sinha

Landau L.D. and Lifshitz E.M., The Classical Theory of Fields, Pergamon Press, 1975.,Weinberg S., Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity, John Wiley & Sons, 1972,,Wald R.M., General Relativity, Overseas Press, 2006.,Wald R.M., General Relativity, Overseas Press, 2006.,G. 't Hooft, Inroduction to General Relativity, Introduction to the theory of Black Holes, http://www.phys.uu.nl/~thooft/

Astronomy and Astrophysics

AA 362 (AUG) 3:0

Radiative Processess in Astrophysics

Elements of radiative transfer and stellar atmospheres. Theory of grey atmospheres. Covariant formulation of classical electrodynamics. Radiation from accelerated charges. Cyclotron and synchrotron radiation. Bremsstrahlung. Thomson and Compton scattering. Plasma effects. Atomic and molecular spectra. Transition rates and selection rules. Opacity calculations. Line formation in stellar atmospheres.

Rybicki, G.B. and Lightman, A.P.: Radiative Processes in Astrophysics.,Mihalas, D.: Stellar Atmospheres.,Rybicki, G.B. and Lightman, A.P.: Radiative Processes in Astrophysics.

AA 363 (AUG) 3:0

Introduction to Fluid Mechanics and Plasma Physics

Boltzmann equation. Derivation of fluid equations. An introduction to stellar dynamics. Important properties of ideal and viscous fluid flows. Gas dynamics. Waves in fluids. Hydrodynamics stability. Turbulence. Plasma orbit theory. Debye shielding and collective behaviour. Waves and oscillations inplasmas. From the Vlasov equation to MHD equations. Flux freezing. MHD waves. Reconnection andrelaxation. Dynamo theory.

Choudhuri, A.R.: The Physics of Fluids and Plasmas.,Landau, L.D. and Lifshitz, E.M.: Fluid Mechanics.,Chen, F.F.: Introduction to Plasma Physics,V.Krishan, Atrophysical Plasmas and Fluids, Kluwer

AA 365 (JAN) 3:0

Galaxies and Interstellar Medium

Galactic structure: local and large scale distribution of stars and interstellar matter, the spiral structure, the galactic centre. Galactic dynamics, stellar relaxation, dynamical friction, star clusters, density wave theory of galactic spiral structure, chemical evolution in the galaxy, stellar populations. Galaxies, morphological classification of galaxies, active galaxies, clusters of galaxies, interactions of galaxies, dark matter, evolution of galaxies.

Nirupam Roy

Mihalas, D. and Binney, J.: Galactic Astronomy.,Binney, J. and Tremaine, S.: Galactic Dynamics,Spitzer, L.: Physical Process in the Interstellar Medium.

AA 371 (JAN) 3:0

General Relativity & Cosmology

Foundations of general relativity. Elements of tensor analysis. Schwarzschild and Kerr spacetimes. Black hole physics. Gravitational radiation. Cosmological models. Observational tests. The early universe. The microwave background. Formation of structures.

Banibrata Mukhopadhyay

Landau, L.D., and Lifshitz, E.M.: The Classical Theory of Fields.,Weinberg, S.: Gravitation and Cosmology.,Peebles, P.J.E.: Physical Cosmology.

AA 377 (JAN) 0:2

Astronomical Techniques (Seminar Course)

Radio: coordinate system, detection principles, resolution and sensitivity, interferometry and aperturesynthesis. IR/Optical/UV: CCD fundamentals, imaging systems, point-spread-function, sensitivity, photometry and spectroscopy, speckle techniques, adaptive optics. X-ray/Gamma-ray astrophysics: detection principles, detectors and imaging systems, resolution and sensitivity, detector response, data analysis methods for spectroscopic and timing studies.
Coordinated laboratory / data analysis exercises in each of the three areas.

Faculty PH

Christianson, W.N., & Hogbohm, J.A.: Radio Telescopes Roy, A.E., & Clarke, D.: Astronomy Principles and Practice.,Kitchin, C.R.: Astrophysical Techniques.,G.F.Knoll;, Radiation Detection and Measurement (2nd ed), Wiley, NY N.Tsoulfanidis, Measurement and Detection of Radiation (2nd ed), Taylor & Francis, Washington DC

Centre for High Energy Physics

HE 215 (AUG) 3:0

Nuclear and Particle Physics

Radioactive decay, subnuclear particles. Binding energies. Nuclear forces, pion exchange, Yukawa potential. Isospin, neutron and proton. Deuteron. Shell model, magic numbers. Nuclear transitions, selection rules. Liquid drop model, collective excitations. Nuclear fission and fusion. Beta decay. Neutrinos. Fermi theory, parity violation, V-A theory. Mesons and baryons. Lifetimes and decay processes. Discrete symmetries, C, P, T and G. Weak interaction transition rules. Strangeness, K mesons and hyperons. Hadron multiplets, composition of mesons and baryons. Quark model and quantum chromodynamics.

Jyothsna Rani Komaragiri

Povh B., Rith K., Scholz C. and Zetsche F., Particles and Nuclei: An Introduction to Physical Concepts (Second edition), Springer, 1999.,Krane K.S., Introductory Nuclear Physics, John Wiley & Sons, 1988.,Griffiths D., Introduction to Elementary Particles John Wiley & Sons, 1987.,Perkins D.H., Introduction to High Energy Physics (Third edition), Addison-Wesley, 1987.

HE 391 (AUG) 3:0

Quantum Mechanics III

Path integrals in quantum mechanics. Action and evolution kernels. Free particle and harmonic oscillator solutions. Perturbation theory, transition elements. Fermions and Grassmann integrals. Euclidean time formulation, statistical mechanics at finite temperature. Relativistic quantum mechanics, Klein-Gordon and Dirac equations. Antiparticles and hole theory. Klein paradox. Nonrelativistic reduction. Coulomb problem solution. Symmetries P, C and T, spin-statistics theorem. Lorentz and Poincare groups. Wigner classification of single particle states. Weyl and Majorana fermions. Modern topics such as graphene, Kubo formulae. Introduction to conformal symmetry and supersymmetry.

Prasad Satish Hegde

Feynman R.P. and Hibbs A.R., Quantum Mechanics and Path Integrals, McGraw-Hill, 1965.,Bjorken J.D. and Drell S., Relativistic Quantum Mechanics, McGraw-Hill, 1965.,Greiner W., Relativistic Quantum Mechanics: Wave Equations (Third edition), Springer, 1990.,Peskin M.E. and Schroeder D.V., An Introduction to Quantum Field Theory, Addison Wesley, 1995.

HE 395 (AUG) 3:0

Quantum Field Theory I

Scalar, spinor and vector fields. Canonical quantisation, propagators. Symmetries and Noether theorem. Path integrals for bosonic and fermionic fields, generating functionals. Feynman diagrams. S-matrix, LSZ reduction formula. Interacting scalar and Yukawa theories. Covariant derivatives and gauge theories. Quantum electrodynamics. Gauge invariance, massless photons, Ward identity. Elementary processes. Scattering cross-sections, optical theorem, decay rates. Loop diagrams, power counting, divergences. Renormalization, fixed point classification. One loop calculations in QED. Callan-Symanzik equations, beta functions. Effective field theory.

Sachindeo Vaidya

Zee A., Quantum Field Theory in a Nutshell (Second edition), Princeton University Press, 2010.,Srednicki M., Quantum Field Theory, Cambridge University Press, 2007.,Ryder L.H., Quantum Field Theory (Second edition), Cambridge University Press, 1996.,Ramond P., Field Theory: A Modern Primer (Second edition), Levant Books, 2007.

HE 397 (AUG) 3:0

The Standard Model of Particle Physics

Weak interactions before gauge theory. V-A theory, massive vector bosons. Spontaneous symmetry breaking, Goldstone bosons, Higgs mechanism. Charged and neutral currents, gauge symmetries and SU(2)xU(1) Lagrangian. Flavour mixing, GIM mechanism. CP violation, K/B systems. Neutrinos. Electroweak precision measurements. Deep inelastic scattering, parton model. Chiral Lagrangians and heavy quark effective field theories. Introduction to supersymmetry and extra dimensions.

Rohini M Godbole

Georgi H., Weak Interactions and Modern Particle Theory, Benjamin/Cummings, 1984.,Halzen F. and Martin A.D., Quarks and Leptons: An Introductory Course in Modern Particle Physics, John Wiley & Sons, 1984.,Pokorski S., Gauge Field Theories (Second edition), Cambridge University Press, 2000.,Peskin M.E. and Schroeder D.V., An Introduction to Quantum Field Theory, Addison Wesley, 1995.

HE 316 (JAN) 3:0

Advanced Mathematical Methods in Physics

Symmetries and group theory. Finite and continuous groups with examples. Group operations and representations. Homomorphism, isomorphism and automorphism. Reducibility, equivalence, Schur's lemma. Permutation groups, Young diagrams. Lie groups and Lie algebras. SU(2), SU(3) and applications. Roots and weights. Dynkin diagrams. Classification of compact simple Lie algebras. Exceptional groups. Elements of topology and homotopy.

Chethan Krishnan

Georgi H., Lie Algebras in Particle Physics (Second edition), Perseus Books, 1999.,Mukhi S. and Mukunda N., Introduction to Topology, Differential Geometry and Group Theory for Physicists, Wiley Eastern, 1990.,Hamermesh M., Group Theory and its Applications to Physical Problems, Addison-Wesley, 1962.

HE 384 (JAN) 3:0

Quantum Computation

Foundations of quantum theory. States, observables, measurement and unitary evolution. Qubits versus classical bits, spin-half systems and photon polarisations. Pure and mixed states, density matrices. Extension to positive operator valued measures and superoperators. Decoherence and master equations. Quantum entanglement and Bell's theorems. Introduction to classical information theory and generalisation to quantum information. Dense coding, teleportation and quantum cryptography. Turing machines and computational complexity. Reversible computation. Universal quantum logic gates and circuits. Quantum algorithms: database search, FFT and prime factorisation. Quantum error correction and fault tolerant computation. Physical implementations of quantum computers.

Apoorva Patel

Nielsen M.A. and Chuang I.L., Quantum Computation and Quantum Information, Cambridge University Press, 2000.,Preskill J., Lecture Notes for the Course on Quantum Computation, http://www.theory.caltech.edu/people/preskill/ph229,Peres A., Quantum Theory: Concepts and Methods, Kluwer Academic, 1993.

HE 386 (JAN) 3:0

Experimental High Energy Physics

Particles and interactions in the standard model. Strong, weak and electromagnetic interactions. Kinematics of particle interactions. Concepts of accelerators, linear and circular Accelerators. Introduction to particle detectors, interaction of particles with matter. Gaseous detectors, scintillator detectors, solid state detector. Readout electronics, vertex detection and tracking. Calorimetry for electrons, photons, charged hadrons and neutrons. Particle identification and detector systems. Experimental tests of the building blocks of matter and their fundamental interactions. Examples of QCD tests, top quark, Z and W bosons, Higgs boson, new particle searches. Review of some particle physics experiments, concepts of collider physics, basic phenomenology of a hard scattering process. Data analysis techniques in collider physics, statistical analysis in particle physics.

Somnath Choudhury

Perkins D.H., Introduction to High Energy Physics (Third edition), Addison-Wesley, 1987.,Leo W.R., Techniques for Nuclear and Particle Physics Experiments: A How to Approach (Second revised edition) Narosa/Springer International, 2012.,Knoll G.F., Radiation Detection and Measurement (Fourth edition), Wiley, 2010.,Grupen C. and Schwartz B., Particle Detectors (Second edition), Cambridge University Press, 2011.,Fernow R.C., Introduction to Experimental Particle Physics Cambridge University Press, 1986.

HE 396 (JAN) 3:0

Quantum Field Theory II

Abelian gauge theories. QED processes and symmetries. Loop diagrams and 1-loop renormalization. Lamb shift and anomalous magnetic moments. Nonabelian gauge theories. Faddeev-Popov ghosts. BRST quantization. QCD beta function, asymptotic freedom. Spinor helicity formalism for gauge theories. Composite operators, operator product expansion. Anomalies. Lattice gauge theory, strong coupling expansion. Confinement and chiral symmetry breaking.

Sudhir Kumar Vempati

Schwartz M.D., Quantum field theory and the standard model, Cambridge University Press, 2014.,Srednicki M., Quantum Field Theory, Cambridge University Press, 2007.,Peskin M.E. and Schroeder D.V., An Introduction to Quantum Field Theory, Addison Wesley, 1995.,Weinberg S., The Quantum Theory of Fields, Vol. I: Foundations, Vol. II: Modern Applications, Cambridge University Press, 1996.

HE 398 (JAN) 3:0

General Relativity

Review of tensor calculus and properties of the Riemann tensor. Killing vectors, symmetric spaces. Geodesics. Equivalence principle and its applications. Scalars, fermions and gauge fields in curved space-time. Einstein's equations and black hole solutions. Schwarzschild solution, Motion of a particle in the Schwarzschild metric. Kruskal extension and Penrose diagrams. Reissner-Nordstrom solution, Kerr solution. Laws of black hole physics. Gravitational collapse. Oppenheimer-Volkoff and Oppenheimer-Synder solutions, Chandrasekhar limit. Csomological models, Friedmann-Robertson-Walker metric. Open, closed and flat universes. Introduction to quantizing fields in curved spaces and Hawking radiation.

Aninda Sinha

Landau L.D. and Lifshitz E.M., The Classical Theory of Fields, Pergamon Press, 1975.,Weinberg S., Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity, John Wiley & Sons, 1972.,Wald R.M., General Relativity, Overseas Press, 2006.,G. 't Hooft, Inroduction to General Relativity, Introduction to the theory of Black Holes, http://www.phys.uu.nl/~thooft/

Division of Electrical Sciences

Preface

The Division of Electrical Sciences comprises the Departments of Computer Science and Automation (CSA), Electrical Communication Engineering (ECE), Department of Electronic Systems Engineering (DESE), and Electrical Engineering (EE). The courses offered in these departments have been grouped into ten professional areas identified by the following codes which appear as prefixes to the course numbers.

E0	Computer Science and Engineering
E1	Intelligent Systems and Automation
E2	Communication Systems
E3	Electronic Devices, Circuits and Technology
E4	Power and Energy Systems
E5	High Voltage and Insulation Engineering
E6	Power Electronics and Drives
E7	Photonic Devices, Circuits and Systems
E8	Electromagnetic, Microwaves and Antennas
E9	Signal Processing, Acoustics and Bioengineering
EP	Dissertation Project

All departments of the Division provide facilities for research work leading to the Ph D and M Tech (Research) degrees. The following course based Master's program are offered individually or jointly by the departments of the Division.

M Tech in Electrical Engineering (EE Department)
M Tech in Communication and Networks (ECE Department)
M Tech in Computer Science and Engineering (CSA Department)
M Tech in Electronics Design and Technology (ESE Department)
M Tech in Systems Science and Automation (EE and CSA Departments.)
M Tech in Signal Processing (EE and ECE Departments)
M Tech in Microelectronic Systems (ECE and ESE Departments)

Prof. Y Narahari
Chairman,
Division of Electrical Sciences

Department of Computer Science and Automation
POOL COURSES FOR 2017-2019 BATCH

POOL A

Course No	Credits	Course Title
E0 203	3:1	Spectral Algorithms
E0 220	3:1	Graph Theory
E0 221	3:1	Discrete Structures
E0 222	3:1	Automata Theory and Computability
E0 224	3:1	Computational Complexity Theory
E0 225	3:1	Design and Analysis of Algorithms
E0 228	3:1	Combinatorics
E0 229	3:1	Foundations of Data Science
E0 234	3:1	Introduction to Randomized Algorithms
E0 235	3:1	Cryptography
E0 244	3:1	Computational Geometry and Topology
E0 248	3:1	Theoretical Foundations of Cryptography
E0 249	3:1	Approximation Algorithms

POOL B

Course No	Credits	Course Title
E0 202	3:1	Automated Software Engineering with Machine Learning
E0 210	3:1	Principles of Programming
E0 227	3:1	Program Analysis and Verification
E0 239	3:1	Software Reliability Techniques
E0 243	3:1	Computer Architecture
E0 252	3:1	Programming Languages: Design and Implementation
E0 253	3:1	Operating Systems
E0 254	3:1	Network and Distributed Systems Security
E0 255	3:1	Compiler Design
E0 256	3:1	Theory and Practice of Computer Systems Security
E0 261	3:1	Database Management Systems
E0 264	3:1	Distributed Computing Systems
E0 271	3:1	Computer Graphics
E0 272	3:1	Formal Methods in Software Engineering

POOL C

Course No	Credits	Course Title
E0 219	3:1	Linear Algebra and Applications
E0 230	3:1	Computational Methods of Optimization
E0 232	3:1	Probability and Statistics
E0 236	3:1	Information Retrieval
E0 238	3:1	Artificial Intelligence
E0 267	3:1	Soft Computing
E0 268	3:1	Practical Data Science
E0 270	3:1	Machine Learning
E1 246	3:1	Natural Language Understanding
E1 254	3:1	Game Theory
E1 277	3:1	Reinforcement Learning

MTech Programme in Communication & Networks (MTech (CN))

The programme will continue to require 36 units of coursework and 28 units of project work as under the current ME(TC) programme.

Core	4 courses	12 units
Soft Core	3 courses	9 units
Electives	remaining courses	15 units
Total		36 units

MINORS

(a) A new feature of the programme is that it give the students the option to graduate with one of 4 "Minors":
  (i) Minor in Integrated Circuits & Systems,
  (ii) Minor in Photonics,
  (iii) Minor in Radio-Frequency Systems
  (iv) Minor in Signal Processing
(b) The selection of a Minor is not however, mandatory.
(c) A student qualifies for a Minor if he/she takes at least 3 courses belonging to a basket of courses specific to each area.
(d) This basket of courses is further divided into two pools, Pool X and Pool Y and a student is required to take a total of 3 courses from Pool X and Pool Y combined and
  (i) at least two courses from Pool X in the case of a Minor in Integrated Circuits & Systems,
  (ii) at least one course from Pool X in the case of a Minor in either Photonics, Radio-Frequency Systems or Signal Processing.
(e) The selection of a minor takes place during the course of the programme by the student in consultation with his Faculty Advisor.
(f) It is understood that the default Major of all students enrolled in the programme is Communication & Networks.
(g) A student who does not opt for a Minor, can either choose to specialize further in the Major by taking 3 additional courses in the area of Communication & Networks or else choosing amongst the many electives available (in consultation with his Faculty Advisor).

IV. SAMPLE COURSE-UNIT BREAKUP

Here is a sample breakup of course units for a student opting for one of the Minors and taking two courses with placement in mind.

Core	4 courses	12 units
Soft Core	3 courses	9 units
Electives	2 courses	6 units
Minor	3 courses	9 units
Total		36 units

3

THE CORE

The following courses are required of every student in the programme and hence constitute the "Core"[1]:

(a) E2 202 (AUG) 3:0 Random Processes
(b) E2 211 (AUG) 3:0 Digital Communication
(c) E2 221 (AUG) 3:0 Communication Networks
(d) E1 244 (JAN) 3:0 Detection and Estimation Theory

SOFTCORE

Requirements:

(a) Students are required to take a total of 3 courses from the two pools, Pool A and B below.
(b) At least 2 of these courses must be from Pool A.

Pool A (in no particular order)
E2 201 (AUG) 3:0 Information Theory
E2 205 (AUG) 3:0 Error-Correcting Codes
E2 223 (AUG) 3:0 Communication Protocols
E2 242 (JAN) 3:0 CDMA & Multiuser Detection
E2 204 (JAN) 3:0 Stochastic Processes and Queueing Theory
E8 203 (AUG) 3:0 RF & Optical Engineering (proposed new course)
E2 203 (JAN) 3:0 Wireless Communication
E2 241 (JAN) 3:0 Wireless Networks

Pool B (in no particular order)
E1 251 (AUG) 3:0 Linear and Nonlinear Optimization
E2 212 (AUG) 3:0 Matrix Theory
E9 201 (AUG) 3:0 Digital Signal Processing
E1 254 (AUG/JAN) 3:1 Game Theory
E9 211 (JAN) 3:0 Adaptive Signal Processing
E9 221 (AUG) 3:0 Signal Quantization and Compression
E9 202 (JAN) 3:0 Advanced Digital Signal Processing : Non-linear Filters

instructor(s) for the academic year 2014-2015 is provided at the end of each course title, only as added information.

REQUIREMENTS FOR EACH MINOR

A. Minor in Integrated Circuits and Systems (ICS)

Requirements:

- Any 3 of the courses listed below under Pools X & Y
- with at least two courses from Pool X

will qualify a student for a “Minor in Integrated Circuits and Systems”.

Pool X
NE 205 (Aug) 3:0 Semiconductor Devices and Integrated Circuit Technology
E3 238 (AUG) 2:1 Analog VLSI Circuits
E0 284 (AUG) 2:1 Digital VLSI Circuits
E7 211 (JAN) 3:0 Photonics Integrated Circuits

Pool Y
E3 237 (JAN) 3:0 Integrated circuits for Wireless Communication
E3 239 (JAN) 2:1 Advanced VLSI Circuits
E8 262 (JAN) 3:0 CAD for High Speed Chip-Package-Systems

B. Minor in Photonics

Requirements:

- Any 3 of the courses listed below under Pools X & Y
- with at least one course from Pool X

will qualify a student for a “Minor in Photonics”.

Pool X
NE 213/E7 213 (Aug) 3:0 Introduction to Photonics)
E8 203 (AUG) 3:0 RF & Optical Engineering (proposed new course)
E7 231 (JAN) 3:0 Fiber-Optic Networks

Pool Y
E7 211 (JAN) 3:0 Photonics Integrated Circuits
E3 214 (AUG) 3:0 Microsensor Technologies
IN 247 (JAN) 3:0 Principles of Tomographic Imaging

C. Minor in Radio-Frequency Systems

Requirements:

- Any 3 of the courses listed below under Pools X & Y
- with at least one course from Pool X

will qualify a student for a "Minor in Radio-Frequency Systems".

Pool X
E8-242 (JAN) 2:1 Radio Frequency Integrated Circuits and Systems
E3 237 (JAN) 3:0 Integrated circuits for Wireless Communication

Pool Y
E8 202 (AUG) 2:1 Computational Electromagnetics
E8 203: (AUG) 3:0 RF & Optical Engineering (proposed new course)
E8 262 (JAN) 3:0 CAD for High Speed Chip-Package-Systems

D. Minor in Signal Processing

Requirements:

- Any 3 of the courses listed below under Pools X & Y
- with at least one course from Pool X

will qualify a student for a "Minor in Signal Processing".

Pool X
E9 202 (JAN) 3:0 Advanced Digital Signal Processing : Non-linear Filters
E9 211 (JAN) 3:0 Adaptive Signal Processing
E9 212 (JAN) 3:0 Spectrum Analysis
E9 213 (JAN) 3:0 Time-Frequency Analysis
E9 221 (AUG) 3:0 Signal Quantization and Compression

Pool Y
E1 213 (JAN) 3:1 Pattern Recognition and Neural Networks
E1 216 (JAN) 3:1 Computer Vision
E9 203 (JAN) 3:0 Compressed Sensing and Sparse Signal Processing
E9 262 (JAN) 3:0 Stochastic Models for Speech/Audio
E9 231 (AUG) 3:0 Digital Array Signal Processing

Project 28 Credits

EP 299	0:28	Dissertation Project
==========		
	0:03	May-July Term
	0:09	August-December Term
	0:16	January-April Term

==========

Electives: The balance of credits to make up the minimum of 64 credits required for completing the M.E. Programme (all at 200 level or higher) Electives from within/outside the department to be taken with the approval of the DCC/Faculty advisor.

M.Tech.. Programme in ELECTRICAL ENGINEERING
(Duration: 2 Years)
64 credits (M.Tech. (EE))

Course No.	Credits	Course Title	
Core Courses: Pool A (One Out of the Two Courses) 3 credits			
E1 241	3:0	Dynamics of Linear Systems (AUG)	Prasanta Kumar Ghosh
E1 251	3:0	Linear & Nonlinear Optimization ((AUG)	Muthuvel Arigovindan
Core Courses: Pool B (Seven Out of the Nine Courses) 21 credits			
E3 252	2:1	Digital Controller for Power Applications(JAN)	Kaushik Basu / U.J Shenoy
E4 231	3:0	Power System Dynamics and Control (AUG)	Gurunath G
E4 233	3:0	Computer Control of Power Systems (JAN)	Gurunath G
E4 234	3:0	Advanced Computer aided Power System Analysis (AUG)	Sarasij Das
E5 201	2:1	Production, Measurement and Application of High Voltage (AUG)	B S Rajanikanth/ B Subba Reddy
E5 206	3:0	HV Power Apparatus (JAN)	Udaya Kumar/.L.Satish/B.S. Rajanikanth
E6 201	2:1	Power Electronics (AUG)	G. Narayanan
E6 211	3:0	Electric Drives (JAN)	G. Narayanan
E8 201	3:0	Electromagnetism (AUG)	Udaya Kumar
*** Electives: 16 Credits**			
E0 247	3:1	Sensor Networks (AUG)	G.N. Rathna
E4 221	2:1	DSP & AI Techniques in Power System Protection (AUG)	U.J. Shenoy
E5 209	3:0	Over-voltages in Power Systems (JAN)	L. Satish
E5 212	3:0	Computational Methods for Electrostatics (JAN)	Udaya Kumar
E5 213	3:0	EHV/UHV Power Transmission Engineering (JAN)	Joy Thomas M
E5 215	2:1	Pulsed Power Engineering (AUG)	Joy Thomas M
E5 231	2:1	Outdoor Insulation (JAN)	Subba Reddy B/Udaya Kumar
E5 253	2:1	Dielectrics and Electrical Insulation Engg.(AUG)	Joy Thomas M
E6 221	3:1	Switched Mode Power Conversion (JAN)	Vinod John
E6 223	3:0	PWM Converters and Applications(JAN)	G.Narayanan
E6 225	3:0	Advanced Power Electronics	Kaushik Basu

Project: 24 Credits

EP 299 0: 24 Dissertation Project
***Not limited to the following list. Students are permitted to take other electives with the consent of the advisor.**

M.Tech. Programme Signal Processing
(Electrial Engineering)
(Duration: 2 Years)
64 credits

M.Tech. (SP)

I Hard Core 12 Credits (All courses are compulsory)			
Course No.	Credits	Title of the Course	Instructor/s
E1 244	3:0	Detection and Estimation Theory(JAN)	Aditya Gopalan / Parimal Parag, ECE
E1 251	3:0	Linear and Nonlinear Optimization(AUG)	Muthuvel Arigovindan, EE
E2 202	3:0	Random Processes(AUG)	Utpal Mukherji,/Anurag Kumar (ECE)
E2 212	3:0	Matrix Theory(AUG)	A G Ramakrishnan (EE)

II Soft Core Minimum of 12 credits			
Course No.	Credits	Title of the Course	Instructor/s
E1 213	3:1	Pattern Recognition and Neural Networks (JAN)	P.S. Sastry, EE
E1 216	3:1	Computer Vision (JAN)	Venu Madhav Govindu, EE
E2 211	3:0	Digital Communication (AUG)	B Sundar Rajan, ECE
E9 211	3:0	Adaptive Signal Processing (JAN)	K Rajgopal, EE
E9 221	3:0	Signal Quantization and Compression(AUG)	T V Sreenivas
E9 213	3:0	Time Frequency Analysis (JAN)	Chandra Sekhar S, EE
E9 241	2:1	Digital Image Processing (AUG)	Chandra Sekhar S, EE
E9 261	3:1	Speech Information Processing (JAN)	Prasanta Kumar Ghosh/Sriram Ganapathy, EE
E9 291	2:1	DSP System Design(AUG)	G.N.Rathna (EE)

Project: 28 Credits

EP 299 0:28 - Dissertation Project
Electives: The balance of credits to make up the minimum of 64 credits required to complete the M Tech Degree Programme (all at the 200 level or higher).

M.Tech. Programme in
Systems Science & Automation
(Duration: 2 Years)
64 credits

M.Tech. (SSA) - (2016-2018)

I Hard Core 13 Credits			
Course No.	Credits	Title of the Course	Instructor/s
E0 251	3:1	Data Structures and Algorithms(AUG)	Susheela Devi, CSA
E1 222	3:0	Stochastic Models and Applications(AUG)	P.S. Sastry, EE
E1 241	3:0	Dynamics of Linear Systems(AUG)	Prasanta Kumar Ghosh,EE
E1 251	3:0	Linear and Nonlinear Optimization(AUG)	Muthuvel Arigovindan, EE
	13 Credits		

II Soft Core Minimum of 12 Credits			
Course No.	Credits	Title of the Course	Instructor/s
E0 219	3:1	Linear Algebra and Applications(AUG)	Dilip Patil, CSA
E0 223	3:1	Automated Verification (JAN)	Aditya Kanade, CSA
E0 235	3:1	Cryptography	Sanjit Chatterjee
E0 241	3:1	Computer Communication Networks (JAN)	Shalab Bhatnagar CSA
E0 246	3:1	Real-Time Systems (JAN)	G.N. Rathna, EE
E0 268	3:1	Data Mining(JAN)	M. Narasimha Murthy/S.K. Shevade (CSA)
E0 270	3:1	Machine Learning (JAN)	Chiranjib Bhattacharyya, CSA
E1 213	3:1	Pattern Recognition and Neural Networks (JAN)	P.S. Sastry, EE
E1 216	3:1	Computer Vision (JAN)	Venu Madhav Govindu, EE
E1 244	3:0	Detection and Estimation Theory (JAN)	Aditya Gopalan / Parimal Parag, ECE
E1 254	3:1	Game Theory (JAN)	Y. Narahari, CSA
E9 201 *	3:0	Digital Signal Processing(AUG)	Soma Biswas , EE
E9 241	2:1	Digital Image Processing (AUG)	Chandra Sekhar S, EE
E9 261	3:1	Speech Information Processing (JAN)	Prasanta Kumar Ghosh/Sriram Ganapathy,EE

***(Above Course is recommended only for those who have not gone through a formal course)**

Project: 24 Credits

EP 299 0:24 - Dissertation Project
Electives: The balance of credits to make up the minimum of 64 credits required to complete the M Tech Degree Programme (all at the 200 level or higher).

ELECTRONIC SYSTEMS ENGINEERING

MTech Programme in Systems Engineering
(Duration: 2 Years)
64 credits

I Hard Core 13 Credits		
Course No.	Credits	Title of the Course
E0 251	3:1	Data Structures and Algorithms
E1 222	3:0	Stochastic Models and Applications
E1 241	3:0	Dynamics of Linear Systems
E1 251	3:0	Linear and Nonlinear Optimization

II Soft Core Minimum of 12 Credits		
Course No.	Credits	Title of the Course
E0 219	3:1	Linear Algebra and Applications
E0 223	3:1	Automated Verification
E0 235	3:1	Cryptography
E0 241	3:1	Computer Communication Networks
E0 246	3:1	Real-Time Systems
E0 268	3:1	Data Mining
E0 270	3:1	Machine Learning
E1 213	3:1	Pattern Recognition and Neural Networks
E1 216	3:1	Computer Vision
E1 244	3:0	Detection and Estimation Theory
E1 254	3:1	Game Theory
E2 212	3:0	Matrix Theory
E9 201 *	3:0	Digital Signal Processing
E9 241	2:1	Digital Image Processing
E9 261	3:1	Speech Information Processing

*(Above Course is recommended only for those who have not gone through a formal course)
Project: 24 Credits
EP 299 0:24 Dissertation Project
Electives: The balance of credits to make up the minimum of 64 credits required to complete the MTech Degree Programme (all at the 200 level or higher).

E0 Computer Science and Automation

E0 202 (JAN) 3:1

Automated Software Engineering with Machine Learning

Engineering high-quality software requires mastering advanced programming concepts, and dealing with large and complex code. This course will introduce program analysis and machine/deep learning techniques to help developers in this quest. It will focus on concurrency and security analysis of smartphone and web applications. There is growing realization in the software community that we can learn useful program properties from large codebases by treating code as data, and augmenting program analysis with machine learning. This course will introduce machine/deep learning techniques to build probabilistic models of source code, and discuss how they can be used to solve novel problems in software engineering. Programming Language Processing: tokenization, parsing and semantic analysis, graph representations, syntactic transformations. Smartphone and Web Programming: multi-threading, asynchronous event-handling, permissions. Program Analysis: static and dynamic analysis of concurrent programs, model checking, information flow analysis for security, random testing. Probabilistic Models of Source Code: program embeddings, probabilistic grammars, statistical language models, structural models. Applications of Machine Learning (e.g., code completion, software testing and debugging).

References:

Zigurd Mednieks and Laird Dornin and G. Blake Meike and Masumi Nakamura. Programming Android. O'Reilly, 2011.
David Harman. Effective JavaScript. Addison-Wesley, 2012.
Steve Souders. Even Faster Websites. O'Reilly, 2009.
Ian Goodfellow and Yoshua Bengio and Aaron Courville. Deep Learning. MIT Press, 2016.
Research papers.

Aditya Sunil Kanade

None,None,None

E0 203 (JAN) 3:1

Spectral Algorithms

Spectral graph algorithms are very popular in theoretical computer science and machine learning, as they provide polynomial time approximations to several hard computational problems. This course will cover some basic topics in spectral graph theory and algorithms with some applications to network analysis. This course emphasizes rigorous analysis of algorithms. Overview of Linear Algebra and Matrix theory, Perron-Frobenius theory, Rayleigh Ratios, Laplacians, Spectral graph partitioning algorithm, Cheeger?s inequal- ity, Davis-Kahan theorem and perturbation analysis, Community detection in networks and stochastic block models, SVD, Mixture Models, Probabilistic spectral clustering, Recursive spectral clustering, optimization via low-rank approximation.

References:

Fan Chung, Spectral Graph Theory, AMS 1997.
Ravindran Kannan, Santosh Vempala, Spectral Algorithms, NOW Publishers, 2009.
Andries E. Brouwer, Willem H. Haemers, Spectra of graphs, Springer 2011.

Anand Louis,Ambedkar Dukkipati

Prerequisites Any course in Linear Algebra or Matrix Theory.,None,None

E0 210 (AUG) 3:1

Principles of Programming

Motivation and objectives of the course:

The design and implementation of scalable, reliable and secure software systems is critical for many modern applications. Numerous program analyses are designed to aid the programmer in building such systems and significant advances have been made in recent years. The objective of the course includes introduction of the practical issues associated with programming for modern applications, the algorithms underlying these analyses, and applicability of these approaches to large systems. There will be special emphasis on practical issues found in modern software. The course project will be geared towards building the programming skills required for implementing large software systems.

Syllabus:

The course will introduce the students to the following topics -- bytecode instrumentation; profiling -- BL profiling, profiling in the presence of loops, preferential path profiling, memory profiling; software bloat; lock-free data structures; memoization; map-reduce programming model; approximate computing; multithreading; fuzzing techniques; record and replay; memory models; data races -- lockset algorithm, happens-before relation, causally-precedes relation; atomicity violations; deadlocks; linearizability; symbolic execution; concolic testing; directed program synthesis; constraint solving; deterministic/stable multithreaded systems; floating-point problems; security -- sql-injection, cross-site scripting, return-oriented programming, obfuscation; malware detection.

References:

Course material available from the webpage; research papers

Gopinath K

Basic knowledge of programming in C/C++/Java.,none,none

E0 219 (AUG) 3:1

Linear Algebra and Applications

Vector Spaces : Subspaces, Linear independence, Basis and dimension, orthogonality. Matrices : Solutions of linear equations, Gaussian elimination, Determinants, Eigenvalues and Eigenvectors, Characteristic polynomial, Minimal polynomial, Positive definite matrices and Canonical forms. Singular Value Decomposition, Applications.References:

G Strang, Linear Algebra and Applications, Thomson-Brooks/Cole, 4th edition, 2006.

Narasimha Murty M

none,none,none

E0 224 (AUG) 3:1

Computational Complexity Theory

Computational complexity theory is the fundamental subject of classifying computational problems based on their `complexities'. In this context, `complexity' of a problem is a measure of the amount of

resource (time/space/random bits, or queries) used by the best possible algorithm that solves the problem. The aim of this course is to give a basic introduction to this field. Starting with the basic definitions and properties, we intend to cover some of the classical results and proof techniques of complexity theory.

Introduction to basic complexity classes; notion of `reductions' and `completeness'; time hierarchy theorem & Ladner's theorem; space bounded computation; polynomial time hierarchy; Boolean circuit complexity; complexity of randomized computation; interactive proofs; complexity of counting.

References:

The book titled `Computational Complexity - A Modern Approach' by Sanjeev Arora and Boaz Barak.
Lecture notes of similar courses as and when required.

Chandan Saha

Basic familiarity with undergraduate level theory of computation and data structures & algorithms would be helpful.,More importantly, some mathematical maturity with an inclination towards theoretical computer science.,none

E0 225 (AUG) 3:1

Design and Analysis of Algorithms

Greedy algorithms, divide and conquer strategies, dynamic programming, max flow algorithms and applications, randomized algorithms, linear programming algorithms and applications, NP-hardness, approximation algorithms, streaming algorithms.

References:
Kleinberg and Tardos, Algorithm Design, Addison Wesley, 2005.
Cormen, Leiserson, Rivest, and Stein, Introduction to Algorithms, 3rd Edition, Prentice Hall, 2009.

Arnab Bhattacharyya,Anand Louis

none,none,none

E0 227 (AUG) 3:1

Program Analysis and Verification

Dataflow analysis: Lattices, computing join-over-all-paths information as the least solution to a set of equations that model the program statements, termination of dataflow analysis, analysis of multi-procedure programs. Abstract interpretation of programs: Galois connections, correctness of dataflow analysis. Pointer analysis of imperative programs. Program dependence graphs, and program slicing. Assertional reasoning using Hoare logic. Type Systems: Monomorphic and polymorphic type systems, Hindley-Milner's type inference algorithm for functional programs.References:

Flemming Nielson, Hanne Riis Nielson, and Chris Hankin: Principles of Program Analysis, Springer, (Corrected 2nd printing, 452 pages, ISBN 3-540-65410-0), 2005.
Benjamic Pierce: Types and Programming Languages, Prentice-Hall India, 2002.
Research papers

Deepak DSouza,Raghavan K V

Exposure to programming,and the basics of mathematical logic and discrete structures.,none,none

E0 230 (AUG) 3:1

Computational Methods of Optimization

Need for unconstrained methods in solving constrained problems. Necessary conditions of unconstrained optimization, Structure of methods, quadratic models. Methods of line search, Armijo-Goldstein and Wolfe conditions for partial line search. Global convergence theorem, Steepest descent method. Quasi-Newton methods: DFP, BFGS, Broyden family. Conjugate-direction methods: Fletcher-Reeves, Polak-Ribierre. Derivative-free methods: finite differencing. Restricted step methods. Methods for sums of squares and nonlinear equations. Linear and Quadratic Programming. Duality in optimization.References:

Fletcher R., Practical Methods of Optimization, John Wiley, 2000.

Chiranjib Bhattacharyya

none,none,none

E0 232 (AUG) 3:1

Probability and Statistics

Probability spaces and continuity of probability measures, random variables and expectation, moment inequalities, multivariate random variables, sequence of random variables and different modes of convergence, law of large numbers, Markov chains, statistical hypothesis testing, exponential models, introduction to large deviations.

References:

An Introduction to Probability and Statistics by Vijay K. Rohatgi, A. K. Md. Ehsanes Saleh, Wiley, 2nd edition 2000.
An Intermediate course in Probability, by Allen Gut, Springer, 2008.

Shalabh Bhatnagar

none,none,none

E0 235 (JAN) 3:1

Cryptography

Elementary number theory, Finite fields, Arithmetic and algebraic algorithms, Secret key and public key cryptography, Pseudo random bit generators, Block and stream ciphers, Hash functions and message digests, Public key encryption, Probabilistic encryption, Authentication, Digital signatures, Zero knowledge interactive protocols, Elliptic curve cryptosystems, Formal verification, Cryptanalysis, Hard problems.

References:

Stinson. D. Cryptography: Theory and Practice.
Menezes. A. et. al. Handbook of Applied Cryptography

Sanjit Chatterjee,Arpita Patra

None,None,None

E0 238 (JAN) 3:1

Artificial Intelligence

ntroduction to Artificial Intelligence, Problem solving, knowledge and reasoning, Logic, Inference, Knowledge based systems, reasoning with uncertain information, Planning and making decisions, Learning, Distributed AI, Communication, Web based agents, Negotiating agents, Artificial Intelligence Applications and Programming.

References:

S. Russel and P. Norvig, Artificial Intelligence - A Modern Approach, Prentice Hall, 1995.
George F. Luger, Artificial Intelligence, Pearson Education, 2001.
Nils J. Nilsson, Artificial Intelligence - A New Synthesis, Morgan Kaufmann Publishers, 2000

Susheela Devi V

None,None,None

E0 243 (AUG) 3:1

Computer Architecture

Processor Architecture: Instruction-Level Parallelism,Superscalar and VLIW architecture; Multi-core processors;
Memory Subsystem: Multilevel caches, Caches in multi-core processors, Memory controllers for multi-core systems;
Multiple processor systems: shared and distributed memory system, memory consistency models, cache coherence, and Interconnection networks;
Advanced topics in architecture.

Govindarajan R

none,none,none

E0 244 (JAN) 3:1

Computational Geometry and Topology

Voronoi diagram, Delaunay triangulation, Geometric Data Structures — Interval tree, Range tree, Segment tree. Complexes — simplicial complex, Rips complex, alpha complex, homology, Betti numbers, persistence homology, Morse functions, Reeb graph, approximation and fixed parameter algorithms for geometric problems - hitting set and set cover, epsilon nets, epsilon approximations, geometric intersection graphs, geometric discrepancy, clustering.

References:

Computational Topology : An Introduction, Herbert Edelsbrunner and John L. Harer, American Mathematical Society, Indian Edition, 2010.
Computational Geometry: Algorithms and Applications, Mark de Berg, Otfried Cheong, Marc van Kreveld, and Mark Overmars, Third Edition, Springer (SIE), 2011.
Geometric Approximation Algorithms, Sariel Har-Peled, American Mathematical Society, Indian Edition, 2013.

Sathish Govindarajan,Vijay Natarajan

Prerequisites E0225 : Design and Analysis of Algorithms,None,None

E0 246 (JAN) 3:1

Real - time Systems

Hard and soft real-time systems, deadlines and timing constraints, workload parameters, periodic task model, precedence constraints and data dependency, real time scheduling techniques, static and dynamic systems, optimality of EDF and LST algorithms, off-line and on-line scheduling, clock driven scheduling, cyclic executives, scheduling of aperiodic and static jobs, priority driven scheduling, fixed and dynamic priority algorithms, schedulable utilization, RM and DM algorithms, priority scheduling of aperiodic and sporadic jobs, deferrable and sporadic servers, resource access control, priority inversion, priority inheritance and priority ceiling protocols, real-time communication, operating systems.
The Laboratory Classes will be conducted using TI C2000 Platform

Rathna G N

References: Jane, Liu W S, Real-Time Systems, Pearson Education, New Delhi, 2001.,Krishna C M and Kang G Shin, Real-time Systems, Tata McGraw-Hill, 2010. TI C2000 Platform Manuals.,Current literature.

E0 247 (AUG) 3:1

Sensor Networks

Basic concepts and issues, survey of applications of sensor networks, homogeneous and heterogeneous sensor networks, topology control and clustering protocols, routing and transport protocols, access control techniques, location awareness and estimation, security information assurance protocols, data fusion and management techniques, query processing, energy efficiency issues, lifetime optimization, resource management schemes, task allocation methods, clock synchronization algorithms. A Wi-Fi application, Communication between MSP 430 based Sensor nodes and with addition of Extra Sensors. Compute Total Energy and estimated life of Battery.

Rathna G N

Pre-requisite: Consent of Instructor,References: Raghavendra C S, Shivalingam K M and Znati T, Wireless Sensor Networks, Springer, New York, 2004.,Zhao T and Guibas L, Wireless Sensor Networks, An Information processing Approach, Morgan Kauffmann, San Fransisco 2004.,TI MSP 430 Platform Manuals and Current Literature.

E0 248 (AUG) 3:1

Theoretical Foundations of Cryptography

This course is a complexity-theoretic introduction to Cryptography. Emphasis will be placed on exploring connections between various fundamental cryptographic primitives via reductions.

Some of the primitives we will cover are one-way functions, pseudo-random generators, pseudo-random functions, trapdoor permutations, encryption, digital signatures, hash functions, commitments. We will also try to cover some special topics (private information retrieval, zero-knowledge proofs, oblivious transfer etc.).

Bhavana Kanukurthi

none,none,none

E0 251 (AUG) 3:1

Data Structures and Algorithms

Abstract data types and data structures, Classes and objects, Complexity of algorithms: worst case, average case, and amoritized complexity. Algorithm analysis. Algorithm Design Paradigms. Lists: stacks, queues, implementation, garbage collection. Dictionaries: Hash tables, Binary search trees, AVL trees, Red-Black trees, Splay trees, Skip-lists, B-Trees. Priority queues. Graphs: Shortest path algorithms, minimal spanning tree algorithms, depth-first and breadth-first search. Sorting: Advanced sorting methods and their analysis, lower bound on complexity, order statistics.

References:

A.V. Aho, J.E. Hopcroft, and J.D. Ullman, Data Structures and Algorithms, Addison Wesley, Reading Massachusetts, USA, 1983
T.H. Cormen, C.E. Leiserson, and R.L. Rivest, Introduction to Algorithms, The MIT Press, Cambridge, Massachusetts, USA, 1990
M.A. Weiss, Data Structures and Algorithms Analysis in C++, Benjamin/Cummins, Redwood City, California, USA, 1994.

Sathish Govindarajan

none,none,none

E0 252 (AUG) 3:1

Programming Languages - Design and Implementation

Example languages from each of the above categories would be discussed along with their implementation details. Formal semantics would be used to enhance the understanding of the features and to assist in the design of correct implementations. However, there will be no deep discussion of the theory. This is neither a course on compiler design nor a course on the theory of programming languages. Emphasis would be on understanding the features and their implementation. Students will be required to carry out mini projects as a part of the course.

Features and implementation of imperative, object-oriented, concurrent, distributed, logic-programming, functional, aspect-oriented, scripting, business-oriented and web programming languages.

References:

Robert Harper, Practical Foundations for Programming Languages, Cambridge University Press, 2012.
John Mitchell, Concepts in Programming Languages, Cambridge University Press, 2002.
John Reynolds, Theories of Programming Languages, Cambridge University Press, 2009.
Selected papers

Srikant Y N

None. However, programming in C/C++/Java/shell/Perl and a course on compiler design at the BE/BTech level would be helpful. There will be no overlap with the compiler design course in the CSA department (E0 255).,none,none

E0 253 (JAN) 3:1

Operating Systems

User Level Specification of OS. Fundamental Concepts of Multiprogrammed OS, Basic Concepts and Techniques for Implementation of Multiprogrammed OS. Processes and the Kernel, Microkernel Architecture of OS. Multiprocessor, Multimedia, and Real-Time OS. POSIX Standards. Management and Control of Processes. Basic Concept of Threads, Types of Threads, Models of Thread Implementations. Traditional and Real-Time Signals. Clocks, Timers and Callouts. Thread Scheduling for Unix, Windows, and Real-Time OS, Real-Time Scheduling. Interprocess/Interthread Synchronization and Communication, Mutual Exclusion/Critical Section Problem, Semaphores, Monitors, Mailbox, Deadlocks. Concepts and Implementation of Virtual Memory(32-bit and 64-bit), Physical Memory Management. File Organization, File System Interface and Virtual File Systems, Implementation of File Systems. I/O Software:Interrupt Service Routines and Device Drivers. Protection and Security. Case Study of Unix, Windows, and Real-Time OS.

References:

Andrew S. Tanenbaum: Modern Operating Systems, Second Edition, Pearson Education, Inc., 2001.

Uresh Vahalia: UNIX Internals: The New Frontiers, Prentice-Hall, 1996.

J. Mauro and R. McDougall: Solaris Internals: Core Kernel Architecture, Sun Microsystems Press, 2001.

Daniel P. Bovet and Marco Cesati: Understanding the Linux kernel, 2nd Edition O'Reilly & Associates, Inc., 2003.

Vinod Ganapathy

None,None,None

E0 254 (AUG) 3:1

Network and Distributed Systems Security

Security Goals and Violations; Security Requirements; Security Services; Discrete Logs, Encryption/Decryption Functions, Hash Functions, MAC Functions; Requirements and Algorithmic Implementation of One-Way Functions; OS Security Violations and Techniques to Prevent Them; Access Control Models; Secure Programming Techniques; Authenticated Diffie-Hellman Key Establishment Protocols; Group Key Establishment Protocols; Block Ciphers and Stream Ciphers; Modes of Encryption; Digital Signatures; Authentication Protocols; Nonce and Timestamps; PKI and X.509 Authentication Service; BAN logic; Kerberos; E-mail Security; IP Security; Secure Socket Layer and Transport Layer Security; Secure Electronic Transactions; Intrusion Detection; Malicious Software Detection; Firewalls.

References:

William Stallings: Cryptography and Network Security: Principles and Practices, Fourth Edition, Prentice Hall, 2006.

Neil Daswani, Christoph Kern and Anita Kesavan: Foundations of Security: What Every Programmer Needs to Know, Published by Apress, 2007.

Yang Xiao and Yi Pan: Security in Distributed and Networking Systems, World Scientific, 2007.

Current Literature.

Ramesh Chandra Hansdah

Knowledge of Java is desirable, but not necessary.,none,none

E0 255 (JAN) 3:1

Compiler Design

Control flow graphs and analysis; Dataflow analysis; Static single assignment (SSA); Compiler optimizations; Dependence analysis, Loop optimizations and transformations, Parallelization, Optimizations for cache locality, and Vectorization; Domain-specific languages, compilation, and optimization; Register allocation, Instruction scheduling; Run time environment and storage management; Impact of language design and architecture evolution on compilers.

References:

Aho, A.V., Ravi Sethi and J.D. Ullman: Compilers - Principles, Techniques and Tools, Addison Wesley, 1988.
S. Muchnick: Advanced Compiler Design and Implementation, Morgan Kauffman, 1998
Selected Papers.

Uday Kumar Reddy B

None,None,None

E0 256 (AUG) 3:1

Theory and Practice of Computer Systems Security

This course will seek to equip students with the fundamental principles and practice of computer systems security. The course will cover the major techniques of offense and defense, thereby educating students to think both as attackers and defenders. By the end of the course, students will have been exposed to the state of the art, and will be equipped with the background to start conducting original research in computer systems security. Core concepts such as basic security goals, threat models, notion of TCB and security policies vs. mechanisms. Operating system primitives for protection, reference monitors, authentication, and authorization. Examples of classic security policies from the literature (e.g., Biba, BLP) and their realization on modern systems. Various forms of hijacking attacks, such as buffer overflows, return-oriented programming, and non-control data attacks, and examples of such attacks as used by exploits in the wild. Design and implementation of defenses such as control-flow integrity, ASLR, privilege separation, capabilities, information-flow control and virtual machine introspection. Attacks and defenses against the Web ecosystem, mobile devices and the cloud platform. Emerging role of modern hardware in improving systems security. Other assorted topics based on current research literature.

References:

Security Engineering, 2nd Edition, Wiley, by Ross Anderson.
http://www.cl.cam.ac.uk/~rja14/book.html (free online copy)
Research papers from systems security conferences and journals.

Vinod Ganapathy

None,but standard undergraduate-level exposure to OS,computer architecture and compilers courses will be assumed.,none,none

E0 259 (AUG) 3:1

Data Analytics

Data Analytics is assuming increasing importance in recent times. Several industries are now built around the use of data for decision making. Several research areas too, genomics and neuroscience being notable examples, are increasingly focused on large-scale data generation rather than small-scale experimentation to generate initial hypotheses. This brings about a need for data analytics. This course will develop modern statistical tools and modelling techniques through hands-on data

analysis in a variety of application domains. The course will illustrate the principles of hands-on data analytics through several case studies (8-10 such studies). On each topic, we will introduce a scientific question and discuss why it should be addressed. Next, we will present the available data, how it was collected, etc. We will then discuss models, provide analyses, and finally touch upon how to address the scientific question using the analyses.Data sets from astronomy, genomics, visual neuroscience, sports, speech recognition, computational linguistics and social networks will be analysed in this course.Statistical tools and modeling techniques will be introduced as needed to analyse the data and eventually address these scientific questions. There will be a few guest lectures from industry also.

References:

Random Processes (E2 202) or Probability and Statistics (E0 232) or equivalent.

Rajesh Sundaresan,Ramesh Hariharan

none,none,none

E0 259 (AUG) 3:1

Data Analytics

Data sets from astronomy, genomics, neuroscience, sports, surveillance cameras, and social networks will be analysed to answer specific scientific questions. Statistical tools and modeling techniques will be introduced as needed to analyse the data and eventually address the scientific question.

Ramesh Hariharan,Rajesh Sundaresan

Prerequisites for taking this course are Random Processes (E2-202).,Probability and Statistics (E0-232),or equivalent. There is no text book for this course. Various handouts will be provided from different sources.

E0 259 (AUG) 3:1

Data Analytics

Data sets from astronomy, genomics, neuroscience, sports, surveillance cameras, and social networks will be analysed to answer specific scientific questions. Statistical tools and modeling techniques will be introduced as needed to analyse the data and eventually address the scientific question.

Rajesh Sundaresan,Ramesh Hariharan

Prerequisites for taking this course are Random Processes (E2-202).,Probability and Statistics (E0-232),or equivalent. There is no text book for this course. Various handouts will be provided from different sources.

E0 261 (AUG) 3:1

Database Management Systems

Design of Database Kernels, Query Optimization (Rewriting Techniques, Access Methods, Join Algorithms, Plan Evaluation), Transaction Management (ARIES), Distributed Databases (Query Processing and Optimization, Concurrency Control, Commit Protocols), Object-Relational Databases (Motivation, Design and Implementation), Spatial Databases (Storage, Indexing Techniques, Query Optimization), Data Mining (Association, Classification and Sequence Rules, Integration with Database Engines), Data Warehousing (Star and Snowflake Schemas, Data Cubes, View

Maintenance), Semistructured and Web Databases (Data Models, Query Systems, XML, XML-Schema, Relational Storage, Compression), Mobile Databases (Broadcast Disks, Indexing Techniques), Applications to E-commerce.

References:

Fundamentals of Database Systems R. Elmasri and S. B. Navathe, Addison-Wesley, 3rd ed., 1999.

Database Management Systems R. Ramakrishnan and J. Gehrke, McGraw-Hill, 2nd ed., 1999.

Readings in Database Systems M. Stonebraker and J. Hellerstein, Morgan Kaufmann, 3rd ed., 1998.

Object-Relational DBMSs M. Stonebraker, Morgan Kaufmann, 1996 .

Data Warehousing (Strategies, Technologies and Techniques) R. Mattison, IEEE Press, 1998.

Data Mining R. Groth, Prentice Hall, 1998.

Recent Conference and Journal papers.

Jayant R Haritsa

Data Structures, C or C++, Undergraduate course in DBMS,none,none

E0 264 (JAN) 3:1

Distributed Computing Systems

Fundamental Issues in Distributed Systems, Distributed System Models and Architectures; Classification of Failures in Distributed Systems, Basic Techniques for Handling Faults in Distributed Systems; Logical Clocks and Virtual Time; Physical Clocks and Clock Synchronization Algorithms; Security Issues in Clock Synchronization; Secure RPC and Group Communication; Group Membership Protocols and Security Issues in Group Membership Problems; Naming Service and Security Issues in Naming Service; Distributed Mutual Exclusion and Coordination Algorithms; Leader Election; Global State, Termination and Distributed Deadlock Detection Algorithms; Distributed Scheduling and Load Balancing; Distributed File Systems and Distributed Shared Memory; Secure Distributed File Systems; Distributed Commit and Recovery Protocols; Security Issues in Commit Protocols; Checkpointing and Recovery Protocols; Secure Checkpointing; Fault-Tolerant Systems, Tolerating Crash and Omission Failures; Implications of Security Issues in Distributed Consensus and Agreement Protocols; Replicated Data Management; Self-Stabilizing Systems; Design Issues in Specialized Distributed Systems.

References:

Randy Chow, and Theodore Johnson, "Distributed Operating Systems and Algorithms", Addison-Wesley, 1997.

Sukumar Ghosh, "Distributed Systems: An Algorithmic Approach", CRC Press, 2006.

Kenneth P. Birman, "Reliable Distributed Systems: Technologies, Web Services, and Applications", Springer New York, 2005.

G. Coulouris, J. Dollimore, and T. Kindberg, "Distributed Systems: Concepts and Designs", Fourth Edition, Pearson Education Ltd., 2005.

Current Literature

Ramesh Chandra Hansdah

Prerequisites NDSS(E0 254) or equivalent course,None,None

E0 265 (JAN) 3:1

Convex Optimization and Applications

The focus of the course will be on the fundamental aspects of convex analysis and optimization, both in terms of theory and algorithms. We will also look at various applications of convex optimization in inverse problems, signal processing, image reconstruction, communications, statistics, and machine learning. In the process of understanding the foundations of various algorithms, the students will be introduced to relevant topics in convex analysis and duality.

Topics

Review of relevant topics in real analysis, linear algebra, and topology. Topics in convex analysis: convex sets and functions, analytical and topological properties, projection onto convex sets, hyperplanes, separation theorems, sub-gradients, etc. Duality and its applications: Optimality conditions, duality, minimax theory, saddle points, KKT conditions.

Canonical programs for constrained optimization: Linear programming, cone programming, and semidefinite programming.

Classical algorithms: simplex, ellipsoid, and interior-point methods. Modern algorithms: accelerated gradient methods, proximal methods, FISTA, forward-backward splitting, augmented Lagrangian, ADMM, etc.

Discussion of some of the popular applications of convex optimization.

Kunal Narayan Chaudhury

References: Boyd S and Vandenberghe L, Convex Optimization,Cambridge University Press, 2004.,Bertsekas D P, Convex Optimization Theory, Athena Scientific, 2009.,Bertsekas D P, Nonlinear Programming, Athena Scientific, 1999.

E0 267 (AUG) 3:1

Soft Computing for Pattern Recognition

To introduce the student to the soft computing paradigm as compared to hard computing. To make them learn the techniques of soft computing like neural networks, fuzzy and rough systems, evolutionary algorithms etc. which can be applied to the task of classification, clustering, and other applications. Definition of soft computing, Soft computing vs. Hard computing; Advantages of soft computing, tools and techniques;Neural Networks : Fundamentals, backpropogation, associative memory, self organizing feature maps, applications;Fuzzy and rough sets : Concepts and applications; Evolutionary algorithms, swarm intelligence, particle swarm optimization, ant colony optimization, applications;Hybrid systems : Integration of neural networks, fuzzy logic and genetic algorithms, integration of genetic algorithms and particle swarm optimization, Applications.

References:

Timothy J.Ross, "Fuzzy Logic with Engineering Applications", McGraw-Hill,1997
David E.Goldberg,Genetic Algorithms in Search, Optimization, and Machine Learning, Pearson Education, 2009.
Melanie Mitchell, An introduction to genetic algorithms, Prentice Hall, 1998. 4. S. Haykin, Neural Networks?, Pearson Education, 2ed, 2001
Z. Pawlak, Rough Sets, Kluwer Academic Publisher, 1991.

Susheela Devi V

none,none,none

E0 268 (JAN) 3:1

Practical Data Science

Introduction, Data Preparation, Linear Methods for Classification and Regression, Additive Models and Tree based methods, Support Vector Machines, Model Assessment and Selection, Unsupervised Learning, Link Analysis, Recommendation Systems and Handling Large Datasets: MapReduce.

References:

James, Witten, Hastie and Tibshirani, An Introduction to Statistical Learning with Applications in R, Springer, 2015
Rajaraman, Leskovec and Ullman, Mining of Massive Datasets, Cambridge University Press, 2014
Hastie, Tibshirani and Friedman, The Elements of Statistical Learning, Springer, 2009
Recent literature

Shirish Krishnaji Shevade

Prerequisites Linear Algebra, Probability and Statistics, Some programming experience in any language.,None,None

E0 270 (JAN) 3:1

Machine Learning

Introduction to machine learning. Classification: nearest neighbour, decision trees, perceptron, support vector machines, VC-dimension. Regression: linear least squares regression, support vector regression. Additional learning problems: multiclass classification, ordinal regression, ranking. Ensemble methods: boosting. Probabilistic models: classification, regression, mixture models (unconditional and conditional), parameter estimation, EM algorithm. Beyond IID, directed graphical models: hidden Markov models, Bayesian networks. Beyond IID, undirected graphical models: Markov random fields, conditional random fields. Learning and inference in Bayesian networks and MRFs: parameter estimation, exact inference (variable elimination, belief propagation), approximate inference (loopy belief propagation, sampling). Additional topics: semi-supervised learning, active learning, structured prediction.

References:

Bishop. C M, Pattern Recognition and Machine Learning. Springer, 2006.
Duda, R O, Hart P E and Stork D G. Pattern Classification. Wiley-Interscience, 2nd Edition, 2000.
Hastie T, Tibshirani R and Friedman J, The Elements of Statistical Learning: Data Mining, Inference and Prediction. Springer, 2nd Edition, 2009.
Mitchell T, Machine Learning. McGraw Hill, 1997.
Current literature.

Chiranjib Bhattacharyya,Ambedkar Dukkipati

Prerequisites Probability and Statistics (or equivalent course elsewhere). Some background in linear algebra and optimization will be helpful.,None,None

E0 271 (AUG) 3:1

Computer Graphics

Principles of computer graphics; graphics pipeline; graphics hardware; transformations; viewing; lighting; shading; modeling; selected topics in meshing, subdivision techniques, multi-resolution methods, visualization, ray tracing; individual projects.

References:

Edward S. Angel. Interactive Computer Graphics, A top-down approach with OpenGL. Addison-

Wesley, 2005.
OpenGL Architecture Review Board, Dave Shreiner, Mason Woo, Jackie Neider, and Tom Davis. OpenGL Programming Guide: The Official Guide to Learning OpenGL. Addison-Wesley, 2005.
Donald Hearn and M. Pauline Baker. Computer Graphics with OpenGL. Prentice Hall, 2003.

Vijay Natarajan

Courses in linear algebra, data structures, algorithms, and programming.,none,none

E0 272 (JAN) 3:1

Formal Methods in Software Engineering

Domain modeling using first-order predicate logic and relational calculus -- the tools Alloy and Event-B. Verification of finite-state systems, and concurrent systems -- Spin. Verifying code correctness using logical reasoning -- VCC. Testing and bounded-exploration of applications -- Pex and AFL.

References:

Logic in Computer Science: Modelling and Reasoning about Systems, by Michael Huth and Mark Ryan.
Software Abstractions: Logic, Language, and Analysis, by Daniel Jackson.
Model Checking, by Edmund M. Clarke, Orna Grumberg, and Doron Peled.
Specifying software: A Hands-On Introduction, by R. D. Tennent.
Research papers.

Deepak DSouza,Raghavan K V

Prerequisites Exposure to programming, and the basics of mathematical logic and discrete structures.,None,None

E0 284 (AUG) 2:1

Digital VLSI Circuits

Introduction to MOS transistor theory, Circuit characterization & simulation, theory of logical effort, interconnect design and analysis combinational circuit design, sequential circuit design. Design methodology & tools, testing & verification, datapath subsystems, array subsystems, power and clock
distribution, introduction to packaging.

Santanu Mahapatra

N. Weste and D. Harris, CMOS VLSI Design. A Circuits and Systems Perspective, Addison Wesley, 2005,J. M. Rabaey, A. Chandrakasan, and B. Nikolic, Digital Integrated Circuits,Current Literature

E0 284 (MAY) 2:1

Digital VLSI Circuits

Introduction to MOS transistor theory, Circuit characterization & simulation, theory of logical effort, interconnect design and analysis combinational circuit design, sequential circuit design. Design methodology & tools, testing & verification, datapath subsystems, array subsystems, power and clock
distribution, introduction to packaging

Santanu Mahapatra

N. Weste and D. Harris, CMOS VLSI Design. A Circuits and Systems Perspective, Addison Wesley, 2005,J. M. Rabaey, A. Chandrakasan, and B. Nikolic, Digital Integrated Circuits,Current Literature

E0 302 (AUG) 3:1

Topics in Software Engineering

Course objective: Study and design of machine learning techniques to improve software engineering.

Motivation: Machine learning has become an effective technique for making sense of large datasets to glean actionable insights. Large software repositories such as open source gits, smartphone app stores and student submissions in MOOCs courses contain a wealth of information. The goal of this course is to study and design state-of-the-art machine learning techniques to improve software engineering using the large amount of code available.

Syllabus: Machine learning models for program analysis, automated program repair, program synthesis, mining software repositories, representation and deep learning for software engineering, programming language processing.

References:

Recent research papers

Aditya Sunil Kanade,Shirish Krishnaji Shevade

Background in programming,Data mining or machine learning course in CSA.,none

E0 304 (JAN) 3:1

Computational Cognitive Neuroscience

This reading course is focused on recent advances computational frameworks in cognitive neuroscience. We will review the state-of-the art in data analysis techniques that permit extracting meaningful information from noisy, high-dimensional brain data (e.g. machine learning and dimensionality reduction) as well as theoretical and computational models of brain function. The course will be organized into four reading modules on Machine learning and classification, Dimensionality reduction, Neural computation and Theory, and Deep convolutional neural networks, discussing recent applications in computational neuroscience. The project will require analyzing large-scale brain datasets, for example, decoding cognitive states from brain imaging data.

Sridharan Devarajan

Familiarity with machine learning, dimensionality reduction, and linear algebra at the advanced undergraduate/early graduate level.,Knowledge of coding (e.g. C/Matlab/Python) is essential.,Some background in neuroscience is preferred, but not essential (background readings will be provided).,,None

E0 312 (AUG) 3:1

Foundations of Secure Computation

Indistinguishability, real-ideal world and simulation-based security notions; Secret Sharing, Verifiable Secret Sharing, Oblivious Transfer, Circuit Garbling and function encoding, Commitment Scheme, Zero-knowledge Proof, Threshold Cryptography, Encryptions, Broadcast Byzantine Agreement, Coin-tossing protocol, Theoretical and practical protocols for secure computation in various models.

References:

Book: “Efficient Two-part Protocols- Techniques and Constructions” by Carmit Hazay and Yehuda Lindell.
Book Draft: “Secure Multiparty Computation and Secret Sharing - An Information Theoretic Appoach” by Ronald Cramer, Ivan Damgaard and Jesper Buus Nielsen.
Recent Research Papers

Arpita Patra

Mathematical maturity.,Basic level crypto course.,none

E0 320 (JAN) 3:1

Topics in Graph Theory

Minors: Introduction - properties which causes dense minors in graphs: average degree, girth, Wagner's characterisation of graphs without K5 minors. Tree Decompositions: treewidth, pathwidth, upper and lower bounds for treewidth, relation of treewidth and minors, influence on algorithmic graph problems. Hadwiger's conjecture - its relation with the four colour theorem, related work.

References:

Graph Theory (Chapters 8 and 12), Reinhard Diestel, Springer, 2000.
Current Literature

Sunil Chandran L

None,None,None

E0 322 (JAN) 3:1

Topics in Algebra and Computation

The course will consist of two parts: Computational aspects of algebra & number theory ; Use of algebraic methods in theoretical computer science. Part 1: Chinese remaindering, Discrete Fourier Transform, Resultant of polynomials, Hensel lifting, Automorphisms of rings, Short vectors in Lattices, Smooth numbers etc. - and show how these tools are used to design algorithms for certain fundamental problems like integer & polynomial factoring, integer & matrix multiplication, fast linear algebra, root finding, primality testing, discrete logarithm etc. Part 2: This will deal with certain applications of algebraic methods/algorithms in cryptography (RSA cryptosystem, Diffie-Hellman), coding theory (Reed-Solomon & Reed-Muller codes, locally decodable codes), analysis of boolean functions (Fourier analysis), and construction of expander graphs.

References:

Modern Computer Algebra by von zur Gathen and Gerhard.
Introduction to Finite Fields by Lidl & Niederreiter.
Relevant research papers and online lecture notes.

Chandan Saha

Prerequisites Basic familiarity with linear algebra and properties of finite fields (as in the Chapter 1-3 of the book 'Introduction to finite fields and their applications' by Rudolf Lidl and Harald Niederreiter). Alternatively, an undergraduate course in algebra. Most importantly, some mathematical maturity with an inclination towards theoretical computer science.,None,None

E0 325 (AUG) 3:1

Topics in Algorithms -- Probability and Statistics in High Dimensions

Many contemporary problems in data science require an understanding of high-dimensional statistics and probability to tackle the issues at hand. The goal of this course will be to give a tour through several mathematical phenomena that arise in high-dimensions and describe techniques to analyze them. Topics include concentration of measure, dimension reduction, restricted isometry, principal component analysis, and VC dimension, and applications to areas such as statistical inference (including linear regression and compressed sensing), empirical processes,and property testing.

Arnab Bhattacharyya,Siddharth Barman

E0 225 (Design and Analysis of Algorithms).,none,none

E0 332 (AUG) 3:1

Matrix Analysis and Computations

Matrix Analysis: Spectral theory of self-adjoint mappings, variational characterization of eigenvalues, perturbation theory for eigenvalues and eigenspaces of normal matrices, majorization and doubly stochastic matrices, numerical range of matrices, Perron-Frobenius theory, calculus of matrix-valued and vector-valued functions, and matrix inequalities.
Computations: Numerical algorithms for matrix factorizations, conditioning and stability, iterative solvers, Krylov subspace method, Arnoldi and Lancosz iterations, specialized Laplacian solvers, modern algorithms for parallel and randomized computations involving huge matrices.

Kunal Narayan Chaudhury

Prerequisites: Basic course on Linear Algebra/Matrix Theory.,References: Bellman R,Introduction to Matrix Analysis,SIAM,1987.

E0 334 (AUG) 3:1

Deep Learning for Natural Language Processing

Introduction, Multilayer Neural Networks, Back-propagation, Training Deep Networks; Simple word vector representations: word2vec, GloVe; sentence, paragraph and document representations. Recurrent Neural Networks; Convolutional Networks and Recursive Neural Networks; GRUs and LSTMs; building attention models; memory networks for language understanding. Design and Applications of Deep Nets to Language Modeling, parsing, sentiment analysis, machine translation etc.

References:

Ian Goodfellow , Yoshua Bengio and Aaron Courville. Deep Learning. MIT Press, 2016

Recent Literature.

Shirish Krishnaji Shevade

A course on Machine Learning or equivalent,none,none

E0 337 (JAN) 3:1

Topics in Advanced Cryptography

The goal of this course is to focus on cutting-edge research themes in cryptography and understand the mathematical objects and/or computational assumptions behind them. Advanced encryption schemes such as, for example, CCA secure encryption, circular secure encryption, searchable encryption, fully-homomorphic encryption and their underlying computational assumptions (LWE etc.). Other advanced topics such as puncturable PRFs, obfuscation, multilinear maps.

Bhavana Kanukurthi

Prerequisites A course in Cryptography and mathematical maturity.,None,None

E0 338 (AUG) 3:1

Topics in Security and Privacy

Recent technological advances in diverse domians such as CPS/IoT, cloud storage and computation, quantum information processing as well as proliferation of tools for digital mass surveillance have thrown up many interesting research problems. This course will focus on some of the theoretical questions in Security and Privacy from a cryptographic perspective. We plan to cover a subset of the following topics:(A) Cryptographic Security in a Post-Quantum World.(B) Design and Analysis of Privacy Enhancing Tools.(C) Efficient, Secure and Verifiable Query Processing in Outsourced Database.(D) Cryptocurrency, Smart Contracts, Blockchain and Applications.

References:

Recent research papers in the relevant areas.

Sanjit Chatterjee

Good performence in E0 235 (Cryptography) and consent of the instructor.,none,none

E0 343 (JAN) 3:1

Topics in Computer Architecture

Architecture and harware description languages (RTL, ISPS, vhdl). Processor architecture, Instruction level parallelism, Latency tolerance, multithreading, interconnection networks, Standards (bus, SCI), architectures, routing, Cache coherency, protocol specification, correctness, performance. Memory consistency models, synchronization primitives, parallel programming paradigms, I/O systems, Interface standards, parallel I/O, performance evaluation, analytical methods, simulation algorithms and techniques, benchmarking.

Matthew Jacob T

Prerequisites Computer Architecture, Operating Systems, Some Familiarity with Analytical Performance Evaluation Techniques.,None,None

E0 358 (AUG) 3:1

Advanced Techniques in Compilation and Programming for Parallel Architectures

Parallel architectures: a brief history, design, Auto-parallelization for multicores, GPUs, and

distributed Memory clusters Lock-free and wait-free data structures/algorithms for parallel programming Study of existing languages and models for parallel and high performance programming; issues in design of new ones.

References:

Aho, Lam, Sethi, and Ullman, Compilers: Principles, Techniques, and Tools, 2nd edition
Herlihy and Shavit, The Art of MultiProcessor Programming
Ananth Grama, Introduction to Parallel Computing
List of research papers and other material which will be the primary reference material will be available on course web page.

Uday Kumar Reddy B

Knowledge of "E0 255 Compiler Design" course content (especially on parallelization) will be very useful, but not absolutely necessary.,Knowledge of microprocessor architecture and some basic understanding of parallel programming models.,none

E0 361 (JAN) 3:1

Topics in Database Systems

Object-oriented Databases, Distributed and Parallel Databases, Multi-databases, Access Methods, Transaction Management, Query Processing, Deductive Databases, multimedia Databases, Real-Time Databases, Active Databases, Temporal Databases, Mobile Databases, Database Benchmarks, Database Security, Data Mining and Data Warehousing.

References:

Readings in Database Systems edited by M. Stonebraker, Morgan Kaufmann, 2nd ed., 1994.
Conference and Journal papers

Jayant R Haritsa

None,None,None

E1 Intelligent Systems and Automation

E1 213 (JAN) 3:1

Pattern Recognition and Neural Networks

Introduction to pattern recognition, Bayesian decision theory, supervised learning from data, parametric and non parametric estimation of density functions, Bayes and nearest neighbor classifiers, introduction to statistical learning theory, empirical risk minimization, discriminant functions, learning linear discriminant functions, Perceptron, linear least squares regression, LMS algorithm, artificial neural networks for pattern classification and function learning, multilayer feed forward networks, backpropagation, RBF networks, deep neural Networks, support vector machines, kernel based methods, feature selection and dimensionality reduction methods.

Subbayya Sastry P

Pre-requisite: Knowledge of Probability theory References:,Dudo R O, Hart P E & Stork D G, Pattern Classification John Wiley & sons, 2002.,Bishop C M, Neural Network & Pattern Recognition, Oxford University Press(Indian Edition) 2003.

E1 216 (JAN) 3:1

Computer Vision

This course will present a broad, introductory survey intended to develop familiarity with the approaches to modeling and solving problems in computer vision. Mathematical modeling and algorithmic solutions for vision tasks will be emphasised. Image formation: camera geometry, radiometry, colour. Image features: points, lines, edges, contours, texture; Shape: object geometry, stereo, shape from cues; Motion: calibration, registration, multiview geometry, optical flow; approaches to grouping and segmentation; representation and methods for object recognition. Applications;

Srinivasa Venu Madhav Govindu

References: David Forsyth and Jean Ponce , Computer Vision: A Modern Approach, Prentice-Hall India, 2003,Hartley R and Zisserman A, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, 2004.,Current literature

E1 222 (AUG) 3:0

Stochastic Models and Applications

Probability spaces, conditional probability, independence, random variables, distribution functions, multiple random variables and joint distributions, moments, characteristic functions and moment generating functions, conditional expectation, sequence of random variables and convergence concepts, law of large numbers, central limit theorem, stochastic processes, Markov chains, Poisson process.

Subbayya Sastry P

References: Ross S M,Introduction to Probability Models,(6th Edition),academic Press and Hardcourt Asia,2000.

E1 241 (AUG) 3:0

Dynamics of Linear Systems

Background material on matrix algebra, differential equations. Representation of dynamic systems, equilibrium points and linearization. Natural and forced response of state equations, state space descriptions, canonical realizations. Observability and controllability, minimal realization. Linear state variable feedback, stabilization, modal controllability, Jordan form, functions of matrices, pole-placement, Lyapunov matrix equations. Asymptotic observers, compensator design, and separation principle. Preliminary quadratic regulator theory.

Pavankumar Tallapragada

References :,Chi-Tsong Chen,Linear Systems Theory and Design,HBJ 1984.,Kailath T, Linear System Theory, Prentice Hall, 1980. Joao P. Hespanha, Linear System Theory, Princeton University Press, 2009

E1 243 (JAN) 2:1

Digital Controller Design

Modeling of Systems: input/output relations, linearization, transfer function and state space representations, circuit averaging, bond graph and space vector modeling; Control system essentialsrepresentation
in digital domain, z-transform, digital filters, s-z mapping, sampling issues, continuous
to discrete domain conversions; Controller design-Bode method, root locus method, PID controller, State space methods, full state feedback, pole placement, estimator design, prediction, current and reduced order estimators, introduction to optimal and robust controller design.

Umanand L

Franklin, G.F., Powell, J.D., Workman, M.L., Digital Control of Dynamic Systems, 2nd Ed., AddisonWesley, MA, USA, 1990,Friedland, B., Control System Design-An Introduction to State Space Methods, McGraw Hill, 1987,Lewis, F.L., Applied Optimal Control and Estimation, Prentice Hall, USA, 1992

E1 244 (JAN) 3:0

Detection and Estimation Theory

Hypothesis testing, Neyman-Pearson theorem, likelihood ratio test and generalized likelihood ratio test, uniformly most powerful test, multiple-decision problems, detection of deterministic and random signals in Gaussian noise, detection in non-Gaussian noise, sequential detection, introduction to nonparametric testing. Parameter Estimation: Unbiasedness, consistency, Cramer-Rao bound, sufficient statistics, Rao-Blackwell theorem, best linear unbiased estimation, maximum likelihood estimation. Bayesian estimation: MMSE and MAP estimators, Wiener filter, Kalman filter, Levinson-Durbin and innovation algorithms.

Aditya Gopalan

H. V. Poor,,An Introduction to Signal Detection and Estimation,Springer-Verlag, 2nd edition, 1994

E1 246 (JAN) 3:1

Natural Language Understanding

Syntax: syntactic processing; linguistics; parts-of-speech; grammar and parsing; ambiguity resolution; tree adjoint grammars. Semantics: semantic interpretation; word sense disambiguation;

logical form; scoping noun phrases; anaphora resolution. Pragmatics: context and world knowledge; knowledge representation and reasoning;local discourse context and reference; discourse structure; semantic web; dialogue; natural language understanding and generation. Cognitive aspects: mental models, language acquisition, language and thought; theories of verbal field cognition. Applications: text summarization, machine translation, sentiment analysis, perception evaluation, cognitive assistive systems; NLP tool-kits augmentation.

References:

Allen J, Natural language understanding, Pearson Education, 1995, 2003.
Jurafsky D, and Martin J H, Speech and language processing: an introduction to natural language processing, computational linguistics and speech recognition, Pearson Education, 2000, 2003.
Posner M I, Foundations of Cognitive Science, MIT Press, 1998.
Research Literature.

Partha Pratim Talukdar

Prerequisites Familiarity with programming (optionally including scripting languages); data structures, algorithms and discrete structures; reasonable knowledge of English language.,None,None

E1 251 (AUG) 3:0

Linear and Nonlinear Optimization

Necessary and sufficient conditions for optima; convex analysis; unconstrained optimization; descent methods; steepest descent, Newton's method, quasi Newton methods, conjugate direction methods; constrained optimization; Kuhn-Tucker conditions, quadratic programming problems; algorithms for constrained optimization; gradient projection method, penalty and barrier function methods, linear programming, simplex methods; duality in optimization, duals of linear and quadratic programming problems

Muthuvel Arigovindan

References: Luenberger D G,Introduction to Linear and Nonlinear Programming, 2nd edition, Addison Wesley, 1984.,Jorge Nocedal and Stephen J. Wright, Numerical Optimization, Second Edition, Springer, 2000.,Edwin Chong, Stanislaw Zak, An Introduction to Optimization, Wiley Student Edition.

E1 254 (JAN) 3:1

Game Theory

Introduction: rationality, intelligence, common knowledge, von Neumann - Morgenstern utilities; Noncooperative Game Theory: strategic form games, dominant strategy equilibria, pure strategy nash equilibrium, mixed strategy Nash equilibrium, existence of Nash equilibrium, computation of Nash equilibrium, matrix games, minimax theorem, extensive form games, subgame perfect equilibrium, games with incomplete information, Bayesian games. Mechanism Design: Social choice functions and properties, incentive compatibility, revelation theorem, Gibbard-Satterthwaite Theorem, Arrow's impossibility theorem, Vickrey-Clarke-Groves mechanisms, dAGVA mechanisms, Revenue equivalence theorem, optimal auctions. Cooperative Game Theory: Correlated equilibrium, two person bargaining problem, coalitional games, The core, The Shapley value, other solution concepts in cooperative game theory.

References:

Roger B. Myerson, Game Theory: Analysis of Conflict, Harvard University Press, September 1997.
Martin J. Osborne, An Introduction to Game Theory, Oxford University Press, 2003.
Y. Narahari, Dinesh Garg, Ramasuri Narayanam, Hastagiri Prakash. Game Theoretic Problems in Network Economics and Mechanism Design Solutions. Springer, 2009.

Narahari Y,Siddharth Barman

None,None,None

E1 261 (AUG) 3:0

Selected Topics in Markov Chains and Optimization

Finite state Markov Chains: Rate of convergence to steady state, Eigenstructure of the transition matrix, Perron-Frobenius Theorem, Reversible transition matrices, bounds on convergence rates; Markov Chain Monte Carlo: Knapsack problem—Target distribution sampler, Gibbs sampling, Metropolis-Hastings algorithm, Simulated Annealing, Examples from Bayesian networks and inference problems; Topics in Graph Theory: Matchings and Factors with applications, Connectivity and Paths; Enumeration combinatorics: Generating functions, Sieve methods, Posets; Semidefinite Programming: Quadratically Constrained Quadratic Programming (QCQP), Maximum Eigenvalue and
Matrix Norm minimization, Applications to combinatorial problems

Shayan Garani Srinivasa,Joy Kuri

Norris J.R., Markov Chains, Cambridge University Press, ISBN-10: 0521633966,Hajek Bruce, An Exploration of Random Processes for Engineers (course notes for EC-534, “Random Processes”), http://www.ifp.illinois.edu/~hajek/,Bremaud Pierre, Markov Chains: Gibbs Fields, Monte Carlo Simulation and Queues,” Springer, 1999

E1 313 (JAN) 3:1

Topics in Pattern Recognition

Foundations of pattern recognition. Soft computing paradigms for classification and clustering. Knowledge-based clustering. Association rules and frequent itemsets for pattern recognition. Large-scale pattern recognition.

References:

R. O. Duda, P. E. Hart, and D.G. Stork, Pattern Classification, John Wiley & Sons (Asia), Singapore, 2002
Recent Literature.

Narasimha Murty M

None,None,None

E1 396 (JAN) 3:0

Topics in Stochastic Approximation Algorithms

Introduction to Stochastic approximation algorithms, ordinary differential equation based convergence analysis, stability of iterates, multi-timescale stochastic approximation, asynchronous update algorithms, gradient search based techniques, topics in stochastic control, infinite horizon discounted and long run average cost criteria, algorithms for reinforcement learning.

References:

H.J.Kushner and G.Yin, Stochastic approximation and recursive algorithms and applications (2nd edition), Springer Verlag, New York, 2003.

A.Benveniste, M.Metiview and P.Priouret, Adaptive algorithms and stochastic approximation, Springer-Verlag,1990.

V.S.Borkar,Stochastic Approximation: A Dynamical Systems Viewpoint, Hindustan Book Agency, 2008.

D.P.Bertsekas and J.N.Tsitsiklis, Neuro-dynamic programming, Athena Scientific, 1996.

Relevant research papers

Shalabh Bhatnagar

Prerequisites A basic course on probability theory and stochastic processes,None,None

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E2 Communicaton Systems

E2 201 (AUG) 3:0

Information Theory

Entropy, mutual information, data compression, channel capacity, differential entropy, Gaussian channel.

Vijay Kumar P

T. M. Cover and J. A. Thomas, Elements of Information Theory,2nd edition,,John Wiley & Sons, 2006.

E2 202 (AUG) 3:0

Random Processes

The axioms of probability theory, continuity of probability, independence and conditional probability, random variables and their distribution, functions of a random variable, expectation, jointly distributed random variables, conditional distribution and expectation, Gaussian random vectors.

Convergence of sequences of random variables, Borel-Cantelli Lemma, laws of large numbers and central limit theorem for sequences of independent random variables, Chernoff bound.

Definition of a random process, stationarity. Correlation functions of random processes in linear systems, power spectral density.

Discrete time Markov chains, recurrence analysis, Foster's theorem, continuous time Markov chains, the Poisson process, simple Markovian queues.

Utpal Mukherji,Parimal Parag

B. Hajek, An Exploration of Random Processes for Engineers, Course Notes, 2009.,A. Kumar, Discrete Event Stochastic Processes: Lectures Notes for an Engineering Curriculum, available on author's website.,D. P. Bertsekas and J. N. Tsitsiklis, Introduction to Probability, Athena Scientific, 2008.,G. R. Grimmett and D. R. Stirzaker, Probability and Random Processes, Oxford Univ.Press, 2001.

E2 203 (JAN) 3:0

Wireless Communication

Wireless channel modeling; diversity techniques to combat fading; cellular communication systems, multiple-access and interference management; capacity of wireless channels; opportunistic communication and multiuser diversity; MIMO – channel modeling, capacity and transmit and receiver architectures; OFDM.

Neelesh B Mehta

D. Tse and P. Viswanath,,"Fundamentals of Wireless Communication", Cambridge University Press, 2005.,A. Goldsmith, "Wireless Communication," Cambridge University Press, 2005.

E2 204 (JAN) 3:0

Stochastic Processes and Queueing Theory

Basic mathematical modeling is at the heart of engineering. In both electrical and computer engineering, many complex systems are modeled using stochastic processes. This course will introduce students to basic stochastic processes tools that can be utilized for performance analysis and stochastic modeling. Detailed study of processes encountered in various stochastic dynamic systems, such as branching, counting, urns, infections, and queues.

Course content:
Poisson process, Renewal theory, Markov chains, Reversibility, Queueing networks, Martingales, Random walk.

Parimal Parag

S. M. Ross, Stochastic Processes, Wiley, 2nd Edition, 1996.,E. Cinlar, Introduction to Stochastic processes, Prentice Hall, 1975.,P. Bremaud, Markov Chains: Gibbs Fields, Monte Carlo Simulation, and Queues, Springer, 1999.,J. R. Norris, Markov Chains, Cambridge, 1998.,F. P. Kelly, Reversibility and Stochastic Networks, Cambridge, 2011.

E2 205 (AUG) 3:0

Error-Control Codes

Basics of binary block codes; mathematical preliminaries: groups, rings, fields and vector spaces; convolutional codes and the Viterbi algorithm; belief propagation with application to the decoding of codes; LDPC codes; finite fields, Reed-Solomon and BCH codes.

Navin Kashyap

R.M. Roth, Introduction to Coding Theory, Cambridge University Press 2006.,F. J. MacWilliams and N. J. A. Sloane, The Theory of Error-Correcting Codes, North-Holland, 1977.,T. Richardson and R. Urbanke, Modern Coding Theory, Cambridge University Press, 2008.,P. V. Kumar, Lecture Notes, NPTEL Course on Error-Correcting Codes, http://www.nptel.iitm.ac.in/syllabus/117108044/

E2 207 (AUG) 3:0

Concentration Inequalities

Introduction to limit results and concentration bounds for random variables, Chernoff-based bounds, variance bounds, the entropy method, bounded difference inequalities, Log-Sobolev inequalities, the transportation method

Himanshu Tyagi

Eval Kushilevitz and Noam Nisan,,"Communication Complexity,",Cambridge University Press, 1997

E2 208 (AUG) 3:0

Topics in Information Theory & Coding

Topics will be drawn from codes for distributed storage, low-density parity-check codes, polar codes and multi-terminal information theory, network-error correcting codes, distributed function computation, network security, interference alignment and index coding.

Sundar Rajan B

T. Cover and J.A. Thomas,,Elements of Information Theory, John Wiley, (2nd Edition), 2006.,R.W. Yeung, Information Theory and Network Coding, Springer, 2008.

E2 209 (JAN) 3:0

Topics in Information Theory & Statistical Learning

This course will cover the basics of, and some recent advances in, the use of information theoretic techniques in statistical learning. The following topics will be covered:

Hypothesis testing and minimax estimation; maximum likelihood estimation; asymptotic optimality; local asymptotic normality; sample optimal testing and estimation (uniformity testing, equality testing, independence testing, missing mass estimation, support estimation, learning Gaussian mixtures); information criteria for model selection (AIC, BIC, MDL); topics in nonparametric estimation.

Himanshu Tyagi

The course will be based largely on research papers, but the following reference books will be used.,Devroye, L., Györfi, L., and Lugosi, G, "A Probabilistic Theory of Pattern Recognition." Springer-Verlag, New York (1996).,Devroye, L. and Lugosi, G, "Combinatorial methods in density estimation." Springer-Verlag, New York (1996).,P. D. Grünwald, The Minimum Description Length Principle. MIT Press (2007).

E2 211 (AUG) 3:0

Digital Communication

Representation of signals and systems; Digital modulation techniques and their performance in AWGN channel; optimum receiver structures for AWGN channel; signal design for band-limited and power-limited channels; power and bandwidth efficiency tradeoff; coding and coded modulation techniques – capacity approaching schemes; ISI and equalization; Multichannel and multicarrier systems; Digital communications through fading multipath channels.

Neelesh B Mehta

S. Haykin,Digital Communication Wiley 1999.,J. G. Proakis,Digital Communication,4th edition

E2 212 (AUG) 3:0

Matrix Theory

Vectors, vector norms, vector algebra, subspaces, basis vectors, Gramm-Schmidt orthonormalization. Matrices, matrix rank, matrix norms, determinant, inverse, condition number. Hermitian and symmetric matrices, positive definite matrices, unitary matrices, projection matrices and other special matrices. LDU decomposition, QR decomposition, eigenvalue decomposition, singular value decomposition. Solving linear system of equations using Matrices. Least-squares approach, total least squares approach. Numerical issues. Perturbation theory of matrices. Differentiation of scalar functions of vectors and matrices. Matrix functions of scalar variables, Kronecker product of matrices. Positive matrices, nonnegative matrices, stochastic matrices and Markov chains.

Ramakrishnan A G

References: Carl D Meyer, Matrix Analysis and Applied Linear Algebra, SIAM Publication, 2000 Theodore Shifrin and Malcolm Ritchie Adams, Linear Algebra: A Geometric Approach, W H Freeman and Comapany, Second Edition, 2011,Gilbert Strang, Linear Algebra and its Applications, Fourth Edition, Thomson Brooks/Cole, 2007. Horn, and Johnson, Matrix Analysis, Second Edition, Cambridge University press, 2017,Golub, and Van Loan, Matrix Computations, Fourth Edition, John Hopkins University Press, 2015

E2 214 (JAN) 3:0

Finite – State Channels

Basic definitions; information-theoretic capacity and channel coding theorems; the Gilbert-Elliott channel; memoryless channels with input constraints; feedback capacity and its dynamic programming formulation; posterior matching schemes for achieving feedback capacity

Navin Kashyap

Pre-requisites: E2 201 (Information theory),R.G. Gallager, Information Theory and Reliable Communication, Wiley, 1968.,Selected journal papers.

E2 221 (AUG) 3:0

Communication Networks

Introduction to networking. TCP and UDP, TCP analysis. IP, optimal routing, algorithms for shortest path routing, routing protocols, Mobile IP. ARQ schemes and analysis, random access, random/slotted ALOHA, splitting algorithms, CSMA-CD, wireless LANs CSMA/CA, IEEE 802.11 MAC. Modelling and performance analysis in networks; deterministic analysis, scheduling; stochastic analysis - traffic models, performance measures, Little's Theorem, M/G/1 model, Priority queueing.

Chockalingam A

A. Kumar, D. Manjunath, and J. Kuri, Communication Networking: An Analytical Approach, Morgan Kaufman Publishers, 2004.,D. Bertsekas and R. Gallager, Data Networks, 2nd Edition, Prentice-Hall India, 2002.,J. F. Kurose and K. W. Ross, Computer Networking: A Top-Down Approach Featuring the Internet, Pearson Education Asia, 2001.

E2 230 (AUG) 3:0

Network Science and Modeling

Introduction to main mathematical models used to describe large networks and dynamical processes that evolve on networks. Static models of random graphs, preferential attachment, and other graph evolution models, Epidemic propagation, opinion dynamics, and social learning, Applications drawn from physical, informational, biological, cognitive, and social systems as well as networked decision systems such as Internet

Chandramani Kishore Singh

M. Newman. Networks: An Introduction. Oxford University Press, 2010,D. Easley and J. Kleinberg, Networks, Crowds and Markets,Current Literature

E2 231 (JAN) 3:0

Topics in Statistical Methods

Random Walks on Graphs – main parameters, the eigenvalue connection, the electrical connection, mixing rate, sampling by random walks, Markov random fields, Gibbs sampling, Markov chain Monte Carlo, Metropolis Hastings, Simulated annealing, Belief propagation, Bethe free energy, Kikuchi approximation, generalized belief propagation, convergence of belief propagation, Cavity method, Correlation decay, Learning Graphical models.

Chandramani Kishore Singh

M. Jordan (ed.),Learning in Graphical Models,MIT Press,1998,M. Mézard and A. Montanari

E2 232 (AUG) 2:1

TCP/IP Networking

IP addressing, IP header; subnetting and supernetting, CIDR, routing table, Ethernet, ARP; Serial links, PPP, ICMP, UDP, TCP: header, connection establishment, ISN, half close, delayed acks, header flags, TCP state transitions, sliding window, Slow Start, Congestion Avoidance, Fast Retransmit, Fast Recovery; DNS; multicasting, IGMP; IEEE 802.11 wireless LANs; Bridges, L2 switches, Spanning Tree algorithm, VLANs; Mobile IP; Private IP; NAT; DHCP; http; routing protocols:
RIP, OSPF, BGP; IPv6

Joy Kuri,Prabhakar T V,Dagale Haresh Ramji

W. Richard Stevens, TCP/IP Illustrated, Vol I: The Protocols, Pearson Education Asia, 2000,Douglas Comer, Internetworking with TCP/IP Vol I: Principles, Protocols and Architecture, Prentice Hall, 4th Edition, 2000,Selected Internet RFCs (Request for Comments), available at http://www.ietf.org/rfc.html

E2 241 (JAN) 3:0

Wireless Networks

Macromodels for power attenuation in mobile wireless networks (path loss, shadowing, multipath fading). Link budget analysis. Cellular networks; FDM/TDM/TDMA: spatial reuse, cochannel interference analysis, cell sectoring, channel allocation (fixed and dynamic), handover analysis, Erlang capacity analysis. CDMA: interference analysis, other cell interference, hard and soft handovers, soft capacity, and Erlang capacity analysis; examples from GSM, IS95 and WCDMA networks. OFDMA: simple models for scheduling and resource allocation. Wireless random access networks: ALOHA, CSMA/CA; IEEE 802.11 WLANs and their analysis. Wireless ad hoc networks: links and random topologies, connectivity and capacity, scaling laws, scheduling in ad hoc networks; wireless ad hoc internets and sensor networks.

A. Kumar, D. Manjunath, and J. Kuri, Wireless Networking, Morgan Kaufman, 2008,G. L. Stuber, Principles of Mobile Communications, 2nd edition, Kluwer Academic Publishers, 2001,D. Tse and P. Viswanath, Fundamentals of Wireless Communication, Cambridge University Press, 2005.

E2 242 (JAN) 3:0

Multiuser Detection

Direct Sequence spread spectrum, spreading sequences and their correlation functions, near-far effect in DS-CDMA, error probability for DS-CDMA on AWGN channels, Multiuser Detection – MF detector, decorrelating detector, MMSE detector. Successive interference canceller, parallel interference canceller, linear PIC. Performance analysis of multiuser detectors and interference cancellers. Low complexity multiuser detectors for MIMO systems. Multiuser/MIMO detection using belief propagation, probabilistic data association, meta-heuristics, and Markov chain Monte carlo techniques. Spatial modulation index modulation for multiuser systems.

Chockalingam A

S. Verdu, Multiuser Detection, Cambridge Univ.Press, 1998.,A. Chockalingam and B. Sundar Rajan, Large MIMO Systems, Cambridge Univ.Press, February 2014.,H. Wymeersch, Iterative Receiver Design, Cambridge Univ. Press, 2007.,D. Tse and P. Viswanath, Fundamentals of Wireless Communication, Cambridge University Press, 2005,Research Papers in Journals

E2 243 (AUG) 2:1

Mathematics for Electrical Engineers

Analysis: The Real Number System, Euclidean Spaces, Metric Spaces, Closed and open sets, Numerical sequences and series, Limits, Continuity. Probability Theory: The axioms of probability theory, Independence and conditional probability, Random variables and their distribution, Expectation, Conditional distribution, Convergence of sequences of random variables, Laws of large numbers and Central limit theorem. Linear Algebra: Vector Spaces, Subspaces, Linear independence, Basis and dimension, Orthogonality; Matrices, Determinants, Eigenvalues and Eigenvectors, Positive definite matrices, Singular Value Decomposition. Convex Optimization: Convex
sets and functions; Optimality conditions, Duality, Minimax theory, Saddle points, KKT conditions.

Chandramani Kishore Singh

Rudin, W., Principles of Mathematical Analysis, McGraw-Hill, 1985,A. Kumar, Discrete Event Stochastic Processes: Lectures Notes for an Engineering Curriculum, available on author's website,Strang G, Linear Algebra and Applications, Thomson-Brooks/Cole, 4th Edition, 2006

E2 251 (AUG) 3:0

Communications Systems Design

Communication link design for AWGN channels; path loss models, noise figure, receiver sensitivity; link budget for deep space communication - a case study. Communication subsystem requirements and specifications: analog/digital front-end, oscillator phase noise, analog/digital up/down conversion, carrier frequency offset (CFO), bandpass sampling, DAC/ADC interface, quantization noise and clipping, dynamic range, ADC selection, automatic gain control (AGC), sampling jitter, CORDIC, I/Q imbalance, DC offset correction, error vector magnitude (EVM), power amplifier (PA) non-linearities. Communication link budget for flat fading channels - a case study. * Communication link budget for ISI channels - multi-carrier (OFDM) and single-carrier (cyclic-prefixed SC) techniques; impact of PA distortions in OFDM, PAPR issues, CFO estimation and correction, SFO estimation and correction. Communication link budget for MIMO wireless and spatial modulation – a case study. Visible light wireless communications (VLC); transmitter, channel, receiver, performance, MIMO-VLC.

Chockalingam A

Tony J. Rouphael, ``Wireless Receiver Architectures and Design:,Antenna, RF, Synthesizers, Mixed Signal and Digital,Signal Processing,'' Academic Press, 2014,Lydi Smaini, ``RF Analog Impairments Modeling for Communication Systems Simulation: Application to OFDM-based Transceivers,'' John-Wiley & Sons, 2012.,Abbas Mohammadi and Fadhel M. Ghannouchi, ``RF Transceiver Design for MIMO Wireless Communications,'' Springer-Verlag, 2012. Fa-Long Luo, ``Digital Front-End in Wireless Communications and Broadcasting: Circuits and Signal Processing,'' Cambridge Univ. Press, 2011. Research papers

E2 331 (JAN) 3:0

Advanced Course in Coding Theory

This course will start with the basics of error-correcting codes and go on to cover specific classes of codes. The classes of codes will be drawn from: codes for distributed storage, LDPC codes, cyclic (algebraic) codes.

Vijay Kumar P

linear algebra (matrix theory),and probability theory,,at a graduate or at least, senior undergraduate level.

E3 Electronic Drives

E3 201 (AUG) 3:0

Introduction to Solid State Electronic Devices

Charge transport in semiconductors, Junctions, MOSFET, BJT, Power diode, Power MOSFET, IGBT, SCR, an introduction to devices with wide band gap semiconductors including SiC Schottky Diodes (no reverse recovery); SiC MOSFETs (up to 1.8 kV), and GaN HFETs (650 V).

Faculty EE

Prerequisite: Basic undergraduate Physics Courses,References: Ben G. Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices,Seventh Edition, Pearson.,Robert F. Pierret, Semiconductor Device Fundamentals,Addison-Wesley Publishing. Jacob Millman, MicroEectronics,McGraw-Hill International Company

E3 214 (AUG) 3:0

Microsensor Technologies

Micro-sensors and micro-actuators; MEMS and MOEMS; classification and characteristics; principles of microsensors - micromechanics, electro-mechanical coupling, electromagnetics, opto-mechanical effects; thermal and fluidic properties; modeling and simulation; technology - lithography, deposition, diffusion, metallization, bulk and surface micromaching; commercial fabrication processes; pressure, vibration, acceleration, rotation, temperature, magnetic field, radiation, chemical and bio microsensors; surface acoustic wave microsensors; mciro-opto-electro-mechanical sensors; fiber optic sensors; smart structures; sensors arrays and distributed sensing; noise in microsensors; control and signal processing; automotive, aerospace, industrial, and biomedical applications.

Srinivas T,Badrinarayana T

J. W. Gardner, V. K. Varadan and O. O. Awadelkarim, Microsensors, MEMS and Smart Devices, John Wiley,,2002 S. D. Senturia, Microsystem Design, Kluwer- Academic Publishers, 2001,P. Raichoudhury (Ed), MEMS and MOEMS Technology and Applications, SPIE Press, 2000.,Current literature: Special issues of journals and selected review articles

E3 220 (AUG) 3:0

Foundations of Nanoelectronic Devices

Mathematical foundations of quantum mechanics, operators, bra and ket algebra, time independent and time dependent Schrodinger equation, crystal lattice and Brillouin zone, Bloch theorem, band theory of solids, tight binding, band structure examples (Si, Ge, III-V) in E-k space, effective mass, principles of operation of p-n junction (homo and hetero junction) and MOSFET, single gate versus multiple gates, bound states, effect of confinement, subbands, quantum capacitance, strain effects, tunneling, tunnel diode, intra-band and band to band tunneling in MOSFET, quantum theory of linear harmonic oscillators, phonons in solids, carrier mobility in MOSFET, quantum theory of angular momentum, electron spin.

Kausik Majumdar

D. J. Griffiths, Introduction of Quantum Mechanics, Prentice Hall.,A. Ghatak and S. Lokanathan, Quantum Mechanics, Trinity Press.,V. K. Thankappan, Quantum Mechanics, New Age. Solid State Physics, N. W. Ashcroft and N. D. Mermin.,S. M. Sze, Physics of Semiconductor devices, Wiley-Interscience.,Y. Taur and T. H. Ning, Fundamentals of modern VLSI devices, Cambridge University Press

E3 225 (JAN) 3:0

Compact Modeling of Devices

Band theory of solids, carrier transport mechanism, P-N junction diode, MOS Capacitor Theory, C-V characteristics, MOSFET operation, Types of compact models, Input Voltage Equation, Charge Linearization, Charge Modeling, Concept of Core Model, Quasi-static and Non-quasi-static Model, Introduction to Verilog-A, Basic theory of circuit simulation, Brief overview of EKV and PSP

Santanu Mahapatra

Tsividis,Y.,Operation and Modelling of the MOS Transistor,Oxford University Press,2012

E3 231 (JAN) 2:1

Digital Systems Design with FPGAs

Introduction to Digital design; Hierarchical design, controller (FSM), case study, FSM issues, timing issues, pipelining, resource sharing, metastability, synchronization, MTBF Analysis, setup/hold time of
various types of flip-flops, synchronization between multiple clock domains, reset recovery, proper resets. VHDL: different models, simulation cycles, process, concurrent and sequential statements, loops, delay models, library, packages, functions, procedures, coding for synthesis, test bench. FPGA: logic block and routing architecture, design methodology, special resources, Virtex-II, Stratix architectures, programming FPGA, constraints, STA, timing closure, case study.

Kuruvilla Verghese

Wakerly, J. F., Digital Design: Principles and Practices 4th Edition, Pearson, 2008,Skahil, K., VHDL for Programmable Logic 1st Edition, Pearson, 2004,FPGA Data sheets, Application Notes,Current literature from relevant journals and conference proceedings

E3 233 (AUG) 2:1

VLSI for Signal Processing

Introduction to DSP systems: DSP algorithms, DSP application needs, scaled CMOS technologies, algorithm representation, Iteration bound: Data flow graph representation, loop bound and iteration bound, algorithms for computing iteration bound, iteration bounds for multirate data flow graphs, Pipelining and parallel processing: pipelining for digital filters, parallel processing, pipelining and parallel processing for low power, Retiming, Unfolding and folding techniques, Scaling and round-off noise problems, Bit-level arithmetic architectures, Synchronous and Asynchronous pipelines, Topics on low power design

Shayan Garani Srinivasa

K. Parhi, VLSI Digital Signal Processing Systems, Wiley, 2011,Lecture notes and research papers from proceedings,Digital VLSI and FPGA, Digital Signal Processing at the UG Level

E3 235 (AUG) 2:1

Design for Analog Circuits

Introduction to Integrated Circuit Technology, Op-Amps, Single-Stage and Two-Stage Amplifiers, Wideband Amplifiers and Comparators, Instrumentation Amplifiers, Filters, MOSFETs, Current Mirrors

and Active Loads, Frequency Response and Feedback techniques for Integrated Circuits, Noise, CMRR of an Op-Amp and Op-Amp Circuits, Analog-to-Digital Converter (ADC) and Digital-to-Analog Converter (DAC) using Op-Amps, Understanding the Datasheet of Op-Amps, Practical Application of Op-Amps, Designing Analog Circuits.

Hardik J Pandya

Gray, Hurst, Lewis, and Meyer, Analysis and Design of Analog Integrated Circuits, John Wiley & Sons, 5th edition, 2009,Horowitz and Hill, The Art of Electronics, Cambridge Univ. Press, 1999,Behzad Razavi, Design of Analog CMOS Integrated Circuits, McGraw-Hill, 2001

E3 237 (JAN) 3:0

Integrated Circuits for Wireless Communication

Wireless transceiver SNR calculations, modulation techniques, linearity and noise, receiver and transmitter Architectures, passive RF networks, design of active building blocks: low noise amplifiers, mixers, power amplifiers, VCOs, phase locked loops and frequency synthesizers, device models for RF design, mm-wave and THz communication systems

Gaurab Banerjee

Behzad Razavi, Design of Analog CMOS Integrated Circuits, McGraw Hill 2001,Grey, Meyer, Hurst & Lewis,,"Analysis & Design of Analog Integrated Circuits," Wiley International.

E3 238 (AUG) 2:1

Analog VLSI Circuits

Review of MOS device characteristics, Long channel MOS, Second order effects, MOS small signal parameters and models, MOS capacitance. Concept of fT, Bipolar transistors, Small signal parameters of BJTs, Common Emitter/Common source Amplifiers, CB/CG Amplifiers Emitter/Source followers, Source Degeneration, Cascodes, emitter/Source coupled pairs, Current Mirrors, Differential Pairs, Frequency Response, Noise, Feedback, Linearity, Operational Amplifiers: Telescopic and Folded Cascode, Stability and Compensation, Slew rate and setting, Common Mode Feedback

Gaurab Banerjee

Behzad Razavi,,Design of Analog CMOS Integrated Circuits, McGraw Hill 2001,Grey, Meyer, Hurst & Lewis,"Analysis & Design of Analog Integrated Circuits," Wiley International.

E3 243 (AUG) 2:1

Digital Controller Design

Modeling of Systems: input/output relations, linearization, transfer function and state space representations, circuit averaging, bond graph and space vector modeling; Control system essentialsrepresentation
in digital domain, z-transform, digital filters, s-z mapping, sampling issues, continuous
to discrete domain conversions; Controller design-Bode method, root locus method, PID controller, State space methods, full state feedback, pole placement, estimator design, prediction, current and reduced order estimators, introduction to optimal and robust controller design.

Umanand L

Franklin, G.F., Powell, J.D., Workman, M.L., Digital Control of Dynamic Systems, 2nd Ed., AddisonWesley, MA, USA, 1990,Friedland, B., Control System Design-An Introduction to State Space Methods, McGraw Hill, 1987,Lewis, F.L., Applied Optimal Control and Estimation, Prentice Hall, USA, 1992,Umanand, L., Power Electronics: Essentials and Applications, Chapters 8 to 11, John Wiley, India, 2009

E3 245 (AUG) 2:1

Processor System Design

Introduction: Basic Processor Architecture, Instruction Set Design, Datapath and Controller, Timing, Pipelining. CISC Processor Design: Architecture, hardware flowchart, implementing from flowchart, exception, control store, microcode design. RISC Processor Design: single cycle implementation, multi cycle implementation, pipelined implementation, exception and hazards handling, RISC-V. Memory Hierarchy: Cache, Paging, TLB. Bus: Bus Topologies, AXI, PCIe, Bus Bridges, BFM, Network-on-Chip. Superscalar Processors Design: Superscalar organization, superscalar pipeline overview, VLSI implementation of dynamic pipelines, register renaming, reservation station, reordering
buffers, branch predictor, and dynamic instruction scheduler etc. Multi Core Design

Kuruvilla Verghese

Computer Organization and Design: The Hardware/Software Interface, The Morgan Kaufmann Series in Computer Architecture and Design, 2011, by David A. Patterson, John L. Hennessy,Modern Processor Design: Fundamentals of Superscalar Processors, McGraw-Hill Series in Electrical and Computer Engineering by John P. Shen,Current Literature

E3 252 (JAN) 2:1

Digital Controllers for Power Applications

Digital Signal Controller (A micro-controller with a DSP engine): Architecture and real time programming in Assembly and Embedded C. Introduction to Fixed Point Arithmetic. Field Programmable Gate Array (FPGA): Architecture and programming of digital circuits including Finite State Machines (FSM) in Verilog HDL. Communication-Chip level: AXI, Board level: SPI, I2C, System level: RS 232, CAN, MODBUS RTU on RS 485. Developing a GUI for supervisory control and monitoring. Introduction to different semiconductor memories: RAM, ROM, NVRAM etc. and their applications. Analog sensing: Anti-aliasing filter design, scaling for fixed point computation, online calibration and biasing. Continuous time feedback controller design and its discrete timeimplementation,D/A and A/D converters, effects of sampling, modeling the Pulse Width Modulator (PWM) etc.Co-design: How to optimally implement an embedded task using a programmable processor (DSC) and a re-configurable hardware (FPGA). Embedded design of a typical Power Conversion System including: process control, protection, monitoring, feedback control etc.

Jayachandra Shenoy U,Kaushik Basu

Prerequisite: Under graduate level analog electronics, digital electronics and classical feedback control theory.,Familiarity with micro-processor, digital signal processing, power electronics (E6 201) previous experience in programming will be helpful but not a necessity.,References: Brown s, and Vranesic Z, Fundamentals of Digital logic with Verilog design, Tata McGraw Hill. Mazidi, Mckinlay and Causey, PIC Micro-controllers and Embedded Systems, Pearson. Franklin G F, Powell J D and Naeini, Feedback Control of Dynamic Systems, Pearson. Erickson R W and Maksimovic D, Fundamentals of Power Electronics, Springer. Proakis J G and Manolakis D K, Digital Signal Processing, Pearson.

E3 257 (JAN) 2:1

Embedded System Design

Introduction to embedded software development, S/W Development environment- Cross compiler, Linker, Debugger, Stand-alone systems; Introduction to embedded computing, Introduction to RISC architecture, Introduction to ARM Cortex architecture and ARM/THUMB instruction set, Clocks and

Power Management, Low power design, Memories, application development, Peripherals

Harsh Dagale

Alred Aho,Monica Lam,Ravi Sethi and Jeffery Ullman,Compliers Principles,Techniques and Tools

E3 258 (JAN) 2:1

Design for Internet of Things

Embedded Systems: Rise of embedded systems and their transition to intelligent systems and to Internet of Things - RFIDs, NFC, Web of Things - Network of interconnected and collaborating objects, Embedded systems architecture: Key hardware and software elements, typical embedded processors like ATOM. Low power and very low power embedded systems, peripherals and sensors in embedded systems, peripheral interfacing - SPI and I2C, Hardware and software protocol stacks - MAC, Routing and application layers, performance considerations. Embedded Systems Design: Partitioning to hardware and software; principles of co-design; performance of these systems - estimation of speed, throughput, power and energy consumption; hardware design elements - design,
validation, and testing tools; software platforms – OS and applications, code optimization, validation and robust code generation; system integration, debugging and test methodology; tools for coding, debugging, optimization, and documentation; measurement of system performance, Linux distributions for embedded systems using tools from Yocto project; Creating virtual prototypes - hardware software emulation. Applications: Healthcare and home automation examples.

Chandramani Kishore Singh,Prabhakar T V

Barry, P., and Crowley, P., Modern Embedded Computing, Morgan Kaufmann, 2012,Wolf, M., Computers as components Third edition, Morgan Kaufmann, 2012,Other online references to be provided during the course

E3 262 (AUG) 2:1

Electronic Systems Packaging

Electronic systems and needs, physical integration of circuits, packages, boards and complete electronic systems; system applications like computer, automobile, medical and consumer electronics
with case studies and packaging levels. Electrical design considerations - power distribution, signal integrity, RF package design and Power-delivery in systems. CAD for Printed Wiring Boards (PWBs) and Design for Manufacturability (DFM). PWB Technologies, Single-chip (SCM) and Multi-chip modules (MCM), flex circuits. Recent trends in manufacturing like microvias, sequential build-up circuits and high-density interconnect structures. Materials and processes in electronics packaging, joining methods in electronics; lead-free solders. Surface Mount Technology – design, fabrication and
assembly, embedded passive components; thermal management of PWBs, thermo-mechanical reliability, design for reliability, electrical test and green packaging issues, Assignments in PCB CAD; Hands-on lab sessions for board manufacturing and assembly.

Mahesh G V

Rao R. Tummala, Fundamentals of Microsystems Packaging, McGraw Hill, NY, 2001,Rao R Tummala & Madhavan Swaminathan, Introduction to System-on-Package, McGraw Hill, 2008,R S Khandpur, Printed Circuit Boards, McGraw Hill, 2006

E3 271 (JAN) 3:0

Reliability of Nanoscale Circuits and Systems

Carrier transport and carrier energy fundamentals, avalanche multiplication and breakdown, hot carrier induced (HCI) degradation mechanism, NBTI/PBTI, TDDB, GOI and Electromigration, ESD and latch-up phenomena, Test models and methods, ESD protection devices and device physics, Advance ESD protection devices, high current effects and filaments, Negative differential resistance, Physics of ESD failure, ESD protection methodology, ESD protection circuits, ESD protection for Analog/RF and mixed signal modules, General rules for ESD design, layout considerations for ESD and latch-up protection, understanding parasitics, ESD circuit simulation basics and requirements, ESD TCAD simulation methodology, System on Chip overview and system ESD aspects, case studies related to product failures and solutions use

Mayank Shrivastava

Review Papers on NBTI/PBTI, HCI Degradation, TDDB, Electromigration,ESD in Silicon Integrated Circuits by Ajith Amerasekera and Charvaka Duvvury, Wiley publication,Basic ESD and I/O Design by Sanjay Dabral and Timothy J. Maloney, Wiley publication

E3 272 (JAN) 3:0

Advanced ESD devices, Circuits and Design Methods

History of key inventions in the field of ESD and latch-up protection, Review on various ESD testers and ESD test models, problems associated with ESD testers and progress on ESD tester development. High current injection, High field effects, Negative differential resistance and Current filaments, Drain extended MOS devices and associated week ESD robustness. ESD behavior of FinFET devices, SiGe-FETs and other quantum well devices, Impact of stress & strain on ESD behavior, ESD devices in advanced CMOS and BiCMOS technology, Impact of technology scaling on
ESD behavior, Special analog and RF ESD protection devices and circuits. Impact of ESD stress on CNTs, Graphene and other 2D material based Nanoelectronic devices. ESD Device modeling for circuit simulations, State-of-the-art on CDM ESD protection, CDM tester models, modeling CDM behavior and CDM simulations, ESD verification flow and methodology, Towards full chip ESD simulation, Transient latch-up, System level ESD, System efficient ESD design (SEED), Case studies.

Mayank Shrivastava

ESD Protection Device and Design for Advanced CMOS Technologies by Oleg Semenov, Hossein Sarbishaei and Manoj Sachdev, Elsevier,ESD RF Technology and Circuits by Steven H. Voldman, Wiley,Nanoelectronics – Nanowires, Molecular Electronics and Nanodevices by Krzysztof Iniewski, McGraw Hill, 201

E3 274 (AUG) 3:0

Design of Power Semiconductor Devices

Power device applications: Power electronic applications, High voltage and high-power circuits, RF power circuits and applications, On-chip circuits and power management system, high switching speed requirements for power system scaling. Semiconductor Physics under extreme conditions: Basics of semiconductor device physics, p-n junction, carrier transport under extreme conditions, avalanche breakdown, and thermal transport. Power Diodes: Various types of power diodes: Si diodes, Schottky diodes and P-i-N diodes; Physics of power diodes, power diode design essentials, breakdown voltage and ON-resistance trade-off, high current and ultra fast transient behavior. Si High
Power MOS devices, design and Technology: VMOS, VDMOS, UMOS, DMOS, LDMOS, DeMOS and
Dual trench MOS; Process flow, discrete and On-chip device manufacturing technology; High power MOS design essentials, breakdown voltage and on-resistance trade-off, parasitic capacitance and resistances, DC, RF and switching characteristics; quasi saturation behavior, high current effects,

Negative differential resistance (NDR), self heating, filament formation and safe operating area (SOA).
GaN and SiC Power MOS devices: Advantage of high bandgap materials, High bandgap material physics, various GaN/SiC devices, device physics and design essentials, GaN/SiC device manufacturing technology; breakdown voltage and on-resistance trade-off, parasitic capacitance and resistances, DC, RF and switching characteristics; quasi saturation behavior, self heating effects and safe operating area (SOA); state-of-the-art GaN/SiC devices and ongoing research. IGBTs and SCR:
IGBTs and SCR device physics and device design essentials, breakdown voltage and on-resistance trade-off, self heating effects and filament formation.

Mayank Shrivastava

Semiconductor power devices: Physics of operation and fabrication technology, Sorab Khushro Ghandhi, Wiley, 1977,Advanced Power MOSFET Concepts, B. Jayant Baliga, 2010,High Voltage Devices and Circuits in Standard CMOS Technologies, Hussein Ballan, Michel Declercq

E3 274 (JAN) 3:0

Design of Power Semiconductor Devices

Power device applications: Power electronic applications, High voltage and high-power circuits, RF power circuits and applications, On-chip circuits and power management system, high switching speed requirements for power system scaling. Semiconductor Physics under extreme conditions: Basics of semiconductor device physics, p-n junction, carrier transport under extreme conditions, avalanche breakdown, and thermal transport. Power Diodes: Various types of power diodes: Si diodes, Schottky diodes and P-i-N diodes; Physics of power diodes, power diode design essentials, breakdown voltage and ON-resistance trade-off, high current and ultra fast transient behavior. Si High
Power MOS devices, design and Technology: VMOS, VDMOS, UMOS, DMOS, LDMOS, DeMOS and
Dual trench MOS; Process flow, discrete and On-chip device manufacturing technology; High power MOS design essentials, breakdown voltage and on-resistance trade-off, parasitic capacitance and resistances, DC, RF and switching characteristics; quasi saturation behavior, high current effects, Negative differential resistance (NDR), self heating, filament formation and safe operating area (SOA).
GaN and SiC Power MOS devices: Advantage of high bandgap materials, High bandgap material physics, various GaN/SiC devices, device physics and design essentials, GaN/SiC device manufacturing technology; breakdown voltage and on-resistance trade-off, parasitic capacitance and resistances, DC, RF and switching characteristics; quasi saturation behavior, self heating effects and safe operating area (SOA); state-of-the-art GaN/SiC devices and ongoing research. IGBTs and SCR:
IGBTs and SCR device physics and device design essentials, breakdown voltage and on-resistance trade-off, self heating effects and filament formation.

Mayank Shrivastava

Semiconductor power devices: Physics of operation and fabrication technology, Sorab Khushro Ghandhi, Wiley, 1977,Advanced Power MOSFET Concepts, B. Jayant Baliga, 2010,High Voltage Devices and Circuits in Standard CMOS Technologies, Hussein Ballan, Michel Declercq

E3 282 (AUG) 3:0

Basics of Semiconductor Devices and Technology

Introduction to semiconductor device physics: Review of quantum mechanics, electrons in periodic lattices, E-k diagrams, quasiparticles (electrons, holes and phonons) in semiconductors. Carrier statics and dynamics, carrier transport under low electric and magnetic fields: Mobility and diffusivity; Carrier statistics; Continuity equation, Poisson's equation and their solution. High field effects:

Velocity
saturation, hot carriers and avalanche breakdown. Semiconductor Junctions: Schottky, p-n junction and hetero-junctions and related physics. Ideal and nonideal MOS capacitor, band diagrams and CVs; Effects of oxide charges, defects and interface states; Characterization of MOS capacitors: HF and LF CVs. Physics of transistors

Mayank Shrivastava

S. M. Sze, Physics of Semiconductor Devices, John Wiley,Donald Neamen, Semiconductor Physics and Devices, 3rd Edition,Current Literature

E3 290 (JAN) 2:1

Microfabrication Technology and Process for Biology and Medicine

Introduction to microfabricated devices for biology and medicine (devices for flow cytometry/sorting, microchips using dielectrophoresis, force measurement with cantilevers, microengineered devices for
medical therapeutics, blood pressure sensors, devices for drug delivery, devices for minimally invasive surgery), Microfabrication technology: Introduction to the clean room, Contaminants, Wafer cleaning processes (DI water, RCA, metallic impurities, etc.), Substrate materials, Techniques of metallization: PVD [(Sputtering – DC, RF, and Magnetron), thermal evaporation, e-beam evaporation,
PLD], Types of masks, Hard and soft Lithography, Types of etching, Design of process flow for device
fabrication for application in biology and medicine, Basics of tissue culture methods: Types of cell growth, Work area and equipment (Laminar flow hoods, CO2 incubators, Microscopes, Preservation, Vessels, Storage), Maintaining cells (harvesting, media and growth requirements), Safety considerations, Cell counting, Device fabrication and inspection in the clean room.

Hardik J Pandya

J.D. Plummer, M.D. Deal, P.G. Griffin, Silicon VLSI Technology, Pearson Education, 2001,S.A. Campbell, The Science and Engineering of Microelectronic Fabrication, Oxford University Press, 2001,S.M. Sze (Ed), VLSI Technology, 2nd Edition, McGraw Hill, 198

E3 325 (AUG) 3:0

Basics of Nanoelectronics

Introduction to CMOS Scaling, The nanoscale MOSFET and design, Finfets, NanoWire FETs and Tunnel FETs, fundamental limit to device scaling and device engineering for CMOS scaling. Carbon nanotube, graphene and other 2D semiconductors and related nanoelectronics, band structure & transport, devices, applications.

Mayank Shrivastava

Fundamentals of Nano transistors By Mark Lundstrom,Current Literature,Current Literature

E4 Powe Drives

E4 221 (AUG) 2:1

DSP and AI Techniques in Power System Protection

Introduction to digital relaying, signal conditioning, sampling and analog to digital conversion, real time considerations, hardware design concepts – microcontroller/DSP based, single/multiprocessor based. Relaying algorithms, software considerations. Digital protection schemes for feeders, transmission lines, generators and transformers, integrated protection scheme – a case study, New relaying principles based on AI techniques, ANN approach and Fuzzy Logic (FL) methods for fault detection and fault location. Software tools for digital simulation of relaying signals, playback simulators for testing of protective relays Laboratory Exercises – Digital techniques for the measurement of phasors, frequency and harmonics, implementation of relaying algorithms and digital protection schemes on hardware platforms. Testing of relays, transient tests based on EMTP data. Design procedures of AI based relays using software tools. Mini-projects.

Jayachandra Shenoy U

References: Warrington A R, and Von C, Protective Relaying: Theory and Practice, Vol. II, Chapman and Hall, 1970.,IEEE Tutorial Course on Microprocessor Relays and Protection Systems, Power Systems Research Group, University of Saskatchewan, 1979 and 1987.,Phadke A G, and Thorp J, Computer Relaying for Power Systems, John Wiley, Inc. 1988.,IEEE Tutorial Course on Advancement in Microprocessor Based Protection and communication, 1997.,Technical papers from IEEE transactions, CIGRE, IEE journals.

E4 231 (AUG) 3:0

Power System Dynamics and Control

Introduction to system dynamics, concepts of stability, modeling of generator, transmission networks, loads and control equipment, small signal stability-low frequency oscillations – methods of analysis for single and multi-machine systems, power system stabilizers.

Gurunath Gurrala

References: Padiyar K R,Power System Dynamics,Stability and Control,Interline Publishing,1996.

E4 233 (JAN) 3:0

Computer Control of Power Systems

State transition diagram, security-oriented functions, data acquisition, SCADA/EMS/WAMS system, state estimation, load forecasting, security assessment. Automatic Generation Control (AGC). Voltage stability assessment, reactive power/voltage control, security oriented economic load despatch, preventive and restorative controls. Unit committment, Hydrothermal Scheduling, Optimal power flow

Gurunath Gurrala

References: Wood A J, and Wallenberg B F, Power Generation, Operation and Control, John Wiley and Sons, 1984.,Russel B D, and Council M E, Power System Control and Protection, Academic press, 1978. Miller T J E, Reactive Power Control in Electrical Power System, John Wiley, USA.,Prabha Kundur, Power System Stability and Control, McGraw Hill Inc., 1983. Kusic G L, Computer Aided Power System Analysis, Prentice Hall of India Pvt. Ltd, 1989.

E4 234 (AUG) 3:0

Advanced Power Systems Analysis

Introduction to Power System Analysis; Admittance Model of Power System Elements; Kron's Reduction; Power Flow Analysis: Gauss–Seidel, Newton Raphson, Fast Decoupled; Programming Consideration for Large Systems; Balanced and Unbalanced Radial Power Flow, AC-DC Power Flow, Harmonic Power Flow, Continuation Power Flow; Steady-State Voltage Stability; Power Flow Tracing; Loss Allocation Methods; Network Congestions; Available Transfer Capability; Contingency Analysis; Z-Bus Formulations; Fault Analysis using Z-Bus; Structure of Indian Power Systems; Indian Electricity Grid Code.

Sarasij Das

References: Kusic G L, Computer Aided Power System Analysis, CRC Press, 2nd edition, 2009.,Arilaga J, and Watson N R, Computer Modelling of Electrical Power Systems, Wiley, 2005.,Grainger J J, and Stevenson W D, Power System Analysis, McGraw Hill Education (India) Pvt Ltd., 2003.,Wang X, Song Y and Irving M, Modern Power Systems Analysis, Springer, 2008,Arilaga J, and Watson N R, Power System Harmonics, Wiley, Second Edition, 2003.

E4 237 (JAN) 2:1

Selected Topics in Integrated Power Systems

Development of large power grids. Hierarchy of integrated power systems. Modelling of various types of series and shunt Flexible AC Transmission Systems (FACTS), phase shifters, multiple schemes of HVDC systems. Unbalanced system analysis and load balancing. Digital techniques for computation of very fast electro-magnetic transients, analysis of switching and fault transients in EHV/UHV systems. Wide Area Monitoring Systems (WAMS), placement of Phasor Measurement Units (PMUs), Phasor and Frequency Estimation, Enhanced State Estimation, observability analysis, Voltage Stability assessment and fault detection using Phasor Measurements.

Gurunath Gurrala

References: Current Literature,Phadke A G, Thorp J S, “Synchronized Phasor Measurements and Their Applications”, Springer, 2008 Acha E, “FACTS: modelling and simulation in power networks”, Wiley, 2004,Hingorani N G and Gyugyi, L and El-Hawary M, “Understanding FACTS: concepts and technology of flexible AC transmission systems”, IEEE press New York, 2000,Kundur P and Balu, N J and Lauby M G, “Power system stability and control”, McGraw-Hill, 1994 Miller T J E, “Reactive power control in electric systems”, Wiley-Interscience, 1982

E4 238 (JAN) 3:0

Advanced Power System Protection

Overview of over-current, directional, distance and differential, out-of-step; protection and fault studies; Service conditions and ratings of relays; Impact of CVT transients on protection; Current Transformer: accuracy classes, dynamic characteristics, impact and detection of saturation, choice for an application; Circuit Breaker: need for breaker failure protection, breaker failure protection schemes, design considerations for breaker failure protection; Transmission line protection: issues and influencing factors, definitions of short, medium and long lines using SIR, protection schemes, fault location identification techniques; Transformer protection: issues, differential protection of auto-transformers, two-winding, three-winding transformers, impact of inrush and over-excitation, application of negative sequence differential, protection issues in ‘modern’ transformers; Generator protection: issues, generating station arrangements, groundings, protection schemes; Bus protection: issues, bus configurations, protection zones, protection schemes; Overview of HVDC protection systems; Protection scheme for distributed generators (DGs); Special Protection Schemes (SPS); Power system protection testing; Common Format for Transient Data Exchange (COMTRADE), Communication architecture for substation automation; Basics of synchrophasor based Wide Area Monitoring Systems (WAMS);

Sarasij Das

References: Horowitz. S.H. and A.G. Phadke, Power system relaying, by John Wiley & Sons, 3 rd edition 2008.,Mason C.R, The Art and Science of Protective relaying, GE Digital Energy Phadke A.G. and Thorp J.S. Synchronized Phasor Measurements and Their Applications, Springer, 2008,C37 series of IEEE standards on power system protection IEC 61850 - Communication Networks and Systems in Substations

E5 High Voltage and Insulation Engineering

E5 201 (AUG) 2:1

Production, Measurement,and Application of High Voltage

Generation of HV AC by cascade transformers, resonant circuit, Tesla coil; Generation of HV DC by Cockroft-Walton voltage multipliers; generation of high impulse voltages and currents, repetitive HV pulses. Methods of measurement of AC, DC and impulses voltages and currents, basic principles of electric breakdown in gaseous medium; basic aspects of EHV/UHV power transmission, and selected industrial applications of corona.
Laboratory: Breakdown experiments on simple air-gaps, Chubb-Fortescue method, Litchenberg figures, experiments on insulator strings including pollution flashover, measurement of high impulse voltages and currents, radio-interference-voltage measurement, capacitance and dissipation factor

Rajanikanth B S,Subba Reddy Basappa

References: Kuffel E, Zaengl W S, Kuffel J, High Voltage Engineering- Fundamentals, Newnes, 2000,Gallagher T J and Pearmain P J, High Voltage - Measurement, Testing and Design, Wiley Interscience, 1983,Rizk F A M and Trinh G N, High Voltage Engineering, CRC Press, 2014,Recent publications

E5 206 (JAN) 3:0

HV Power Apparatus

HV power transformers, equivalent circuit, surge phenomenon, standing and traveling wave theory, ladder network representation, short circuit forces, impulse testing, diagnostics and condition monitoring of transformers, natural frequencies and its measurement, modern techniques.
Introduction to HV switching devices, electric arcs, short circuit currents, TRV, CB types, air, oil and SF6 CB, short circuit testing.

Satish L,Rajanikanth B S,Udaya Kumar

References: Bernard Hochart, Power Transformer Handbook, Butterworth, 1987.,The J & P Transformer Book, 12th Edn, M J Heathcote, Newnes, 1998. Transformers, Bharat Heavy Electricals Limited, Tata McGraw Hill, 2001.,Blume L F, and Boya Jian, Transformer Engineering, John Wiley and Sons, 1951. Garzon R D, HV Circuit Breakers – Design and Applications, Marcel and Dekker NY, 1996.,Flurscheim C H, Power Circuit Breaker: Theory and Design, Peter Peregrinus Ltd., 1975. Ryan H M, and Jones G R, SF6 Circuit Breaker, Peter Peregrinus Ltd., 1989.

E5 209 (JAN) 3:0

Over voltages in Power Systems

Transient phenomena on transmission lines, methods of analysis and calculation, use of PSPICE, principle of EMTP lightning discharges, origin and characteristics of lightning and switching overvoltages, behaviour of apparatus and line insulation under overvoltages. Protection of Apparatus against Overvoltages, Surge arresters, VFTO in GIS, insulation co-ordination.

Satish L

References:,Ragaller K (ed.),Surges in High Voltage Networks,Plenum Press,1980.

E5 212 (JAN) 3:0

Computational Methods for Electrostatics

Laplace's and Poisson's equations in insulation design, transient fields due to finite conductivity, method of images, images in two-layer soil, numerical methods, finite difference, finite element and charge simulation methods tutorials and demonstration on PC. Programming assignments.

Udaya Kumar

References: Sadiku M N O, Numerical Techniques in Electromagnetics, Second Edn, CRC Press.,Weber E, Electromagnetic Fields, Dover, 1951. Silvester P P and Ferrari R L, Finite Elements for Electrical Engineers, Cambridge University Press, 1996.,Selected journal papers.

E5 213 (JAN) 3:0

EHV/UHV Power Transmission Engineering

Electrical power transmission by HVAC and HVDC, Overhead transmission lines, Bundled conductors, Mechanical vibration of conductors, Surface voltage gradient on conductors, Corona & associated power loss, Radio-noise and Audible-noise & their measurement, Fields under transmission lines, Overhead line insulators, Insulator performance in polluted environment, EHV cable transmission - underground cables and GIL, High Voltage substations-AIS and GIS, Grounding of towers and substations, Over voltages in power systems, Temporary, lightning and Switching over voltages, Design of line insulation for power frequency voltage, lightning and switching over voltages, Insulation Co-ordination.

Joy Thomas M

References: Begamudre R D, Extra High Voltage AC Transmission Engineering –Wiley Eastern Limited, 1990,Transmission line Reference Book 345 kV & above, Electrical Power Research Institute, (EPRI), 1982 USA. Journal Publications,Current literature from journals and conference proceedings.

E5 215 (AUG) 2:1

Pulsed Power Engineering

Overview of Pulsed Power Engineering, Energy storage devices, Pulsed power generators, Pulse transformers, Pulse modulators, PFN schemes, Marx circuits, Magnetic pulse compression, FCG, Explosively driven FCGs, Homopolar generators. Power conditioning systems, Switching devices, Insulation requirements for pulsed power systems- gaseous, liquid, solid and magnetic insulation and their behaviour under pulsed voltages. Measurement techniques of pulsed power parameters. Applications of pulsed power systems, pulsed power systems for high power lasers, HPM, UWB, IRA, Railgun, ETC, NEMP and ESD simulators. Pulsed power systems for biological and pollution control applications.

Laboratory experiments on the above topics

Joy Thomas M

References:,Advances in Pulsed Power Technology,Vol. 1 & 2,Plenum Press,New York

E5 231 (JAN) 2:1

Outdoor Insulation

Electric power transmission, AC & DC, overhead lines, air insulated substations, outdoor insulation functions, Types of line and station insulators up to 1200 kV, wall/equipment bushings, HVDC insulators, Materials used for outdoor insulation; porcelain, glass, synthetic/composite, wood, Types of stresses – electrical, mechanical, thermal, environmental, and extraneous and their implications, Aging mechanisms and failure modes, Deterioration of synthetic insulator due to UV rays and corona, Performance of Insulators in polluted/contaminated conditions and remedial measures, Field experience and standards employed for the evaluation, Maintenance and inspection of insulators in service, Computer simulation for estimation of electrical surface and bulk stress, lab experiments on insulator discs/strings for dry/wet (artificial rain) and polluted conditions, for both ac and dc high voltages.

Udaya Kumar,Subba Reddy Basappa

References: Transmission Line Reference book 345 kV and above, EPRI, Palo Alto, USA, 1982,Ravi S Gorur, Edward Cherney and Jeffrey Burnham, “Outdoor Insulators”, text book, Phoenix, Arizona, USA 1999.,Bradwell A, “Electrical Insulation”, text book, Peter Peregrinus Ltd, London, UK, 1983 Recent Journal/ Conference and CIGRE publications.

E5 253 (AUG) 2:1

Dielectrics and Electrical Insulation Engineering

Dielectrics and Electrical Insulation Engineering

Joy Thomas M

References:,Kuffel E, Zaengl W S and Kuffel J, High Voltage Engineering Fundamentals, Butterworth-Heineman press, Oxford, 2000,Papers from IEEE Trans on Dielectrics and Electrical Insulation

E6 Electronic Power Drives

E6 201 (AUG) 3:1

Power Electronics

Power switching devices: diode, BJT. MOSFET, IGBT; internal structure, modeling parameters, forward characteristics and switching characteristics of power devices; control and protection of power switching devices; electromagnetic elements and their design; choppers for dc to dc power conversion; single and multi-quadrant operation of choppers; chopper controlled dc drives; closed loop control of dc drives.

Hands-on exercises: soldering and desoldering practice, pulse generator circuit, inductor design and fabrication, thermal resistance of heat sink, switching characteristics of MOSFET, dc-dc buck converter, CCM and DCM operation, linear power supply, output voltage feedback for over-current protection, dc-dc boost converter, measurement of small-signal transfer functions, closed loop control of boost converter.

Narayanan G

References: Mohan N, Power Electronics; Principles, Analysis and Design , John Wiley, 1989.,Robert Ericson, Fundamentals of Power Electronics, Chapman & Hall, 1997,Umanand L, Power Electronics: Essentials and Applications, Wiley India,

2009,Baliga B J, Power Semiconductor Devices,. PWS Publishing Company, 1996,Sorab K.Ghandhi, Semiconductor Power Devices, John Wiley and Sons, 1976

E6 202 (AUG) 2:1

Design of Power Converters

Power semiconductor switches, drive circuits for MOSFETs and IGBTs, snubber circuits, rectifier circuits, dc-dc switched mode converter circuits, pulse width modulation, non-isolated and isolated converters, magnetics for switched mode power conversion, design of magnetics, magnetic amplifiers, inverter circuits-self oscillating and driven inverter circuits, efficiency and losses in power electronic circuits, thermal issues and heat sink calculation.

Umanand L

Mohan, Undeland and Robbins, Power Electronics: Converters, Applications and Design, John Wiley and Sons, 1989,Chryssis, G.C., High frequency switching power supplies, McGraw Hill 2nd Edition, 1989,Umanand, L., Power Electronics: Essentials and Applications, chapters 1 to 7, John Wiley, India, 2009

E6 211 (JAN) 3:0

Electric Drives

Closed loop control of DC drives. Static inverters-Voltage source inverters, inverter control; six step and pulse width modulated operation, AC motor operation from inverters. Voltage source drives, closed loop control of AC drives.

Narayanan G

References: Ranganathan V T, Electric Drives, Course Notes, IISc, 2005-06,Fitzgerald A E , Kingsley C Jr. and Umans S D, Electric Machinery, Tata McGraw Hill, 2003. Leonhard W., Control of Electrical Drives, 3rd Edition, Springer,Miller T J E, Brushless Permanent-Magnet and Reluctance Motor Drives, Oxford Science Publications, 1989 Krishnan R, Permanent-Magnet-Synchronous and Brushless DC motor Drives, CRC Press, Taylor & Francis Group, 2010,Current Literature.

E6 212 (JAN) 3:0

Design and Control of Power Converters and Drives

Basics of phase controlled converters, Choppers, Front end Ac to DC converter, DC motor speed control, inverters, six step operation, sinusoidal PWM control, current hysteresis PWM and space vector PWM control of three phase inverters. Generation of the three phase PWM signals from sampled reference phase amplitudes and PWM control in overmodulation region, Speed control of induction motor; V/f operation, dynamic equivalent circuit model of induction motor and vector control of induction motor. Current source inverter, Multilevel inverters and its control.

Gopakumar K

Leonhard W., Control of Electrical Drives, Springer-Verlag, 1985,Mohan, Undeland and Robbins, Power Electronics: Converters, Application and Design, John Wiley and Sons, 1989,Krishnan, R., Electric Motor drives: Modelling, Analysis and Control, Prentice Hall, March 2001 Gopakumar K., Lecture notes

E6 221 (JAN) 3:1

Switched Mode Power Conversion

Switched mode power supplies (SMPS): Non-isolated dc-dc converter topologies: continuous

conduction mode (CCM) and discontinuous conduction mode (DCM) analysis; non-idealities in the SMPS. Modeling and control of SMPS, duty cycle and current model control, canonical model of the converter under CCM and DCM. Extra element theorem, input filter design. Isolated dc-dc converters: flyback, forward, push-pull, half bridge and full bridge topologies. High frequency output stage in SMPS: voltage doubler and current doubler output rectifiers. Power semiconductor devices for SMPS: static and switching characteristics, power loss evaluation, turn-on and turn-off snubber design. Resonant SMPS: load resonant converters, quasy resonant converters and resonant transition converters.

Laboratory excercises on : Opamp circuits for current and voltage sensing in converters, differencial amplifiers for sensing in presence of common mode signals, higher order opamp filters, phase shifters, and pulse width modulators, comparator circuits, efficiency modeling and prediction in dc-dc converters, dymnamic response and compensator design for dc-dc converters.

Vinod John

References: Robert Ericson, Fundamentals of Power Electronics, Chapman & Hall, 2004.,Ramanarayanan V., Switched Mode Power Conversion, 2007 Umanand L, Power Electronics: Essentials and Applications, Wiley India, 2009.,Jayant Baliga B, Power Semiconductor Devices, PWS 1996.

E6 222 (JAN) 2:1

Design of Photovoltaic Systems

Introduction to photovoltaic energy conversion, Solar radiation and measurement, Solar cell and their characterization, Influence of insolation and temperature, Maximum power point tracking, Electrical storage with Batteries, controllers, DC power conditioning, AC power conditioners for grid connection,
Solar power drives, Applications for pumping/refrigeration, Economic analysis of PV system, Energy analysis of PV system

Umanand L

Chenming, H. and White, R.M., Solar Cells from B to Advanced Systems, McGraw Hill Book Co.,Ruschenbach, HS, Solar Cell Array Design Hand Varmostrand, Reinhold, NY, 1980,Proceedings of IEEE Photovoltaics Specialists Conference, Solar Energy Journa

E6 223 (JAN) 3:0

PWM Converters and Applications

AC/DC and DC/AC power conversion. Overview of applications of voltage source converters, pulse modulation techniques for 1-phase and 3-phase bridges; bus clamping PWM, space vector based PWM, advanced PWM techniques, practical devices in converter. Calculation of switching and conduction losses. Compensation for dead time and DC voltage regulation; dynamic model of a PWM converter, multilevel converters; constant V/F induction motor drives; estimation of current ripple and torque ripple in inverter fed drives. Line-side converters with power factor compensation.

Narayanan G

References: Mohan, Undeland and Robbins; Power Electronics; Converters, Applications and Design, John Wiley and Sons, 1989.,Erickson R W, Fundamentals of Power Electronics, Chapman and Hall, 1997.,Vithyathil J, Power Electronics: Principles and Applications; McGraw Hill, 1995. Current Literature.

E6 224 (AUG) 3:0

Topics in Power Electronics and Distributed Generation

Introduction to distribution systems, fault calculations, fault contribution and protection coordination with Distributed Generation (DG), intentional and unintentional islanding, impact on distribution system voltage profile, relaying requirements for DG systems. Power converters for grid interconnection and micro-source-side power converter topologies, inverter modeling, component selection, design for efficiency and reliability, grounding and filtering requirements. Power converter design trade-off considering efficiency and reliability. Control requirements for DG, phase locking, current control, DC bus control, power quality, unbalance, harmonics, surges, voltage and frequency windows.

Vinod John

References: IEEE papers and standards, datasheets, current literature.,Ramanarayanan V., Switched Mode Power Conversion, 2007.,Arthur R, Bergen, Vittal, Power Systems Analysis (2nd Ed) Prentice Hall, 1999.,Ned Mohan, Tore M, Undelnad, William P, Robbins (3 Edition), Power Electronics: Converters, Applications and Design; Wiley 2002.

E6 225 (AUG) 3:0

Advanced Power Electronics

Rectifiers: Line commutated, unidirectional power factor correction (PFC), bi-directional, rectifiers with isolation. AC to AC power converters: Matrix converters, Multistage conversion: voltage link and current link topology, High frequency link converters. DC to DC converters: Dual active bridge, Resonant converters. Inverters: Multilevel, Inverters for open ended load configurations, Resonant inverters. High frequency magnetics: Modeling and loss estimation, Inductor and transformer design. Thermal design. Emerging power semi-conductor devices.

Kaushik Basu

Prerequisites: E6 201:Power Electronics or E6 202: Design of Power Converters,References: Ned Mohan, Tore M Undeland, William P Robbins, Power Electronics: Converters, Applications and Design, Wiley, Third Edition 2007.,Erickson R W and Maksimovic D, Fundamentals of Power Electronics, Springer, Second Edition 2005.,Umanand L, Power Electronics and Essentials, Wiley, 2009.,Ramanarayanan V, Switched Mode Power Conversion, Course Notes, IISc, 2004. Current literature

E7 Protonic Drivces

E7 211 (JAN) 3:0

Photonics Integrated Circuits

Principles: Introduction to Photonics; optical waveguide theory; numerical techniques and simulation tools; photonic waveguide components – couplers, tapers, bends, gratings; electro-optic, acousto-optic, magneto-optic and non-linear optic effects; modulators, switches, polarizers, filters, resonators, optoelectronics integrated circuits; amplifiers, mux/demux, transmit receive modules;

Technology: materials – glass, lithium niobate, silicon, compound semiconductors, polymers; fabrication – lithography, ion-exchange, deposition, diffusion; process and device characterization; packaging and environmental issues;

Applications: photonic switch matrices; planar lightwave circuits, delay line circuits for antenna arrays, circuits for smart optical sensors; optical signal processing and computing; micro-opto-electro-mechanical systems; photonic bandgap structures; VLSI photonics

Srinivas T,Badrinarayana T,Varun Raghunathan

C. R. Pollock and M. Lip Son, Integrated Photonics, Kluwer Pub., 2003.,T. Tamir, (ed), Guided-wave optoelectronics, (2nd edition), Springer-Verlag, 1990,H. Nishihara, M. Haruna, and T. Suhara, Optical Integrated Circuits, McGraw-Hill, 1988,E. J.

Murphy, (Editor), Integrated Optical Circuits and Components: Design and Applications, Marcel and Dekker, 1999.,Current literature: Special issues of journals and review articles

E7 214 (JAN) 3:0

Optoelectronics Devices

This course is intended to be an introduction and bit more in-depth discussion into the field of semiconductor optoelectronics. This would be a good bridge between the microelectronic devices and photonics disciples offered at the Institute. The course would require some basic understanding of semiconductors and calculus at undergraduate level as a pre-requisite. The main topics which would be covered are as follows:

Quick refresher into semiconductor physics: band structures, doping, density of states, carrier concentration and p-n junctions.
Optical transitions in semiconductors: different radiative and non-radiative processes, and rate calculations.
Light emitters: LEDs and Lasers, diode structures, characteristics (LI curves, speed etc.), Lasing condition, hetero-structures, quantum wells, quantum dot lasers and VCSELs.
Light detectors: Photodiodes, structure, biasing conditions, photovoltaic and photoconductive devices, solar cells, p-i-n and avalanche photodiodes, characteristics (responsitivity, gain and speed), and noise processes in detection.
Light modulation: Electro-optic devices, amplitude and phase modulation, Franz-Keldysh effect, quantum confined stark effect.
Review of current topics in optoelectronics: heterogeneously integrated lasers, thermo-photo voltaic devices, silicon photonics, Germanium lasers, SPASERS, Polariton lasers etc.
3-4 homeworks, one midterm, one final and a group project are intended as means of evaluating the students.

Varun Raghunathan

Suitable textbooks and reference books for this course are as follows: B.E.A. Saleh and M.C. Teich, "Fundamentals of Photonics," Wiley, 2nd edition, ISBN: 978-0-471-35832-9.,J.M. Liu, "Photonic devices," Cambridge University Press, 1st edition, ISBN: 978-0-521-55859-4.,P. Battacharya, "Semiconductor optoelectronic devices," Pearson Education, 2nd edition, ISBN: 978-8177581669.,S.L. Chuang, "Physics of Photonic devices," Wiley-Blackwell, 2nd edition, ISBN: 978-0470293195.

E7 221 (AUG) 2:1

Fiber-Optic Communication

Introduction to fiber optics; light propagation. Optical fibers; modes, dispersion, low, nonlinear effects; Optical transmitters: LEDs, Semiconductor Lasers, Transmitter design; Optical receivers: Photodetectors, Receiver design, Noise, sensitivity; System design and performance: voice, video, data transmission, analog and digital systems, standards;

Broadband local area optical networks and WDM systems; coherent communication systems; long distance telecommunications using optical amplifiers and solitons. Introduction to topics of current interest: all optical networks, integrated optics, MOEMS; microwave photonics.
Experiments on characteristics of optical fibers, sources and detectors, analog and digital link, WDM system, tutorial on optical fiber system design, simulation of optical fiber modes.

Shivaleela E S,Varun Raghunathan,Srinivas T

A. Selvarajan, S. Kar and T. Srinivas, Optical Fiber Communications, Principles and Systems, Tata – Mc Graw Hill,,2002. G. Keiser, Optical Fiber Communications, 2nd Edition, McGraw Hill, 1991,I. P. Kaminov and T. L. Koch, Optical Fiber Telecommunications IIIA and IIIB, Academic Press, 1997.

E7 231 (JAN) 3:0

Fiber-Optics Networks

Introduction to Fiber-optic networks; Components for optical networks; Broadcast and select networks; Wavelength routing networks; Virtual topology design; Control and Management; Access networks; Deployment considerations; Photonics switching; Recent developments and futuristic issues.

Shivaleela E S,Srinivas T

Prerequisite: E7 221 or equivalent,R. Ramaswami and K. N. Sivarajan, Optical Networks: A practical Perspective, (2nd Ed), Morgan Kufmann Publishers 2002.,S. V. Kattalopoulos, Introduction to DWDM Technology, IEEE Press, 2000,Current literature: special issues of journals and review articles

E8 Electromagnetics, Microwaves and Antennas

E8 201 (AUG) 3:0

Electromagnetism

Review of basic electrostatics, dielectrics and boundary conditions, systems of charges and conductors, Green's reciprocation theorem, elastance and capacitance co-efficient, energy and forces, electric field due to steady currents, introduction to magnetostatics, vector potential, phenomena of induction, self and mutual inductance, time-varying fields, Maxwell's equations.

Udaya Kumar

References:,Kraus J D, Electromagnetics, McGraw Hill International.,Jeans J H, The Mathematical Theory of Electricity and Magnetism, Cambridge University Press.,Smythe W R, Static and Dynamic Electricity, McGraw Hill Book Company, New York.

E8 202 (AUG) 2:1

Computational Electromagnetics

Maxwell's equations, Wave equations, scalar and vector potentials, fundamental theorems in EM Method of moments: Greens Functions; Surface equivalence principle; Electrostatic formulation; Magnetostatic formulation; Electric Field Integral Equation; Magnetic Field Integral Equation; Direct and Iterative Solvers; Finite difference time domain methods: 1D wave propagation, yee Algorithm, Numerical dispersion and stability, Perfectly matched absorbing boundary conditions, Dispersive materials. Antenna and scattering problems with FDTD, non-uniform grids, conformal grids, periodic structures, RF circuitAdvanced topics in numerical electromagnetics based on recent literature

About the course

The course will have programming assignments (using Matlab/Fortran/C++).

Dipanjan Gope,Vinoy K J

A. Taflove and SC Hagness Computational Electrodynamics: The Finite Difference Time Domain Method, 3ed Ed., Artech House,Andrew F. Peterson, Scott L. Ray, Raj Mittra: Computational Methods for Electromagnetics, 1st Ed., IEEE Press Series on Electromagnetic Wave Theory,Walton C. Gibson: The Method of Moments in Electromagnetics, 1st Ed., Chapman and Hall,Roger F. Harrington: Field Computation by Moment Methods, 1993, Wiley-IEEE Press

E8 242 (JAN) 2:1

Radio Frequency Integrated Circuits and Systems

Introduction to wireless systems, personal communication systems, High frequency effects in circuits and systems. Review of EM Fundamentals and Transmission line Theory, terminated transmission lines, smith chart, impedance matching, Microstrip and Coplanar waveguide implementations, microwave network analysis, ABCD parameters, S parameters. Behavior of passive IC components and networks, series and parallel RLC circuits, resonant structures using distributed transmission lines, components and interconnects at high frequencies Basics of high frequency amplifier design, biasing techniques, simultaneous tuning of 2 port circuits, noise and distortion. MEMS technologies and components for RF applications: RF MEMS switches, varactors, inductors and filters. Introduction to microwave antennas, definitions and basic principles of planar antennas. CRLH meta materials for microwave circuits and components.

Course will have a Lab component involving design, fabrication and testing of some basic passive circuits and antennas with Industry Standard Softwares.

Vinoy K J

D M Pozar, Microwave Engineering, John Wiley 2003,D M Pozar., Microwave and RF Wireless Systems,T H Lee., The design of CMOS Radio Frequency Integrated Circuits,V K Varadan., K. J Vinoy., K.A Jose., RF MEMS and Their Applications

E9 Signal Processing

E9 201 (AUG) 3:0

Digital Signal Processing

Discrete-time signals and systems, frequency response, group delay, z-transform, convolution, discrete Fourier transform (DFT), fast Fourier transform (FFT) algorithms, discrete Cosine transform (DCT), discrete Sine transform (DST), relationship between DFT, DCT, and DST; design of FIR and IIR filters, finite word length effects, Hilbert transform, Hilbert transform relations for causal signals, Karhunen-Loève transform. Introduction to linear prediction, bandpass sampling theorem, bandpass signal representation.

Soma Biswas,Prasanta Kumar Ghosh

References:,Proakis and Manolakis, Digital Signal Processing, Prentice Hall India,.,Oppenheim A V , Schafer R W, Discrete-time Signal Processing, Prentice Hall, 1998.,Sanjit K Mitra, Digital Signal processing : A Computer Based Approach, Tata McGraw-Hill

E9 202 (AUG) 3:0

Advanced DSP : Non-linear Filters

Introduction to non-linear filters: LTI, LTV, NLTI, NLTV; frequency response, optimality and robustness. Sliding estimator as a filter. Recursive, non-recursive estimator; Non-Gaussian models: generalized Gaussian and stable distributions; robust estimation.

Median smoother, Rank-order filter, Weighted Median Smoother. Center weighted Median and adaptation. Threshold decomposition of signals, stacking property; positive Boolean function and stack filtering. Introduction to order statistics, joint densities, moments, sample selection probability. Weighted median filter, Link between linear and non-linear smoother and filter, Mallows Theorem. Generalized median/mean filtering: L-estimator; L-ell-filter, optimality; Myriad mode-filtering, Myriadization of linear filter.

Volterra series, quadratic and higher order filters; frequency domain property. Kalman filter, extended Kalman filter.

Sreenivas T V

Pre-requisite: E9-201 or equivalent. References:,G. R. Arce, "Non-linear signal processing: A statistical approach," Wiley 2004.,J. Astola and P. Kuosmanen, "Fundamentals of non-linear digital filtering," CRC Press,V. John Mathews and G. L. Sicuranza, “Polynomial Signal processing”, John-Wiley 2000.

E9 203 (JAN) 3:0

Compressed Sensing and Sparse Signal Processing

Introduction to Compressed Sensing. Basic theory: l1 minimization, null space property, necessary and sufficient conditions for l0 – l1 equivalence. Mutual coherence and the Restructed Isometry property, and their consequences. RIP and random matrices. Johnson-Lindenstrauss Lemma Stable signal recovery and the restricted eigenvalue property. Recovery algorithms and their performance guarantees. Special/advanced topics upon student request.

Hari K V S

Pre-requisite: Random Processes, Matrix Theory,M. Elad, “Sparse and Redundant Representations”, Sprinter, 2010.,H. Rauhut, “Compressive Sensing and Structured Random Matrices,” Radon Series Comp. Appl. Math., 2011.,R. Baranuik, M. A. Davenport, M. F. Duarte, C. Hegde, “An Introduction to Compressive Sensing,” Rice University Connextions Course, 2011.

E9 205 (AUG) 3:1

Machine Learning for Signal Processing

Introduction to real world signals - text, speech, image, video. Feature extraction and front-end signal processing - information rich representations, robustness to noise and artifacts,signal enhancement. Basics of pattern recognition, Generative modeling - Gaussian and mixture Gaussian models, hidden Markov models, factor analysis and latent variable models. Discriminative modeling - support vector machines, neural networks and back propagation.Introduction to deep learning - convolutional and recurrent networks, pre-training and practical considerations in deep learning, understanding deep networks. Clustering methods and decision trees. Decoding time sequences with finite state networks. Feature and model adaptation methods. Feature selection methods. Applications in computer vision and speech recognition.

Sriram Ganapathy

Pre-requisites Random Process / Probablity and Statistics Linear Algebra / Matrix Theory,References: Bishop C M, Pattern Recognition and Machine Learning, 2nd Edition, Springer, 2011. Goodfellow I, Bengio Y, Courville A, Deep Learning, MIT Press, 2016.,Gonzalez R C, Woods R E, Digital Image Processing, 3rd Edition, Prentice Hall, 2008. Rabiner L and Juang H, Fundamentals of speech recognition”, Prentice Hall, 1993.,Li Deng, Deep Learning : Methods and Applications, Microsoft Technical Report. Yu D, Deng L, Automatic Speech Recognition - Deep learning approach" Springer, 2014.,Szeliski R, Computer Vision: Algorithms and Applications, Springer, 2010

E9 206 (AUG) 3:0

Digital Video: Perception and Algorithms

The course will cover algorithms for digital video processing from the point of view of human visual perception. Topics include video sampling, frequency response of human visual systems, color perception, video transforms, retinal and cortical filters (difference of Gaussians, Laplacian of Gaussians, center-surround responses, 3D Gabor filterbanks, steerable pyramids), motion detection, Reichardt detector, optical flow algorithms (Horn-Schunck, Black-Anandan, Fleet-Jepson, optical flow in the brain, block motion), video compression, statistical video models (spectrum power law, divisive normalization, Gaussian scale mixtures, optical flow statistics, Weber-Fechner law), video quality assessment, stereopsis, denoising, foveation and saliency.

Rajiv Soundararajan

A. C. Bovik, Al Bovik's Lecture Notes on Digital Video, The University of Texas at Austin, 2017.,M. Tekalp, Digital Video Processing, Prentice Hall, 1995.,A. C. Bovik, The Essential Guide to Video Processing, Academic Press, 2009

E9 207 (JAN) 3:0

Basics of Signal Processing

Introduction to probability and random processes: basic definitions, discrete, continuous and mixed random variables, probability density function, cumulative density function, various notions of stationarity, ergodicity, filtering noise through linear systems, Signal spaces and signal geometry, Topics in sampling: Shannon sampling theorem for bandlimited and random signals, basic ideas on compressive sampling, Sampling rate conversion: decimation, expansion and rational fractional rate conversion, filter banks and applications. Introduction to transform methods: Fourier transforms and convergence issues, wavelets and algorithms for fast decomposition.

Shayan Garani Srinivasa

Moon and Stirling,Mathematical Methods and Algorithms for Signal Processing,Prentice Hall 2000,P. P. Vaidyanathan,Multirate systems and filterbanks

E9 211 (AUG) 3:0

Adaptive Signal Processing

Review of estimation theory. Wiener Solution. Kalman filter and its application to estimation, filtering and prediction. Iterative solution; of method of steepest descent and its convergence criteria, least mean square gradient algorithm (LMS), criteria for convergence and LMS versions: normalized LMS, leaky, sign, variable stepsize, transform domain LMS algorithm using DFT and DCT. Block LMS (BLMS) algorithm: frequency domain BLMS (FBLMS). Recursive least square (RLS) method, fast transversal, fast lattice RLS and affine projection algorithms. Applications of adaptive filtering: spectral estimation, system identification, noise cancelling acoustic and line echo cancellation, channel equalization.

Hari K V S

References:,Ali H Sayed,Adaptive Filters, John Wiley/IEEE, 2008

E9 213 (JAN) 3:0

Time-Frequency Analysis

Time-frequency distributions: temporal and spectral representations of signals, instantaneous frequency, Gabor's analytic signal, the Hilbert and fractional Hilbert transforms, Heisenberg's uncertainty principle, densities and characteristic functions, global averages and local averages, the short-time Fourier transform (STFT), filterbank interpretation of STFT, the Wigner distribution and its derivatives, Cohen's class of distributions (kernel method), bilinear time-frequency distributions, Wigner's theorem, multicomponent signals, instantaneous bandwidth, positive distributions satisfying the marginals, Gabor transform

Spaces and bases: Hilbert space, Banach space, orthogonal bases, orthonormal bases, Riesz bases, biorthogonal bases, Frames, shift-invariant spaces, Shannon sampling theorem, B-splines.

Wavelets: Wavelet transform, real wavelets, analytic wavelets, dyadic wavelet transform, wavelet

bases, multi resolution analysis, two-scale equation, conjugate mirror filters, vanishing moments, regularity, Lipschitz regularity, Fix-Strang conditions, compact support, Shannon, Meyer, Haar and Battle-Lemarié wavelets, Daubechies wavelets, relationship between wavelets and filterbanks, perfect reconstruction filterbanks.

Chandra Sekhar Seelamantula

References: Cohen L, Time Frequency Analysis, Prentice Hall, 1995,Mallat S, A Wavelet Tour of Signal Processing -,The Sparse Way, Elsevier, Third Edition, 2009.

E9 231 (JAN) 3:0

MIMO Signal Processing

In this course, we cover the theory, algorithms, and practical considerations in multiple-antenna adaptive wireless communication systems. The topics covered will include the useful results from information theory, parameter estimation theory, array processing, and wireless communications, all specialized to the case of advanced multiple-antenna adaptive processing. We will also discuss various design issues in ad hoc networks, cognitive radio, and MAC protocols for multiple antenna systems.

Chandra R Murthy

Daniel W. Bliss and Siddhartan Govindasamy, "Adaptive Wireless Communications: MIMO Channels and Networks,",Cambridge University Press, 2013,Xiaodong Wang and Vincent Poor, "Wireless Communication Systems: Advanced Techniques for Signal Reception," Prentice Hall Inc., 2004

E9 241 (AUG) 2:1

Digital Image Processing

Continuous image characterization, sampling and quantization, 2D Fourier transform and properties, continuous/discrete image processing, rotation, interpolation, image filtering (shift-invariant filters, bilateral filters, nonlocal means), spatial operators, morphological operators, edge detection, texture, 2-D transforms (discrete Fourier transform, discrete cosine transform, Karhunen-Loève transform, wavelet transform), image pyramid, image denoising, segmentation, restoration.

Chandra Sekhar Seelamantula

References: Lim J S,Two-dimensional signal and image processing,Prentice Hall,1990.,Jain A K, Fundamentals of digital image processing, Prentice Hall, 1989. Gonzalez R. C. and Woods R. E., Digital image processing, Prentice Hall, 2008. Dudgeon D.E. and Merserau R. M., Multidimensional digital signal processing, Prentice Hall Signal Processing Series, 1983.

E9 243 (AUG) 3:0

Computer Aided Tomographic Imaging

Introduction to principles of tomography and applications, tomographic imaging. Radon transform and its properties, mathematical framework. Introduction to X-ray tomography, emission computer tomography, magnetic resonance imaging systems. Projection and Fourier slice theorem. Scanning geometries: translate and rotate, translate-rotate, rotate on a circular trajectory for 2-D imaging and helical or spiral scan trajectory for 3-D imaging. Transform domain algorithms: Fourier inversion algorithms, filtered back projection algorithms – reconstruction with non-diffracting sources, parallel projections and fan projections for 2-D and cone beam projections on circular and spiral trajectory for 3-D reconstruction. Computer implementation, iterative reconstruction techniques: algebraic

reconstruction techniques, statistical modeling of generation, transmission and detection processes in X-Ray CT, artifacts and noise in CT images. Image reconstruction with incomplete and noisy data, applications of Radon transform in 2-D Signal and Image processing.

Rajgopal K

References:,Kak A C, and Slaney M, Principles of Computerized Tomographic Imaging, IEEE Press, 1988.,Herman G T, Image Reconstruction from Projections, Implementation and Applications: Topics in Applied Physics, Vol 32, Springer Verlag, 1979.,Natterer F, The Mathematics of Computerized Tomography, SIAM Classics In Applied Mathematics, Vol. 32, 2001.,Natterer F, and Wubbeling F, Mathematical Tools in Image Reconstruction, SIAM, 2001.

E9 243 (JAN) 3:0

Computer Aided Tomographic Imaging

Introduction to principles of tomography and applications, tomographic imaging. Radon transform and its properties, mathematical framework. Introduction to X-ray tomography, emission computer tomography, magnetic resonance imaging systems. Projection and Fourier slice theorem. Scanning geometries: translate and rotate, translate-rotate, rotate on a circular trajectory for 2-D imaging and helical or spiral scan trajectory for 3-D imaging. Transform domain algorithms: Fourier inversion algorithms, filtered back projection algorithms – reconstruction with non-diffracting sources, parallel projections and fan projections for 2-D and cone beam projections on circular and spiral trajectory for 3-D reconstruction. Computer implementation, iterative reconstruction techniques: algebraic reconstruction techniques, statistical modeling of generation, transmission and detection processes in X-Ray CT, artifacts and noise in CT images. Image reconstruction with incomplete and noisy data, applications of Radon transform in 2-D Signal and Image processing.

Rajgopal K

References: Kak A C, and Slaney M, Principles of Computerized Tomographic Imaging, IEEE Press, 1988.,Herman G T, Image Reconstruction from Projections, Implementation and Applications: Topics in Applied Physics, Vol 32, Springer Verlag, 1979.,Natterer F, The Mathematics of Computerized Tomography, SIAM Classics In Applied Mathematics, Vol. 32, 2001. Natterer F, and Wubbeling F, Mathematical Tools in Image Reconstruction, SIAM, 2001.

E9 245 (AUG) 3:1

Selected Topics in Computer Vision

This course will develop the use of multiview geometry in computer vision. A theoretical basis and estimation principles for multiview geometry, dense stereo estimation and three-dimensional shape registration will be developed.The use of these ideas for building real-world solutions will be emphasised. Topics Stereo estimation: current methods in depth estimation 3D registration: ICP and other approaches Multiple view geometry: projective geometry. Multilinear relationships in images, estimation.

Srinivasa Venu Madhav Govindu

Pre-requisites: E1 216 or permission of the instructor.,References:,Hartley R, and Zisserman A, Multiple View Geometry in Computer Vision, Second Edn, Cambridge University Press, 2004.,Faugeras O, and Luong Q T,The Geometry of Multiple Images, MIT Press 2001.,Current literature

E9 246 (JAN) 3:1

Advanced Image Processing

Image Features - Harris corner detector, Scale Invariant Feature Transform (SIFT), Speeded Up Robust Features (SURF), edge detection, Hough Transform; Image Enhancement - Noise models, image denoising using linear filters, order statistics based filters and wavelet shrinkage methods,

image sharpening, image super-resolution; Image Segmentation - Graph-based techniques, Active Contours, Active Shape Models, Active Appearance Models; Image Compression - Entropy coding, lossless JPEG, perceptually lossless coding, quantization, JPEG, JPEG2000; Image Quality - Natural scene statistics, quality assessment based on structural and statistical approaches, blind quality assessment; Statistical tools - Kalman Filter, Hidden Markov Models; Video Processing - Video standards, motion estimation, compression.

Soma Biswas

Pre-requisites: E9 241: Digital Image Processing,References: David A. Forsyth and Jean Ponce, Computer Vision: A Modern Approach, Pearson Education, 2003,Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2010. Simon J.D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012.

E9 251 (JAN) 3:0

Signal Processing for Data Recording Channels

Introduction: Review of basic principles behind the physics of magnetic recording, super paramagnetic limits, technological trends in magnetic storage/optical systems, recording schemes in magnetic and optical devices. Signal Modeling: Communication theoretic framework of read/write channels. Models for analog read back signal with inter-symbol interference, noise and distortion sources, notion of channel and user bit densities towards SNR definition. Signal Processing Methods:
Equalization and timing recovery, PLLs, ML based timing recovery methods, Detection techniques based on the BCJR algorithm and its low complexity variations, turbo-equalization methods. Coding Techniques: Introduction to constrained modulation codes, review of algebraic and graphical coding techniques, interleaving mechanisms and analysis of the code performance. Implementation: Hardware related aspects for realizing signal processing algorithms on a system-on-chip (SoC).

Shayan Garani Srinivasa

Bergmans,J.W.M.,Digital Baseband Transmission and Recording,Kluwer Academic Press,1996

E9 252 (AUG) 3:0

Mathematical methods and techniques in signal processing

Review of basic signals, systems and signal space: Review of 1-D signals and systems, review of random signals, multi-dimensional signals, review of vector spaces, inner product spaces, orthogonal
projections and related concepts. Basics of multi-rate signal processing: sampling, decimation and interpolation, sampling rate conversion (integer and rational sampling rates), oversampled processing
(A/D and D/A conversion), and introduction to filter banks. Signal representation: Transform theory and methods (FFT and variations, KLT), other transform methods. Statistical signal modeling: The least squares method, Pade's approximation, Prony's method, Shanks' method, iterative pre-filtering, all-pole modeling and linear prediction, autocorrelation and covariance methods, FIR least squares inverse filter design, applications and examples. Inverse problems (signal reconstruction): underdetermined least squares, pseudo-inverse (SVD), min-norm solutions, regularized methods, reconstruction from projections, iterative methods such as projection onto convex sets, expectationmaximization
and simulated annealing.

Shayan Garani Srinivasa

Moon & Stirling, Mathematical Methods and Algorithms for Signal Processing, Prentice Hall, 2000 (required),Monson Hayes, Statistical Digital Signal Processing and Modeling, John Wiley and Sons, 1996 (optional),Class Notes

E9 261 (JAN) 3:1

Speech Information Processing

Human speech communication: physiology of speech production, phonetics and phonology. speech perception and illusions. Time- domain features. Time-varying signal analysis: short-time Fourier transform, spectrogram, quasi-stationary analysis: cepstrum, linear-prediction models. Line spectral pair, Mel frequency cepstral coefficients. sinusoidal models. Principles of Speech synthesis, prosody, quality evaluation, pitch and time scale modification. Speech as a sequence of vectors: orthogonal transforms, principal component analysis, vector quantization, Gaussian mixture model and their applications. Dynamic time warping and hidden Markov models. Speaker recognition.

Prasanta Kumar Ghosh

Pre-requisites: E9-201 or consent of the instructor.,References: Handbook of Speech Processing, Benesty, Jacob; Sondhi, M. M.; Huang, Yiteng (Eds.), Springer, 2008. Gold B, and Morgan N, Speech and Audio Signal Processing, John Wiley, 2000.,Douglas O'shoughnessy, Speech Communication, IEEE Press 2000. Taylor P, Text-to-Speech Synthesis, Cambridge Univ. Press, 2009. Rabiner L R, and Schafer R W, Theory and applications of digital speech processing, Pearson, 2011.,Quatieri T F, Discrete-time speech signal processing, Prentice-Hall, 2002. Recent literature.

E9 262 (JAN) 3:0

Stochastic Models for Language, Speech and Audio

Human speech communication, concept=> signal=> concept & levels of information. Discrete and continuous representations, signal representation as a pattern; structure representation through lexicon, grammar. ASR: text recognition, speaker recognition, language identification, keyword spotting. Gaussian models and Bayesian inference; maximum likelihood parameter estimation. Mixture Gaussian models, EM algorithm derivation; relation to K-means algorithm, LBG algorithm and EM generalization. Application to speaker-ID. Units of speech: linguistic, acoustic and stochastic; segmentation problem. Dynamic programming introduction. maximum-likelihood segmentation; segment clustering and automatic sub-word units. Graphical models and Markov models; Language modeling, N-grams and their estimation. Tree structured language model, minimum entropy decision tree algorithm; language perplexity measure. Application to spoken language-ID. Hidden Markov model (HMM): Markov structure for latent variables; Gaussian density, discrete density, mixture Gaussian and semi-continuous density models. HMM evaluation, training and decoding problems: forward-backward algorithm, Baum-Welch algorithm, Viterbi algorithm, segmental K-means (SKM) algorithm. HMM duration density and explicit duration modeling and modified EM algorithm. Finite state network (FSN) of HMMs and lexicon building. Continuous speech recognition (CSR) through FSN decoding using time-synchronous Viterbi algorithm. Viterbi beam search for large vocabulary CSR. Linear Dynamical Systems and kalman filtering, relation to HMM.

Sreenivas T V

Pre-requisite: E2-202 Random Processes or equivalent.,* X. Huang and A. Acero and H. Hon: "Spoken Language Processing," Prentice Hall, 2001 + Research papers,* C.M. Bishop: "Pattern Recognition and Machine learning," Springer, 2006.,* L.R. Rabiner and B.H. Juang: "Fundamentals of speech recognition," Prentice Hall, 1993.

E9 271 (JAN) 3:0

Space-Time Signal Processing and Coding

Multiple-Input Multiple-Output (MIMO) communication systems: Space-Time Code construction and decoding algorithms, Distributed space-time coding. Coding and signal processing for multi-way relay systems. Coding and algorithms for broadcast, multicast and interference channels. Simultaneous Wireless Information and Power Transfer (SWIPT) systems. Wireless Network Coding

Sundar Rajan B

Pre requisites: Digital Communication,Introduction to Space-Time Wireless Communications,,A. Paulraj, R. Nabar and D. Gore. Cambridge University Press, 2003. Current literature

E9 282 (JAN) 2:1

Neural Signal Processing

Biophysics and computational techniques for the analysis of action potentials, Local Field Potential (LFP), Electrocortico/encephalogram (ECoG/EEG) and functional Magnetic Resonance Imaging (fMRI). Techniques include stochastic processes, self organized criticality, time-frequency analysis, sparse signal processing, coherence, information theoretic methods, ICA/PCA, forward and inverse modeling, directed tranfer functions, Granger causality, image processing methods and reverse correlation.

Chandra Sekhar Seelamantula

References: Kandel, Schwartz and Jessell. Principles of Neural Science, 4th Edition.,Buzsaki G, Rhythms of the brain, Oxford University Press, USA 2006.,Poldrack R A, Mumford J A and Nichols T E, Handbook of functional MRI data analysis, Cambridge University Press, New York, 2009. Mallat S, A Wavelet Tour of Signal Processing - The sparse way, Elsevier, Third Edition, 2009 Thomas M. Cover and Joy A. Thomas, Elements of Information Theory, 2nd Edition, Wiley series in Telecommunications and Signal Processing, 1991.

E9 291 (AUG) 2:1

DSP System Design

DSP Architecture: Single Core and Multicore; Pipelining and Parallel Processing; DSP algorithms: Convolution, Correlation, FIR/IIR filters, FFT, adaptive filters, sampling rate converters, DCT, Decimator, Expander and Filter Banks. DSP applications.
Weekly laboratory exercises using Beagle and xilinx FPGA boards.

Rathna G N

References: Rulph Chassaing, Digital signal processing and applications with C6713 and C6416 DSK, Wiley, 2005,Keshab K Parhi, VLSI Digital Signal Processing Systems:Design and Implementation, student Edition, Wiley, 1999.,Nasser Kehtarnavaz, Digital Signal Processing System Design: LabVIEW-Based Hybrid Programming, Academic Press, 2008,Current Literature.

E9 292 (JAN) 2:1

Real-Time Signal Processing with DSP

Implementation of discrete-time systems, DSP device architecture and programming (TMS320C6x), FIR/IIR digital filter design, Multirate DSP, Power spectrum estimation, Linear prediction and adaptive filtering, Real-time system development, DSP Programming, Code Composer Studio and DSP BIOS, Spawning and controlling tasks and data I/O, Real-time scheduling analysis, load analysis, Queues, semaphores and mailboxes, Real-time data exchange using Lab view, Mini Project.

Rathna G N

Pre-requisite: Knowledge of Digital Signal Processing,Nasser kehtarnawaz, Real-Time Digital Signal Processing based on TMS320C6000,TMS320C6x Data Sheets from TI

Division of Mechanical Sciences

Preface

The Division of Mechanical Sciences consists of the departments of Aerospace Engineering, Atmospheric and Oceanic Sciences, Civil Engineering Chemical Engineering, Divecha Centre for Climate Change, Earth Sciences, Mechanical Engineering, Materials Engineering, Product Design and Manufacturing and Sustainable Technology. It also administers an Institute facility, 'Advanced Facility for Microscopy and Microanalysis'. The courses offered in the different departments of the Division have been reorganized after review and revision, and have been grouped department wise. These are identified by the following code.

AE	Aerospace Engineering
AS	Atmospheric and Oceanic Sciences
CE	Civil Engineering
CH	Chemical Engineering
ER	Earth Sciences
ME	Mechanical Engineering
MT	Materials Engineering
PD	Product Design and Manufacturing
ST	Sustainable Technologies

The first two digits of the course number have the departmental code as the prefix. All the Departments/Centres (except the Space Technology Cell and Divecha Centre for Climate Change) of the Division provide facilities for research work leading to the degrees of M Tech (Research) and Ph D. There are specific requirements for completing a Research Training Programme for students registered for research at the Institute. For individual requirements, students are advised to consult the Departmental Curriculum Committee. M Tech Degree Programmes are offered in all the above departments except in the Centre for Product Design and Manufacturing which offers M.Des. Department of Civil Engg and CiSTUP jointly offer an M Tech Programme in Transportation Engineering. Most of the courses are offered by the faculty members of the Division, but in certain areas, instruction by specialists in the field and experts from industries are also arranged.

Prof. Vikram Jayaram
Chairman
Division of Mechanical Sciences

Aerospace Engineering

Details of the Aerospace Engineering

M Tech Programme Duration: 2 years 64 Credits

Hard Core: 24 Credits

AE 203 3:0 Fluid Dynamics
AE 220 3:0 Flight and Space Mechanics
AE 221 3:0 Flight Vehicle Structures
AE 245 3:0 Mechanics and Thermodynamics of Propulsion
AE 259 3:0 Navigation, Guidance and Control
AE 271 1:2 Flight Vehicle Design
AE 276 1:2 Experimental Techniques
AE 211 3:0 Mathematics for Aerospace Engineers

In place of AE 211, any Mathematics course of 3 credits approved by DCC may be taken

Project: 19 Credits

AE 299 : 0:19 Dissertation Project

Electives: A balance of 21 credits is required to make up a minimum of 64 credits. A minimum of two courses in Aerodynamics/Guidance and Control/ Propulsion/ Structure needs to be taken from the departmental courses listed below. This leaves approximately 12 credits to be taken from electives within/ outside the department.

AE 203 (AUG) 3:0

Fluid dynamics

Properties of fluids, characteristics of the atmosphere, motion of a fluid element, conservation laws of mass, momentum and energy, inviscid flows, potential flows, vortex motion, aerodynamics of airfoils, boundary layer transition and turbulent flows.

Sourabh Suhas Diwan

Gupta, V., and Gupta, S.K.,,Fay, J.A.,,Kuethe, A.M., and Chou, S.H.

AE 206 (AUG) 3:0

Hypersonic Flow Theory

Characteristic features of hypersonic flow, basic equations boundary conditions for inviscid flow, shock shapes over bodies, flow over flat plate, flow over a wedge, hypersonic approximations, Prandtl-Meyer flow, axisymmetric flow over a cone. Hypersonic small disturbance theory, applications to flow over a wedge and a cone, blast wave analogy, Newtonian impact theory, Busemann centrifugal correction and shock expansion method, tangent cone and tangent wedge methods. Introduction to viscous flows, hypersonic boundary layers, non-equilibrium high enthalpy flows. High enthalpy impulse test facilities and instrumentation. Computational fluid mechanics techniques for hypersonic flows, methods of generating experimental data for numerical code validation at hypersonic Mach numbers in hypervelocity facilities

Gopalan Jagadeesh

Cherynl, C.G.,Hayes, W.D.,,Cox, R.N

AE 209 (AUG) 3:0

Aerodynamic testing facilities measurements

Aerodynamic testing in various speed regimes, requirements of aerodynamic testing, design aspects of low speed wind tunnels, flow visualization methods, measurement methods for flow variables. Wind tunnel balances, elements of computer-based instrumentation, measurements and analyses methods. Elements of high speed wind tunnel testing: design aspects to supersonic and hypersonic wind-tunnels, other high speed facilities like shock tube shock tunnels, free piston tunnels, ballistic ranges and low density tunnels, special aspects of instrumentation for high speed flows.

Vasudevan B

William H Roe Jr., and Alan Pope,Pankhrust, R.C., and Holder, D.W.,,Lukasiewicz, J.,,Alan Pope and Kenneth L Going

AE 211 (AUG) 3:0

Mathematical methods for aerospace engineers

Applied linear algebra and probability theory; Boundary value problems, Finite differences, and finite elements ; Fouries series, integrals, DFTs and FFTs; Initial value problems and their numerical solution; Solution of sparse systems; Calculus of variations and adjoint methods.

Kartik Venkatraman

G. Strang,G. Strang,G. Strang

AE 214 (AUG) 3:0

Turbulent shear flows

Origin of turbulence, laminar-turbulent transition, vortex dynamics, statistical aspects of turbulence, scales in turbulence, spectrum of turbulence, boundary layers, pipe flow, free shear layers, concepts of equilibrium and similarity, basic ideas of turbulence modeling, measurement techniques.

Gopalakrishnan S

Tritton, D.J.,,Tennekes, H., and Lumley, J., A,Townsend, A.A.

AE 217 (AUG) 2:1

Computation of viscous flows

Review of schemes for Euler equations, structured and unstructured mesh calculations, reconstruction procedure, convergence acceleration devices, schemes for viscous flow discretization, positivity, turbulence model implementation for unstructured mesh calculations, computation of incompressible flows. Introduction to LES and DNS.

Balakrishnan N(CFD)

Charles Hirch,Charles Hirch,Charles Hirch

AE 220 (AUG) 3:0

Flight and Space Mechanics

Pioneers in aerospace history, basics of flight; airflow in standard atmosphere. Airplane aerodynamics–airfoils and finite lifting surfaces, thrust, power, level flight gliding, take-off, landing and basic manouvres. Airplane performance, stability and control, mechanics of launch vehicles and satellites. Introduction to aerospace design, structural components and engine options. Glimpses of new technologies like unmanned, micro aerial and hypersonic vehicles.

Ramesh O N

Anderson, J.D. Jr., Introduction to Flight,,, Fifth Edition, McGraw Hill Higher Education 2007,Barnard, R.H., Philpott, D.R., and Kermode, A.C., Mechanics of Flight, Eleventh Edition, Prentice Hall 2006

AE 221 (AUG) 3:0

Flight Vehicle Structures

Characteristics of aircraft structures and materials, introduction to elasticity, torsion, bending and flexural shear, flexural shear flow in thin-walled sections, elastic bucking, failure theories. Variational principles and energy methods, analysis of composite laminates, loads on aircraft, basic aeroelasticity.

Dinesh Kumar Harursampath

Sun, C.T,Megson, T.H.G,Wallerstein, D.V.

AE 224 (AUG) 3:0

Analysis and design of composite structures

Introduction to composite materials, concepts of isotropy vs. anisotropy, composite micromechanics (effective stiffness/strength predictions, load-transfer mechanisms), Classical Lamination Plate theory (CLPT), failure criteria, hygrothermal stresses, bending of composite plates, analysis of sandwich plates, buckling analysis of laminated composite plates, inter-laminar stresses, First Order Shear Deformation Theory (FSDT), delamination models, composite tailoring and design issues, statics and elastic stability of initially curved and twisted composite beams, design of laminates using carpet and AML plots, preliminary design of composite structures for aerospace and automotive applications. Overview of current research in composites.

Omkar S N,Dinesh Kumar Harursampath,Narayana Naik

Gibson, R.F,Jones, R.M,Daniel, I.M.

AE 227 (AUG) 3:0

Multi-body dynamics using symbolic manipulators

Computer-aided modeling and simulation of 3D motions of multi-body systems. Coupled, multibody kinematics and dynamics, reference frames, vector differentiation, configuration and motion constraints, holonomicity, generalized speeds, partial velocities and partial angular velocities, Rodrigues parameter, inertia dyadics, parallel axes theorems, angular momentum, generalized forces, energy integrals, momentum integrals, generalized impulses and momentum, exact closed – form and approximate numerical solutions. Comparing Newton/Euler's, Lagrange's and Kane's

methods. Generation and solution of equations of motion using computer algorithms and software packages from amongst MotionGenesisTM Kane, AUTOLEVTM MATHAMATICA® and MATLAB®. Overview of flexible multi-body dynamics and applications in aerospace vehicular dynamics.

Dinesh Kumar Harursampath

Kane, T., and Levinson, D.,,Wolfram, S.,,Mitiguy, P.

AE 228 (AUG) 3:0

Fatigue and failure of materials

Fatigue and damage tolerance in aerospace structures. Fatigue mechanism (macro and micro aspects), fatigue properties and strength, concept of stress concentration factor, effect of residual stresses, total-life approaches (stress-life, strain-life, fracture mechanics), effect of notches, constant and variable amplitude loading (cycle counting, damage summation, etc), multi-axial fatigue theories. Special topics on fatigue in composites will also be covered

Suhasini Gururaja

S. Suresh,,J.Schijv,T.L .Anderson

AE 232 (AUG) 3:0

Wave propagation in structures

Structural dynamics and wave propagation, continuous and discrete Fourier transform, FFT, sampled wave forms, spectral analysis of wave motion, propagating and reconstructing waves, dispersion relations, signal processing and spectral estimation, longitudinal wave propagation in rods, higher order rod theory, flexural wave propagation in beams, higher order beam theories, wave propagation in complex structures, spectral element formulation, wave propagation in two dimensions, wave propagation in plates.

Gopalakrishnan S

Doyle, J.F.,Grof, K.F,Grof, K.F

AE 238 (AUG) 3:0

Rotary wing aeroelasticity

Review of structural dynamics. Dynamics of rotating beams: hinged rigid blades, elastic blades, rotor speed characteristics and fan plots, blades in flap, lag and torsion. Aerodynamic loads, forced response and vibration, harmonic balance method, finite element in time. Vehicle trim. Stability analysis methods: constant coefficients, Floquet theory. Blade aeroelastic instabilities. Ground resonance and air resonance.

Ranjan Ganguli

Bielawa, R.L.,Johnson, W.,Bramwell, Done, Balmford

AE 241 (AUG) 3:0

Structural vibration control

Introduction to vibration control, passive and active vibration control. Concept of vibration isolation, dynamic vibration absorber, visco-elastic polymers as constrained and unconstrained configuration in passive vibration control. Constitutive modeling of structures with PZTs/PVDF materials, electro restrictive, magneto restrictive and shape memory alloys. Application of PZT patches, PVDF films, electro restrictive, magneto restrictive materials and shape memory alloys (SMA) in structural vibration control.

Siddanagouda Kandagal

Nashif, D.N., Jones, D.I.G., and Henderson, J.P.,Srinivasan, A.V., and McFarland, D.M.,,Inman, D.J.

AE 245 (AUG) 3:0

Mechanics and Thermodynamics of Propulsion

Introduction to propulsive devices, air-breathing and non-air-breathing systems. Performance parameters, cycle analysis of ramjet, turbo-jet, turbo-fan and turbo-prop engines, afterburners.Rotating components: centrifugal and axial compressors, axial turbines. Non-rotating components: combustion chambers, intakes and nozzles

Swetaprovo Chaudhuri

Hill, P.G., and Peterson, C.,,Mattingly, J.D.,Saravanamuttoo, H.I.H., Rogers, C.F.C., and Cohen, H.

AE 249 (AUG) 3:0

Introduction to acoustics

Conservation equations, wave equation, acoustic energy, intensity and source power, spherical waves, frequency content of rounds, levels and the decibel Fourier series and long duration rounds. Reflection, transmission and excitation of plane waves, specific acoustic impedance, multilayer transmission and reflection, radiation from vibrating bodies. Monopoles and Green's functions. Reciprocity in acoustics.

Sheshadri T S

Allan d'Pierce,Allan d'Pierce,Allan d'Pierce

AE 250 (AUG) 3:0

Advanced Combustion

Introduction; review of chemical equilibrium, heat of combustion, adiabatic flame temperaturekinetics. Review of Reynolds transport theorem and conservation equations. Non-premixed flames: mixture fraction, coupling functions. Burke Schumann flame and droplet combustion. Premixed flames: Thermodynamical considerations – Rankine Hugoniot relations: deflagration and detonation, flame speed and thickness phenomenology. Adiabatic flame speed and flame speed with heat loss. Flame stretch, flame speed with stretch, experimental techniques to determine laminar flame speed.Chemical structure of a premixed flame. Introduction to Turbulent Combustion: RANS equations, Favre averaging, length scales, energy spectra, mixing, intermittency.

Turbulent Premixed Flames: Regime Diagrams, Turbulent flame speed. Turbulent Non-Premixed Flames: Mixing, scalar dissipation rates, extinction. Introduction to Combustion Instabilities

Santosh Hemchandra

S. Chaudhuri,KN Lakshmisha,T S Sheshadri or D Sivakumar

AE 259 (AUG) 3:0

Navigation guidance and control

Navigation and guidance: continuous waves and frequency modulated radars, MTI and Doppler radars; types of navigation; LORAN, Decca, Omega, VOR, INS GPS; guided missiles, guidance laws: pursuit, LOS and PN laws. Control: Control systems – classical linear time invariant control systems, transfer function representations, stability, time domain characteristics, frequency domain characteristics, root locus, Nyquist and Bode plots, Exposure to state space analysis.

Ashwini Ratnoo,Debasish Ghose

Skolnik, M.I.,Zarchan, P,Ogata, K

AE 260 (AUG) 3:0

Linear control systems design

Review of classical control systems, motivation for modern control design, state space representation of dynamical systems, review of linear algebra and matrix theory, linearization, time response of linear systems in state space form, stability, controllability and observability of linear systems, numerical methods in systems engineering, pole placement control design. pole placement observer design. Lyapunov stability theory for autonomous systems, static optimization, optimal control design. Linear Quadratic Regulator (LQR) theory and its extensions. An overview of LQ observer and Kalman Filter theory for state estimation. Overview of flight dynamics. Application of linear system theory for flight control design.

Radhakant Padhi

Nise, N.,,Ogata K.,Gopal, M.

AE 261 (AUG) 3:0

Space dynamics and control

Elements of orbital mechanics, orbit determination, orbital transfer and rendezvous, orbital perturbations, station keeping/orbit control. Spacecraft attitude dynamics, spin stabilization, gravity gradient, dual spin stabilization, three-axis stabilization and control. Altitude estimation, G P S Systems and case studies.

Seetharama Bhat M

Chobotov, V.A.,Kaplan, M.H.,Brown, C.D

AE 265 (AUG) 3:0

Biologically inspired computing and its applications

Introduction, neural networks – different learning techniques, McCulloch-Pitts neuron, perceptrons, delta rule, multilayer perceptron networks, radial basis function network, self-organizing networks. Introduction to evolutionary computing and GA, GA terminology and operators (mutation, crossover, inversion). Selection, replacement and reproduction strategies. Fitness, proportional, random, and tournament and rank based selection. Swarm intelligence – basic ideas, swarm behavior, flocking, self-organization, adaptation, multi-agent systems, trail laying, self-assembling, task handling, combinatorial optimization. Applications of biologically inspired algorithms in engineering. Introduction, neural networks – different learning techniques, McCulloch-Pitts neuron, perceptrons, delta rule, multilayer perceptron networks, radial basis function network, self-organizing networks. Introduction to evolutionary computing and GA, GA terminology and operators (mutation, crossover, inversion). Selection, replacement and reproduction strategies. Fitness, proportional, random, and tournament and rank based selection. Swarm intelligence – basic ideas, swarm behavior, flocking, self-organization, adaptation, multi-agent systems, trail laying, self-assembling, task handling, combinatorial optimization. Applications of biologically inspired algorithms in engineering.

Omkar S N

Bonabeau, E., Dorigo, M., and Theraulaz, G.,,Simon Haykin,Michalewicz, Z.

AE 266 (AUG) 3:0

Introduction to neural network engineering applications

Introduction, network topology, learning–supervised, unsupervised and reinforced; perception and adaline, back-propagation and multi-layer feed-forward network, radial basis function network, recurrent networks, nonlinear airfoil characterization, online monitoring of manufacturing process, medical diagnosis, data screening.

Omkar S N

Haykin, S.,,Haykin, S.,,Haykin, S.

AE 271 (AUG) 2:1

Flight vehicle design

Design process, airworthiness, safety, environmental issues, requirements, overall configuration and systems, fuselage layout, wing and tail design, mass and balance, power plant selection, landing gear layout, aircraft performance, cost estimation, and initial design and sizing.

Omkar S N

Daniel P Raymer,,Jan Roskam,,Thomas C Corke

AE 328 (AUG) 3:0

Research Tecniques in Non-Destructive Evaluation

Quantitative non destructive evaluation involved probabilistic methods of quality control and life assessment. Signal analysis and image processing in NDE, ultrasonic, thermographic and

tomographic methods for evaluation of composites

Ramachandra Bhat M

Thompson, D.O., and Chimenti, D.E.,Thompson, D.O., and Chimenti, D.E.,Thompson, D.O., and Chimenti, D.E.

AE 330 (AUG) 3:0

Dynamics of Flow Past on Oscillating Wing

Equations of motion of fluid flow past oscillating wings; Oscillating wing fluid dynamics at low Reynolds numbers; Quasi-steady fluid dynamic models for oscillating wings; Panel methods for unsteady flow; Potential flow models flapping wings; Small perturbation theory for oscillating slender bodies of revolution; Discrete viscous vortex methods.

Kartik Venkatraman

Tuncer Cebeci, Max Platzer, Hsun Chen, Kuo-cheng Chang, Jian P Shao,Childress, S.,,Mueller, T. J.

AE 357 (AUG) 3:0

Applied Non-Linear Control

Introduction and motivation, phase plane analysis, mathematical preliminaries. Review of functional analysis, topology and matrix theory; Lyapunov stability theory: autonomous systems; back-stepping design; dynamic inversion (feedback linearization). Applications of neural networks in control system design, neuro-adaptive control, nonlinear observers, Lyapunov stability theory: non-autonomous systems, adaptive control, advanced nonlinear flight control

Radhakant Padhi

Marquez, H.J.,,Slotine, J.J.E.,,Khalil, H. K.

AE 364 (AUG) 3:0

Micromechanics of composites

Suhasini Gururaja

T Mura,Brett Bendnarcyk,T Mura

AE 202 (JAN) 3:0

Atmospheric Flight Dynamics

Review of equations of motion, stability, derivative estimation, static stability and control, longitudinal and lateral modes, transfer function and response characteristics, feedback and automatic control, response to atmospheric gust and turbulence. Handing qualities, human pilot modeling case studies of typical airplanes, roll and spin characteristics, flight simulators, stability and control derivative estimation from wind tunnel and flight tests.

Dinesh Kumar Harursampath

Elkin, B. & Reid, L.D.,,John Wiley,John Wiley

AE 204 (JAN) 3:0

Aerodynamics

Introduction to small perturbation theory, 2-D airfoils in subsonic and supersonic flow, numerical methods for 2-D airfoils, similarity rules, Multhop's method, vortex lattice and double lattice methods, effects of sweep and AR, aerodynamics of wing-fuselage system and aerodynamics of control surfaces. High angle of attack aerodynamics, non-linear aerodynamics, unsteady aerodynamics.

Ramesh O N,Balakrishnan N(CFD)

Houghton, E.L.,,Basewell, R.P.,,Basewell, R.P.

AE 207 (JAN) 3:0

Hypersonic Aerothermodynamics

Hypersonic aerodynamics, shock waves and basic properties of gases, characteristic features of hypersonic flows, equations of motion of equilibrium and non-equilibrium flows. Transport properties of gases, definition and techniques of estimation of aero-thermodynamic environments including CFD, ground based test facilities for hypersonic flow- field measurements including heat transfer and aerodynamic forces, analysis of stagnation region flow-field and pressure distribution over hypersonic flight vehicles. Viscous interactions, aerothermodynamics and design considerations of hypersonic reentry vehicles

Gopalakrishnan S

John J Bertin,John J Bertin,John J Bertin

AE 210 (JAN) 3:0

Gas dynamics

Fundamentals of thermodynamics, propagation of small disturbances in gases, normal and oblique shock relations, nozzle flows, one-dimensional unsteady flow, small disturbance theory of supersonic speeds, generation of supersonic flows in tunnels, supersonic flow diagnostics, supersonic flow over two-dimensional bodies, shock expansion analysis, method of characteristics, one-dimensional rarefaction and compression waves, flow in shock tube.

Gopalan Jagadeesh,Joseph Mathew

Liepmann, H. W. & Roshko A.,Becker, E.,John D. Anderson

AE 216 (JAN) 3:0

Numerical fluid flow

Introduction to CFD, equations governing fluid flow, hyperbolic partial differential equations and shocks, finite difference technique and difference equations, implicit difference formula, time discretization and stability, schemes for linear convective equation, analysis of time integration schemes, monotonicity, schemes for Euler equations, finite volume methodology. Introduction to unstructured mesh computations.

Balakrishnan N(CFD)

Charles Hirch,Charles Hirch,Charles Hirch

AE 218 (JAN) 3:0

Computational gas dynamics

Governing equations of compressible fluid flows, classification of partial differential equations, analysis of hyperbolic conservation laws, basics of discretization, finite difference and finite volume methods, numerical diffusion, numerical methods for scalar and vector conservation laws, central and upwind discretization methods, flux splitting methods, Riemann solvers, kinetic (Boltzmann) schemes, relaxation schemes.

Raghurama Rao S V

Laney, B.,Toro, E. F.,Godlewski, E. and Raviart, P.

AE 219 (JAN) 3:0

Numerical grid generation and flows computations

Basics of fluid dynamics, gas dynamics, governing equations of fluid dynamics, various levels of approximation, partial differential equations, basics of discretization, finite difference, finite volume methods, mesh-less methods, space marching and time marching approaches, geometrical complexities for mesh generation, methods of mesh generation, examples of simple flow computations

Kulkarni P S

Tannehill, J.C., Anderson, D.A., and Pletcher, R.H.,,Anderson,Joe Thompson

AE 223 (JAN) 3:0

Energy and finite element methods

Introduction to Energy Methods; Principle of Virtual Work, Principle of Minimum Potential Energy, Raleigh Ritz Method, Hamilton's Principle. Introduction to Variational Methods, Weak form of

Governing Equation, Weighted residual method, Introduction to Finite elements, and Galerkin Finite elements. Finite Element Method - Various element formulations for metallic and composite structures, isoparametric element formulation, Numerical Integration, concept of consistency, completeness and mesh locking problems. Finite element methods for structural dynamics and wave propagation, Mass and damping matrix formulation, Response estimation through modal methods, direct time integration, Implicit and Explicit Methods. Introduction to super convergent finite element formulation and spectral finite elements.

Gopalakrishnan S

Cook, R.D., Malkus, D.S., and Plesha, M.E,Bathe, K.J.,,Varadan, V.K., Vinoy, K.J., and Gopalakrishnan, S.

AE 230 (JAN) 3:0

Aeroelasticity

Effect of wing flexibility on lift distribution; Torsional wing divergence; Unsteady aerodynamics of oscillating wing; Bending-torsion flutter of wing sections and wings; Stall flutter, panel flutter, and transonic flutter; Gust response of elastic airplane; Aeroservoelasticity; Aeroelastic effects on aircraft stability derivatives; Flight dynamics and aeroelasticity

Kartik Venkatraman

Wright, J.R., and Cooper, J.E,Pierce, G,R.L., Ashley, H., and Halfman, R.L

AE 234 (JAN) 3:0

Engineering optimization

Constrained and unconstrained minimization of linear and nonlinear functions of one or more variables, necessary and sufficient conditions in optimization, KKT conditions, numerical methods in unconstrained optimization, one dimensional search, steepest descent and conjugate gradient methods, Newton and quasi-Newton methods. Finite difference, analytical and automatic differentiation, linear programming, numerical methods for constrained optimization, response surface methods in optimization, orthogonal arrays, stochastic optimization methods

Ranjan Ganguli

Ranjan Ganguli,Ranjan Ganguli,Ranjan Ganguli

AE 235 (JAN) 3:0

Non destructive testing and evaluation

Fundamentals and basic concepts of NDT & E, Principles and applications of different NDE tools used for testing and evaluation of aerospace structures viz., ultrasonics, radiography, electromagnetic methods, acoustic emission, thermography. Detection and characterization of defects and damage in metallic and composite structural components.

Ramachandra Bhat M

Sharpe, R. A.,Sharpe, R. A.,Sharpe, R. A.

AE 240 (JAN) 3:0

Modal analysis: Theory and applications

Introduction to modal testing and applications, Frequency Response Function (FRF) measurement, properties of FRF data for SDOF and MDOF systems, signal and system analysis, modal analysis of rotating structures; exciters, sensors application in modal parameter (natural frequency, damping and mode shape) estimation. Vibration standards for human and machines, calibration and sensitivity analysis in modal testing, modal parameter estimation methods, global modal analysis methods in time and frequency domain, derivation of mathematical models – modal model, response model and spatial models. Coupled and modified structure analysis. Application of modal analysis to practical structures and condition health monitoring

Siddanagouda Kandagal

Ewins, D. J.,Clarence, W. de Silva,Kenneth, G. Mc Connel

AE 246 (JAN) 3:0

Combustion

Thermodynamics of reacting systems. Chemical kinetics: equilibrium, analysis of simple reactions, steady-state and partial equilibrium approximations. Explosion theories; transport phenomena: molecular and convective transports. Conservation equations of multi-component, reacting systems. Premixed flames: Rankine-Hugoniot relations, theories of laminar premixed flame propagation, quenching and flammability limits. Diffusion flames: Burke-Schumann theory, laminar jet diffusion flame. Droplet combustion, turbulent combustion. Closure problem, premixed and nonpremixed turbulent combustion. Introduction to DNS and LES

Lakshmisha K N

Turns, S. R.,Kuo, K. K.,Law, C. K.

AE 247 (JAN) 3:0

Aircraft engines

Description of air breathing engines, propeller theory, engine propeller matching, piston engines, turbofan, turbo-prop, turbojet, component analysis, ramjets, velocity and altitude performance, thrust augmentation starting, principles of component design/selection and matching.

Sheshadri T S,Sivakumar D

Zucrow, M. J.,Hill, P. G. & Peterson, C. R.,Shepherd, D. G.

AE 248 (JAN) 3:0

Rocket Prppulsion

Introduction to rocket engines, features of chemical rocket propulsion, rocket equation, thrust equation, quasi-one-dimensional nozzle flow, types of nozzles, thrust control and vectoring, aerothermochemistry, propellant chemistry, performance parameters, solid propellant rocket internal ballistics, components and motor design of solid propellant rockets, ignition transients, elements of liquid propellant rocket engines, and spacecraft propulsion.

Charlie Oommen,Rajan N K S

Sutton, G. P.,Barrare, M.,Huzel, D. K. & Huang, D. K.

AE 258 (JAN) 3:0

Robust control systems for aerospace vechicles

Control system specifications for aerospace vehicles, robustness issues: robust stability and robust performance, PID controller, dead beat control, eigen structure assignment techniques, LQR, Kalman filter and implementation, LQG/LTR, H2 and H8 control optimization, LMI methods, LFT & μ-synthesis. Introduction to neuro-fuzzy control, examples of state, output feedback and tracking control systems for aerospace vehicles: MATLAB/simulink implementation

Seetharama Bhat M

Zhou, K., Doyle, J.C., and Glover, K.,Green, M., and Limebeer, D.J.N.,,Lin, C-F

AE 262 (JAN) 3:0

Guidance theory and applications

Fundamentals of guidance; interception and avoidance; taxonomy of guidance laws, classical and empirical guidance laws; applied optimal control and optimal guidance laws; differential games and pursuit evasion problems. Recent advances in guidance theory. Collision detection and avoidance strategies. Applications to guided missiles. Unmanned aerial vehicles and mobile robots

Ashwini Ratnoo,Debasish Ghose

Zarchan, P.,,G.M. Siouris,N.A.Sneyhdor

AE 276 (JAN) 1:2

Experimental techniques

Basic concepts of measurement, standards, error analysis, modern instrumentation systems. Dimensional analysis, experiments design, advanced techniques of measurements in fluid mechanics, solid mechanics, combustion and controls. Experiments in aerodynamics, structural mechanics, combustion and control.

Sivakumar D

Holman Doeblin E. O.,Holman Doeblin E. O.,Holman Doeblin E. O.

AE 281 (JAN) 3:0

Introduction to helicopters

Hover, axial flight and autorotation, rigid blade flapping in forward flight, multi-blade coordinates, different reference planes. Helicopter quasi-steady and unsteady aerodynamics, rotor wake modeling and dynamic stall. Floquet theory, introduction to rotor control performance and vibration. Helicopter design process.

Omkar S N

Gessow, A., and Myers, G.C. Jr,Leishman, G.J.,,Leishman, G.J.

AE 282 (JAN) 3:0

Unmanned Aerial Vehicles

History of Unmanned Air Vehicle (UAV) development. Unmanned aircraft systems: coordinate frames, kinematics and dynamics, forces and moments, lateral and longitudinal autopilots. UAV navigation: accelerometers, gyros, GPS. Path planning algorithms: Dubin's curves, way-points, Voronoi partitions. Path following and guidance: Straight line and curve following, vision based guidance; Future directions and the road ahead.

Ashwini Ratnoo

Randal W.Beard and Timothy W.McLa,Kimon P.Valavanis,Kimon P.Valavanis

AE 299 (JAN) 0:19

Dissertation Project

The M.E. project is aimed at training the students to analyse independently any problem posed to them. The project may be a purely analytical piece of work, a completely experimental one or a combination of both. In a few cases, the project may also involve a sophisticated design work. The project report is expected to show clarity of thought and expression, critical appreciation of the existing literature and analytical and/or experimental or design skill.

Gopalakrishnan S

Dissertation Project,Dissertation Project,Dissertation Project

AE 315 (JAN) 3:0

Unsteady Flow

Examples of unsteady flows, impulsively started flows. Theory of linear and weakly nonlinear oscillations and waves, stability. DNS and LES for transitional and turbulent flows

Joseph Mathew

Lighthill, J.,,Drazin, P.G., and Reid, W.H,Drazin, P.G., and Reid, W.H

AE 316 (JAN) 3:0

Hydrodynamic stability

Hydrodynamic stability theory for laminar-turbulent transition. Linearized flow equations, normalmode analysis, the Eigen-Value Problem (EVP) and instability criteria: Rayleigh equation, discussion of Kelvin-Helmholtz, Rayleigh-Taylor, Richtmyer-Meshkov, Rayleigh-Benard and other instabilities. Boundary layer stability: Orr-Sommerfeld equations, Tollmien-Schlichting waves, dual role of viscosity. Introduction to absolute instability, secondary instability theories. Weakly non-

parallel shear flow instability: Parabolized Stability Equation (PSE) methods, extensions to include nonlinearity. Global stability theory, non-parallel two and three— dimensional flow with multiple inhomogeneous directions: BiGlobal, TriGlobal methods. Nonmodal treatment of hydrodynamic stability as an Initial Value Problem (IVP).

Arnab Samanta

Schmid, P. & Henningson, D.,,Drazin, P.G. & Reid, W.H.,,Drazin, P.G. & Reid, W.H.

AE 317 (JAN) 3:0

Aero Acoustics

Review of classical acoustics: linearized equations of motion; classical wave equation: plane and spherical waves, wave propagation in homogeneous and inhomogeneous media; models for acoustic sound sources: point sources, monopoles, dipoles and quadrupoles, Green's function solutions for wave equations,Kirchhoff-Helmholtz theorem for rigid boundaries. Aeroacoustic sources:Lighthill's acoustic enalogy, integral solutions and far-field approximations; effect of solid surface: Curle's theory and Ffowcs Williams-Hawkings' equation. Computational approaches: numerical aspects; direct methods: Reynolds-averaged Navier-Stockes equations (RANS), direct numerical simulations (DNS), application of large eddy simulations (LES); hybrid methods: flowsound separation, numerical evaluation of Lighthill's integral.

Arnab Samanta

Pierce, A.D.,,Howe, M.S.,,Crighton, D.G.

AE 355 (JAN) 3:0

Advanced Topics in electromagnetic scattering

Oscillations of a sphere, Rayleigh scattering and Mie scattering from ablate spheroids, effect of dielectric constant on scattering cross sections, numerical examples of Mie resonances in scattering; solutions of Maxwell’s equations for scattering from arbitrary cross sections, applications of perturbation techniques, extended T-matrix approach to RCS computations for spacecraft structures, comparisons with method of moment solutions and asymptotic techniques; Fundamentals of propagation through and scattering from chiral media, RCS modification using chirality, design to geometric fixed structures for EM scattering.

Balakrishnan N

Stratton, J.A.,,Waterman, P.C,Waterman, P.C

AE 357 (JAN) 3:0

Applied Non-Linear Control

Introduction and motivation, phase plane analysis, mathematical preliminaries. Review of functional analysis, topology and matrix theory; Lyapunov stability theory: autonomous systems; back-stepping design; dynamic inversion (feedback linearization). Applications of neural networks in control system design, neuro-adaptive control, nonlinear observers, Lyapunov stability theory: non-autonomous systems, adaptive control, advanced nonlinear flight control.

Radhakant Padhi

Marquez, H.J.,,Slotine, J.J.,Khalil, H. K.

AE 360 (JAN) 3:0

Non liner Mechanics of composite structures

Introduction to classical geometrical and physical non-linearities and non-classical geometrophysical non-linearities in structural mechanics. Mechanics of composite lamina and laminates including response and failure as affected by nonlinearities. Variational asymptotic methods of constructing nonlinear composite beam, plate and shell theories. Non-classical effects resulting from non-linearities. Effects of nonlinearities on stability of thin-walled structures. Introduction to nonlinear finite element analysis including mixed formulations. Applications to engineering structures like pipes, springs and rotor blades.

Dinesh Kumar Harursampath

Hodges, D.H.,,Berdichevsky, V.L.,,Berdichevsky, V.L.

AE 361 (JAN) 3:0

Applied Optimal control and state estimation

Introduction and motivation review of static optimization, calculus of variations and optimal control formulation; numerical solution of two-point boundary value problems: shooting method, gradient method and quasi-linearization; Linear Quadratic Regulator (LQR) design: Riccati solution, stability proof, extensions of LQR, State Transition Matrix (STM) solution; State Dependent Riccati Equation (SDRE) design; dynamic programming: HJB theory; approximate dynamic programming and adaptive critic design; MPSP Design; optimal state estimation: Kalman filter, extended Kalman filter; robust control design through optimal control and state estimation; constrained optimal control systems: Pontryagin minimum principle, control constrained problems, state constrained problems; neighbouring extremals and sufficiency conditions. Discrete time optimal control: Generic formulation, discrete LQR. Introduction and motivation review of static optimization, calculus of variations and optimal control formulation; numerical solution of two-point boundary value problems: shooting method, gradient method and quasi-linearization; Linear Quadratic Regulator (LQR) design: Riccati solution, stability proof, extensions of LQR, State Transition Matrix (STM) solution; State Dependent Riccati Equation (SDRE) design; dynamic programming: HJB theory; approximate dynamic programming and adaptive critic design; MPSP Design; optimal state estimation: Kalman filter, extended Kalman filter; robust control design through optimal control and state estimation; constrained optimal control systems: Pontryagin minimum principle, control constrained problems, state constrained problems; neighbouring extremals and sufficiency conditions. Discrete time optimal control: Generic formulation, discrete LQR.

Radhakant Padhi

Naidu, D.,Sinha, A.,,Bryson, A.

AE 362 (JAN) 3:0

Cooperative Control with aerospace applications

Introduction to cooperative control, mathematical preliminaries: algebraic graph theory, matrices for cooperative control, stability of formations. Consensus algorithms, consensus for single and double integrator dynamics, consensus in position, direction, and attitude dynamics. Distributed multi-vehicular cooperative control. Generalized cyclic pursuit; spacecraft formation flying. UAV

applications in search, coverage, and surveillance of large areas, and in monitoring and controlling of hazards. Routing and path planning of UAVs. Role of communication. Operation in uncertain environments and uncertainty

Debasish Ghose

Shamma J,Qu, Z.,,Ren, W., and Beard, R.

AE 363 (JAN) 3:0

Kalman Filter And Applications

Brief introduction to randomness, probability, statistics, random processes, optimization, linear systems, and matrix theory. and Kalman filter formulations. Estimation with measurement noise alone and together with process noise. Linear, linearised, extended, particle and ensemble Kalman filters. Spring-mass-, damper system. State and parameter estimation, tracking, space debris, data fusion, GPS/INS integration, allied topics with measurement and process noise. Filter tuning to obtain the best possible optimum solutions.

Radhakant Padhi

Gelb (Ed.),J. L. Crassidis and J. L. Junkins,D. Simon

Centre for Atmospheric and Oceanic Sciences

M Tech Programme in Climate Science
(Duration: 2 years
Total Credits: 64)

Core Courses: 24 Credits

AS 202 3:0	Geophysical Fluid Dynamics
AS 203 3:0	Atmospheric Thermodynamics
AS 204 3:0	Atmospheric Radiation and Climate
AS 205 2:1	Ocean Dynamics
AS 207 3:0	Introduction to Atmoshphric Dynamics
AS 211 3:0	Observational Techniques
AS 216 3:0	Introduction to Climate System

One 3:0 credit Mathematics Course offered at (SERC/ Maths/CHE/CAOS/CEas)

Project: 28 Credits

Elective: A balance of 15 credits required to make up a minimum of 64 credits for completing the M Tech Programme.

AS 202 (AUG) 3:0
Geophysical Fluid Dynamics

Large-scale, slowly evolving flows on a rotating earth. Vorticity, potential vorticity (pv), consequences of pv conservation. Poincare, Kelvin and Rossby waves. Rotating shallow water equations, effects of stratification and the rotating-stratified Boussinesq equations. Quasi-geostrophic flow and pv, Rossby waves on the mid-latitude beta plane. Basic concepts of tropical dynamics.Waves, jets and undercurrents on the equatorial beta plane. Waves and large- scale flow in the atmosphere and ocean from observations.

Jai Suhas Sukhatme,Debasis Sengupta

Pedlosky, J., Geophysical Fluid Dynamics, Springer Verlag, 1977,Gill, A., Atmosphere and Ocean Dynamics, Academic Press Inc., 1982.,Holton,J.R., An Introduction to Dynamic Meteorology, Academic Press, 1992. Relevant Journal Articles.

AS 203 (AUG) 3:0
Atmospheric Thermodynamics

Vertical structure and composition of the atmosphere, kinetic theory of gases, first and second principles of thermodynamics, thermodynamics of dry air, concept of saturation vapour pressure, water vapour in the atmosphere, properties of moist air, isobaric and isothermal processes, atmospheric stability, parcel and area methods, nucleation, effect of aerosols, clouds and precipitation, forms of atmospheric convection.

Arindam Chakraborty

Iribarne, I.V., and Godson, W.I., Atmospheric Thermodynamics, 2nd Edn, D Reidel Publishing Company, 1971,Rogers, R.R., A Short Course in Cloud Physics, 2nd Edition, Pergamon Press, 1979,Bohren, C.F., and Albhecht, B.A., Atmospheric Thermodynamics, Oxford University Press, 1998,Tsonis, A.A., An Introduction to Atmospheric Thermodynamics, Cambridge University Press, 2002,Wallace, J.M., and Hobbs, P.V., Atmospheric Science – An Introductory Survey, 2nd Edn, Academic Press, 2006.

AS 204 (AUG) 3:0

Atmospheric Radiation and Climate

Black body radiation, properties of surfaces, Kirchoff's law, radiative transfer in gases, solar radiation, terrestrial radiation, Rayleigh and Mie scattering, aerosols, vertical thermal structure, radiation budget, cloud forcing, and simple climate models.

Satheesh S K,Srinivasan J

Scheme of Instruction 2016 Page 183,Petty, G.W., A first course in Atmospheric Radiation, Sundog Publishing, Madison, Wisconsin, 2nd edition, 2006,Liou, K.N., Introduction to Atmospheric Radiation, Academic Press, San Diego, 2nd edition, 2002.

AS 205 (AUG) 2:1

Ocean Dynamics

Introduction to physical oceanography, properties of sea water and their distribution, mixed layer, barrier layer, thermocline, stratification and stability, heat budget and air-sea interaction, ocean general circulation, thermohaline circulation, basic concepts and equations of motion, scale analysis, geostrophic currents, wind-driven ocean circulation, Ekman layer in the ocean, Sverdrup flow, vorticity in the ocean, waves in the ocean, surface gravity waves, Rossby and Kelvin waves.

Vinayachandran P N

Stewart, R.H., Introduction to Physical Oceanography, http://oceanworld.tamu.edu (online book),Talley, L.D. Pickard, G.L., Emery, W.J., Descriptive Physical Oceanography, 6th Edn, Elsevier , 2011.,Gill, A.E., Atmosphere-Ocean Dynamics, Academic Press, 1982.,Cushman-Roisin, B., Introduction to Geophysical Fluid Dynamics, Prentice Hall, 1994.

AS 207 (AUG) 3:0

Introduction to Atmospheric Dynamics

Introduction to weather and climate. Momentum, continuity and thermodynamic energy equations. Basic equations in isobaric coordinates. Balanced flow: inertial flow, cyclostrophic flow. Thermal wind, calculation of vertical velocities, circulation and vorticity. Planetary boundary layer: atmospheric turbulence, Boussinesq approximation. Introduction to quasi-geostrophic systems. Atmospheric waves.

Jai Suhas Sukhatme

Holton,J.R.,An Introduction to Dynamic Meteorology,4th Edn,Elsevier

AS 211 (AUG) 3:0

Observational Techniques

Principles of measurement and error analysis, fundamentals of field measurements, in situ measurement of atmospheric temperature, humidity, pressure, wind, radiation, precipitation and aerosols. Tower based techniques and automatic measurement systems. Upper air observations, radiosonde techniques. Measurements in the ocean, CTD, ADCP and ARGO. Modern measurement techniques.

Satheesh S K,Bhat G S

Guide to Meteorological Measurements and Methods of Observation, World Meteorological Organization Publication No. 8,,7th Edition, WMO,Geneva.radiative transfer,,the role of radiation in climate.

AS 216 (AUG) 3:0

Introduction to Climate System

Equations of motion for the atmosphere and oceans, observed mean state of the atmosphere and oceans, exchange of momentum, energy and water between the atmosphere and surface, angular momentum cycle, global water cycle, radiation, energetics, entropy in climate system, climate variability.

Govindasamy Bala

J. Peixoto and A.H. Oort,Physics of Climate,,American Institute of Physics

AS 202 (JAN) 3:0

Geophysical Fluid Dynamics

Large-scale, slowly evolving flows on a rotating earth. Vorticity, potential vorticity (pv), consequences of pv conservation. Poincare, Kelvin and Rossby waves. Rotating shallow water equations, effects of stratification and the rotating-stratified Boussinesq equations. Quasi-geostrophic flow and pv, Rossby waves on the mid-latitude beta plane. Basic concepts of tropical dynamics.Waves, jets and undercurrents on the equatorial beta plane. Waves and large- scale flow in the atmosphere and ocean from observations.

Jai Suhas Sukhatme,Debasis Sengupta

Pedlosky, J., Geophysical Fluid Dynamics, Springer Verlag, 1977,Gill, A., Atmosphere and Ocean Dynamics, Academic Press Inc., 1982.,Holton,J.R., An Introduction to Dynamic Meteorology, Academic Press, 1992. Relevant Journal Articles

AS 208 (JAN) 3:0

Satellite Meteorology

Introduction to radiative transfer, radiative properties of surface, radiative properties of the atmosphere, scattering of radiation, image analysis. Thermal, infrared and microwave techniques for measurement of temperature, humidity and cloud height. Atmospheric sounders, limb sounding, radiation budget.

Satheesh S K,Srinivasan J

Kidder, S.Q., and Vonder Haar, T.R., Satellite Meteorology, Academic Press, 1995,Houghton, J.T., Taylor, F.W., and Rodgers, C.D.,,Remote Sensing of Atmosphere, Cambridge Univ. Press, 1984

AS 209 (JAN) 3:0

Mathematical Methods in Climate Science

Review of probability and statistics: probability distributions, sample statistics. Confidence intervals. Hypothesis testing; goodness of fit tests, time-series analysis: Fourier transforms, principal component analysis (PCA).

Venugopal Vuruputur

Papoulis, A., & U. Pillai, Probability, Random Variables and Stochastic Processes, 4th edition, McGraw Hill, 2002.,Wilks, D., Statistical Methods in the Atmospheric Sciences, 2nd edition, Academic Press, 2006.,O. Brigham, Fast Fourier Transforms, Prentice Hall, First Edition, 1974.,Press, W. H., S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery, Numerical Recipes in C/Fortran: The Art of Scientific Computing, 3rd Ed., Cambridge Univ. Press, 2007

AS 211 (JAN) 2:1

Observational Techniques

Principles of measurement and error analysis, fundamentals of field measurements, in situ measurement of atmospheric temperature, humidity, pressure, wind, radiation, precipitation and aerosols. Tower based techniques and automatic measurement systems. Upper air observations, radiosonde techniques. Measurements in the ocean, CTD, ADCP and ARGO. Modern measurement techniques

Satheesh S K,Bhat G S

Guide to Meteorological Measurements and Methods of Observation,,World Meteorological Organization Publication No. 8,,7th Edition, WMO, Geneva.radiative transfer, the role of radiation in climate.

Civil Engineering

Annexure -1

M Tech Programmes
Geotechnical Engineering

Hard Core: 24 Credits (All courses are mandatory)

CE 201	3:0	Basic Geomechanics
CE 202	3:0	Foundation Engieering
CE 203	3:0	Earth and Earth Retaining Structures
CE 204	3:0	Foundation Engineering
CE 205	3:0	Geoenvironmental Engineering
CE 206	3:0	Ground Improvement and Geosynthetics

One 3:0 credit core course from either the Structural Engineering or the Water Resources and Environmental Engineering streams
A suitable 3:0 credit mathematics course will be identified by the department at the beginning of the term.

Project: 22 Credits
CE299 0:22 Dissertation Project
Electives: 18 Credits, of which at least 9 credits must be from among the group electives listed below.

CE 231	2:0	Soil Stabilization by Admixtures
CE 232	2:0	Fundamentals of Soil Behaviour
CE 234	2:0	Soil Dynamics
CE 236	2:1	Behaviour and Testing of Unsaturated Soils
CE 237	2:0	Rock Mechanics
CE 239	3:0	Computational Geotechnics
CE 240	3:0	Engineering Seismology
CE 241	3:0	Introduction to the theory of Plasticity
CE 242	3:0	Probabilistic Methods in Civil Engineering
CE 266	3:0	Pavement Engineering

Water Resources and Environmental Engineering

Hard Core: 24 Credits (All courses are mandatory)

CE 207	3:0	Computational Fluid Dynamics in Water Resources Engineering
CE 208	3:0	Surface Water Hydrology
CE 209	3:0	Ground Water and Contaminant Hydrology
CE 210	3:0	Systems Techniques in Water Resources & Environmental Engineering.
CE 211	3:0	Water Quality Modeling
CE 212	3:0	Design of Water Supply and Sewerage Systems

One 3:0 credit core course from either the Geotechnical Engineering or the Structural Engineering streams
A suitable 3:0 mathematics course will be identified by the department at the beginning of the term.

Project: 22 Credits
CE299 0:22 Dissertation Project
Electives: 18 Credits, of which at least 9 credits must be from among the group electives listed below.

CE 255	3:0	Urban Hydrology
CE 256	3:0	Stochastic Hydrology
CE 258	3:0	Remote Sensing and GIS for Water Resources and Environmental Engineering
CE 259	3:0	Regionalization in Hydrology and Water Resources Engineering.
ME 201	3:0	Fluid Mechanics
AS216	3:0	Introduction to Climate Systems

Structural Engineering
Hard Core: 24 Credits (All courses are mandatory)

CE 214	3:0	Solid Mechanics
CE 215	3:0	Mechanics of Structural Concrete
CE 216	3:0	An Introduction to Finite Elements in Solid Mechanics
CE 217	3:0	Linear Structural Dynamics
CE 218	3:0	Optimization Methods
CE 219	3:0	Stability of Structures

One 3:0 core course from either the Geotechnical Engineering or the Water Resources and Environmental Engineering streams
A suitable 3:0 credit mathematics course will be identified by the department at the beginning of the term.

Project: 22 Credits
CE 299 0:22 Dissertation Project
Electives: 18 Credits of which at least 9 credits must be from among the group electives listed below.

CE 273	3:0	Fracture Mechanics
CE 275	3:0	Nonlinear FEM in Structural Engineering
CE 276	3:0	Structural Masonry
CE 287	3:0	Stochastic Structural Dynamics
CE 291	3.0	Uncertainty Modelling and Analysis
CE 294	3:0	Monte Carlo Simulations in Structural Mechanics

M Tech Programme in Transportation and Infrastructure Engineering

Hard Core: 25 Credits (All courses are mandatory)

CE 266 3:0 Pavement Engineering
CE 212 3:0 Design of Water Supply and Sewerage Systems
CE 263 3:0 Modelling Transport and Traffic
CE 218 3:0 Optimization Methods
MG 223 3:0 Applied Operations Research
ST 210 3:1 Principles and Applications of GIS and Remote Sensing
MA 261 3:0 Probability Models
MG 221 2:1 Applied probability and Statistics
MG 226 3:0 Regression and Time series analysis

Project: 22 credits

CE 299 0:22 Dissertation Project

Electives: 18 Credits of which at least 9 credits should be from among the electives listed below.

CE 204 3:0 Foundation Engineering
CE 206 3:0 Ground Improvement and Geosynthetics
CE 267 3:0 Transportation Statistics and Micro-simulation
CE 215 3:0 Mechanics of Structural Concrete
CE 216 3:0 Introduction to Finite Elements in Solid Mechanics
ST 202 3:0 Renewable Energy – Technology, Economics and Environment
ST 203 3:0 Technology and Sustainable evelopment

CE 201 (AUG) 3:0

Basic Geo-mechanics

Introduction to genesis of soils, basic clay mineralogy; Principle of effective stress, permeability and flow; Fundamentals of Tensors, Introduction to stresses and deformation measures; Mohr-Coulomb failure criteria, soil laboratory tests; Critical state and stress paths. Shear Strength and Stiffness of Sands; Consolidation, shear strength and stiffness of clays

Tejas Gorur Murthy,Anbazhagan P

Wood,D.M.,Soil Behaviour and Critical State Soil Mechanics,Cambridge University Press,1991.

CE 202 (AUG) 3:0

Foundation Engineering

Bearing capacity of shallow foundations, penetration tests, plate load tests. Settlement of shallow foundations, elastic and consolidation settlements; settlement, estimates from penetration tests, settlement tolerance. Allowable bearing pressure. Foundations on problematic soils. Principles of foundation design. Introduction of deep foundations. Bearing capacity and settlement of piles and pile groups in soils. Machine foundations. Reinforced soil beds

Sitharam G Thallak

Bowles, J.W., Foundation Analysis and Design, 5th Edn., McGraw-Hill, 1996.,Das, M. B., Principles of Foundation Engineering, Brooks/Cale Engineering Division, 1984.,--

CE 203 (AUG) 3:0

Surface Water Hydrology

Review of basic hydrology, hydrometeorology, infiltration, evapotranspiration, runoff and hydrograph

analysis. Flood routing – lumped, distributed and dynamic approaches, hydrologic statistics, frequency analysis and probability, introduction to environmental hydrology, urban hydrology. Design issues in hydrology.

Srinivas V V

Bedient, P. B., and Huber, W. C., Hydrology and Floodplain Analysis, Prentice Hall, 2002.,Chow, V.T., Maidment, D.R. and Mays, L.W,. Applied Hydrology, McGraw-Hill 1988.,Linsley, R.K., Kohler, M.A. and Paulhus, J.L.H., Hydrology for Engineers, McGraw Hill, 1985.

CE 204 (AUG) 3:0

Solid Mechanics

Introduction to tensor algebra and calculus, indicial notation, matrices of tensor components, change of basis formulae, eigenvalues, Divergence theorem. Elementary measures of strain. Lagrangian and Eulerian description of deformation. Deformation gradient, Polar decomposition theorem, Cauchy-Green and Lagrangian strain tensors. Deformation of lines, areas and volumes. Infinitesimal strains. Infinitesimal strain-displacement relations in cylindrical and spherical coordinates. Compatibility. Tractions, body forces, stress at a point, Cauchy's theorem. Piola-Kirchhoff stress tensors. Momentum balance. Symmetry of the Cauchy stress tensor. St. Venant's Principle. Virtual Work. Green's solids, elastic strain energy, generalized Hooke's Law, material symmetry, isotropic linear elasticity in Cartesian, cylindrical and spherical coordinates, elastic moduli, plane stress, plane strain,. Navier's formulation. Airy stress functions. Selected problems in elasticity. Kirchhoff's uniqueness theorem, Betti-Maxwell reciprocal theorem, Principle of stationary potential energy, Torsion in circular and non-circular shafts and thin-walled tubes, warping. Pure bending of thin rectangular and circular plates, small deflection problems in laterally loaded thin rectangular and circular plates. Outline of Mindlin plate theory.

Narayan K Sundaram

Fung, Y. C. and Pin Tong, Classical and Computational Solid Mechanics, World Scientific, 2001,Boresi, A.P., and Lynn P.P., Elasticity in Engineering Mechanics, Prentice Hall 1974.,Malvern L., Introduction to the Mechanics of a Continuous Medium, Prentice Hall, 1969

CE 205 (AUG) 3:0

Finite Element and Mesh-Free Methods

Elements of calculus of variations; normed function spaces and inner product spaces; Riesz representation theorem and weighted-residual/Galerkin/Rayleigh-Ritz methods; finite elements (FE) - weak formulations with continuous and piecewise smooth shape functions; isoparametric FE formulations; smooth, polynomial reproducing shape functions and moving least squares (MLS); virtual work/weak formulations with MLS methods; local error estimates; numerical integration – Gauss quadrature; applications to plane stress, plane strain and the general 3D linear elastostatic cases; enforcing essential and natural boundary conditions; dimensional descent and applications to beams; MATLAB-based simulation exercises.

Debasish Roy

Zienkiewicz, O.C. and Taylor, R. L., 2000, “The Finite Element Method: Vol. 1 (The Basis)”, Butterworth-Heinemann.,Chen, Y., Lee, J. and Eskandarian, A., 2006, “Meshless Methods in Solid Mechanics”; Springer.,Brenner, C. S. and Scott, L. R., 1994, “Mathematical Theory of Finite Element Methods”, Springer-Verlag.

CE 220 (AUG) 3:0

Design of Substructures

Design considerations, field tests for bearing capacity and settlement estimates, selection of design parameters. Structural design considerations. Codes of practice. Design of spread footings, combined footings, strap footings, ring footings, rafts, piles and pile caps and piers.

P Raghuveer Rao

Bowles, J.E. Foundation analysis and design. 5th Edn., McGraw Hill, 1996
Indian Standard Codes

CE 231 (AUG) 3:0

Forensic Geotechnical Engineering

Introduction, Definition of a Forensic Engineer, Types of Damage, Planning the Investigation, investigation methodology, Collection of Data, Distress Characterization, Development of Failure, Hypothesis, Diagnostic Tests, Back Analysis, Technical Shortcomings, Legal Issues Reliability Aspects, Observation Method of Performance Evaluation, Case Histories related to settlement of Structures, lateral movement, backfill settlements, causes due to soil types such as collapsible soil, expansive soil, soluble soils, slope Failures and landslides, debris flow, slope softening and creep, trench collapses, dam failures, foundation due to earthquakes, erosion, deterioration, tree roots, groundwater and moisture problems, groundwater problems, retaining failures problems, pavement failures and issues, failures in soil reinforcement and geosynthetics, development of codal provisions and performance based analysis procedures.

Sivakumar Babu G L

Bolton M (1991) A Guide to Soil Mechanics, Universities Press,Robert W. Day (2011) Forensic Geotechnical and Foundation Engineering, Second Edition, McGraw-Hill Companies, Inc.,Rao, V.V.S. and Sivakumar Babu, G.L (2016) Forensic Geotechnical Engineering, Springer Nature.

CE 236 (AUG) 3:0

Fracture Mechanics

Definition of stress intensity factor. Fracture toughness. Energy release rate, critical energy release rate. Crack mouth opening displacement, R-curve. Elasto-plastic fracture mechanics and J-integral. Mixed-mode crack propagation, fatigue crack propagation. Computational fracture mechanics. Introduction to fracture of quasi-brittle materials like concrete, Non-linear fracture models with softening, Size effect in fracture of concrete.

Chandra Kishen J M

David Broek, Elementary Engineering Fracture Mechanics, Sijthoff and Noordhaff, Alphen Aan Den Rijn, The Netherlands.,Anderson, T.L., Fracture Mechanics : Fundamentals and Applications, CRC Press, USA, Second Edition,Shah, S.P., Swartz, S.E. and Quyang, C., Fracture Mechanics of Concrete: Applications of Fracture Mechanics to Concrete, Rock and Other Quasi-Brittle Materials, John Wiley and Sons, USA.

CE 241 (AUG) 3:0

Advanced Structural Dynamics

FE models for dynamics of built-up structures. Integration of equations of equilibrium. Explicit and implicit methods. Treatment of uncertainty in vibration problems. Random process models for loads. Simulation based approaches. Reduction of sampling variance. FE model updating. Bayesian framework for system identification. MCMC samplers. Kalman and particle filters.

C S Manohar

Pre-requisites: CE 210 [Structural Dynamics] or equivalent, and background in probability models.

Yuen, Ka-Veng. Bayesian methods for structural dynamics and civil engineering. John Wiley & Sons, NY, 2010.
Petyt, Maurice. Introduction to finite element vibration analysis. Cambridge University Press, 2010 Cambridge.
Bathe, Klaus-Jürgen. Finite element procedures. PHI, New Delhi, 2006.

CE 242 (AUG) 3:0

Fire structural engineering

Role of structural engineering in fire safety. Introduction to fire dynamics. Models for enclosure fire dynamics. Review of heat transfer and thermo elasticity. Material properties at elevated temperature. Behavior of beams, columns, walls, and slabs at elevated temperature. Thermal buckling. Finite element modeling of structures under fire. Treatment of material and geometric nonlinearities. Joint behavior. Modeling of building frames under fire. Review of fire resistant design. Treatment of uncertainties and concepts of performance based design.

C S Manohar and H S Mukunda

Buchanan, A H 2002, Structural design for fire safety, Wiley, Chichester.
Wang,Y., I Burgess, F Wald, and M Gillie, 2013, Performance-based fire engineering of structures, CRC Press.
Drysdale, D 1998, An introduction to fire dynamics, 2nd Edition, Wiley.
Karlsson, B and J Quintiere. 1999, Enclosure fire dynamics. CRC press, Boca Raton
Quintere, J G 2006, Fundamentals of fire phenomenon. John Wiley.

CE 243 (AUG) 3:0

Bridge Engineering

Bridge types, aesthetics, general design considerations and preliminary design, IRC/ AASHTO design loads, concrete bridge design - reinforced and prestressed girder bridges, steel bridge design Composite bridges, design of bridge bearings, Pier, Abutment and foundation; seismic and wind load analysis, analysis of cable supported bridge systems, bridge inspection and maintenance.

Ananth Ramaswamy

Barker and Puckett Design of Highway Bridges, John Wiley and Sons 2007

CE 245 (AUG) 3:0

Design of Water Supply and Sewerage Systems

Basics of hydraulics and hydrology. Introductory chemistry and biology. Water distribution systems, water processing, and operation of networks. Design of water supply units, wastewater flows and collection systems, wastewater processing. Advanced wastewater treatment and water reuse.

Mohan Kumar M S

Mark J Hammer & Mark J Hammer Jr., Water and Wastewater Technology, Fifth Edition, Pearson Prentice Hall, Columbus, USA, 2004.,-,-

CE 246 (AUG) 3:0

Urban Hydrology

Review of basic hydrology. Storm water runoff generation; return period; hydrologic risk; frequency analysis – IDF relationships; open channel flow in urban watersheds; interception storage, infiltration, depression storage; combined loss models; estimation of runoff rates from urban watersheds; flow routing; storm water drainage structures; storm water detention; structural and non-structural control measures; Source control techniques; urban storm water models. Introduction to urban ground water systems.

Mujumdar P P

Butler, D. & Davies, J.W., Urban Drainage, Spon Press, 2nd Edn., 2004.,Akan A.O and Hioughtalen R.J., Urban Hydrology, Hydraulics and Storm Water Quality – Engineering Applications and Computer Modeling, John Wiley & Sons 2003.,Hall, M.J., Urban Hydrology. Elsevier, 1984. Shaw, E.M., Hydrology in Practice, 3rd Edn., Chapman & Hall, 1994.

CE 247 (AUG) 3:0

Remote Sensing and GIS for Water Resources & Environmental Engineering

Basic concepts of remote sensing. Airborne and space borne sensors. Digital image processing. Geographic Information System. Applications to rainfall - runoff modeling. Watershed management. Irrigation management. Vegetation monitoring. Drought and flood monitoring. Environment and ecology. Introduction to digital elevation modeling and Global Positioning System (GPS). Use of relevant software for remote sensing and GIS applications.

Nagesh Kumar D

Lillesand T.M. and Kiefer R.W. Remote Sensing and Image Interpretation, John Wiley & Sons, 2000.,Sabins, F.F. Remote Sensing - Principles and Interpretation, Freeman & Co., New York, 1986.,Heywood, I., Cornelius, S., and Carver, S. An Introduction to Geographical Information Systems, Pearson Education, 1998.

CE 249 (AUG) 3:0

Water Quality Modeling

Basic characteristics of water quality, stoichiometry and reaction kinetics. Mathematical models of physical systems, completely and incompletely mixed systems. Movement of contaminants in the environment. Water quality modeling in rivers and estuaries - dissolved oxygen and pathogens. Water quality modeling in lakes and ground water systems.

Sekhar M

Chapra, S.C., Surface Water Quality Modeling, McGraw Hill, 1997.,Tchobanoglous, G., and Schroeder, E.D., Water Quality, Addison Wesley, 1987.,-

CE 263 (AUG) 3:0

Modelling Transport and Traffic

Approaches to travel demand modelling; trip-based modelling approach, activity based travel demand modelling, land use-transport models; traffic flow theory; deterministic and stochastic models of traffic flows; delay and saturation flow models; pedestrian flow modeling; optimization of public transport system

Ashish Verma

Ortuzar J. de D. and L.G. Willumsen, Modelling Transport, John Wiley and Sons, 2001,May, A.D. Traffic Flow Fundamentals, Prentice Hall, 1990,Vuchic Vukan R., Urban Transit: Operations, Planning and Economics, Prentice Hall, 2005.

CE 269 (AUG) 3:0

Principles of Traffic Engineering

Traffic flow elements and its characterization: vehicle characteristics, human factors, infrastructure elements, capacity and LoS concepts, Highway Capacity Manual (HCM) methods. Uninterrupted Traffic Flow: speed-flow-density relationships, multi-regime models, car-following, lane-changing, simulation framework. Interrupted Traffic Flow: signal design, shock-wave theory, gap-acceptance behavior, delay and queue analysis. Design of traffic facilities: expressways, signalized and un-signalized intersections, interchanges, parking, signs and markings.

Ashish Verma

Roess, R.P., Prassas E.S. & McShane, W.R. (2010), Traffic Engineering, Prentice Hall, USA. May, A. D. (1990), Traffic Flow Fundamentals, Prentice Hall, USA.,Highway Capacity Manual (2010), Transportation Research Board, USA. Kadiyali, L. R. (2000), Traffic Engineering and Transport Planning, Khanna Publishers, India.,Salter, R J. & Hounsell, N. B. (1996), Highway Traffic Analysis and Design, Macmillan Education, UK.

CE 270 (AUG) 3:0

Travel Demand Modeling

Individual travel behavior and aggregate-level travel demand analysis; Alternative approaches to modeling travel demand (aggregate, trip-based approaches and disaggregate, activity-based approaches); Econometric methods for modeling travel demand (development, estimation, and application of statistical models for travel behavior analysis); Linear regression for activity and trip generation (specification, interpretation, estimation, hypothesis testing, market segmentation, non-linear specification, tests on assumptions); Mode choice and destination choice using discrete choice methods (introduction to binary logit and multinomial logit models, contrast with gravity methods); Traffic assignment/route choice (network equilibrium, system optimum); Model transferability; Microsimulation for activity-based models; Recent advances.

J. de D. Ortuzar and L.G. Willumsen, Modelling Transport (4th edition), John Wiley and Sons, 2011.,F. Koppelman and C.R. Bhat. A Self-Instructing Course in Mode Choice Modeling: Multinomial and Nested Logit Models, 2006.,S. Washington, M. Karlaftis, F. Mannering. Statistical and econometric methods for transportation data analysis (2nd edition), CRC Press, 2010.

CE 299 (AUG) 0:22

Dissertation Project

The project work is aimed at training the students to analyze independently problems in geotechnical engineering, water resources and environmental engineering, structural engineering and transportation and infrastructural engineering. The nature of the project could be analytical, computational, experimental, or a combination of the three. The project report is expected to show clarity of thought and expression, critical appreciation of the existing literature, and analytical, computational, experimental aptitudes of the student.

Faculty

CE 206 (JAN) 3:0

Earth and Earth Retaining Structures

Lateral earth pressure coefficients, Rankine and Coulomb theories. Graphical constructions, passive earth pressure with curved rupture surfaces, arching, stability of retaining walls, stability of vertical cuts. Braced excavations, anchored sheet piles, stability of infinite slopes, stability of finite slopes. Methods of slices - Swedish, Morgenstern and Price methods. Stability analysis of earth and rock-fill dams.

Jyant Kumar

Terzaghi, K., Theoretical Soil Mechanics, John Wiley, 1965.,Taylor, D.W., Fundamentals of Soil Mechanics, John Wiley, 1948.,Bowles, J.W., Analysis and Design of Foundations, 4th and 5th Ed., McGraw-Hill, 1988 & 1996.,Lambe, T.W. and Whitman, R.V., Soil Mechanics, Wiley Eastern Limited, 1976.

CE 207 (JAN) 3:0

Geo-environmental Engineering

Sources, production and classification of wastes, Environmental laws and regulations, physico-chemical properties of soil, ground water flow and contaminant transport, contaminated site characterization, estimation of landfill quantities, landfill site location, design of various landfill components such as liners, covers, leachate collection and removal, gas generation and management, ground water monitoring, end uses of landfill sites, slurry walls and barrier systems, design and construction, stability, compatibility and performance, remediation technologies, stabilization of contaminated soils and risk assessment approaches.

Sivakumar Babu G L

Sharma, H.D., and Reddy, K.R., Geoenvironmental Engineering: Site Remediation, Waste Containment and Emerging Waste Management Technologies, John Wiley & Sons, Inc., Hoboken, New Jersey, 2004.,Rowe, R. Kerry, Quigley, Robert M., Brachman, Richard W. I., and Booker, John R. Barrier Systems for Waste Disposal Facilities , 2nd edn 2004. Spon Press, Taylor & Francis Group, London.,Tchobanoglous, G., Theisen, H. and Vigil, S.A., Integrated Solid Waste Management - Engineering Principles and Management Issues, McGraw Hill (1993).

CE 208 (JAN) 3:0

Ground Improvement and Geosynthetics

Principles of ground improvement, mechanical modification. Properties of compacted soil. Hydraulic modification, dewatering systems, preloading and vertical drains, electro-kinetic dewatering, chemical modification, modification by admixtures, stabilization using industrial wastes, grouting, soil reinforcement principles, properties of geo-synthetics, applications of geo-synthetics in bearing capacity improvement, slope stability, retaining walls, embankments on soft soil, and pavements, filtration, drainage and seepage control with geo-synthetics, geo-synthetics in landfills, soil nailing and other applications of geo-synthetics.

Sivakumar Babu G L

Hausmann, M.R., Engineering Principles of Ground Modification, McGraw-Hill, 1990.,Jones, C.J.E.P., Reinforcement and Soil Structures, Butterworth Publications, 1996.,Koerner, R. M., Designing with Geosynthetics, Prentice Hall Inc. 1998.

CE 209 (JAN) 3:0

Mechanics of Structural Concrete

Introduction, Limit state design philosophy of reinforced concrete, Stress-strain behavior in multi-axial loading, failure theories, plasticity and fracture, ductility, deflections, creep and shrinkage, Strength of RC elements in axial, flexure, shear and torsion, RC columns under axial and eccentric loading, Beam-column joints, Strut and Tie modelling, Yield line theory of slabs, Seismic resistant design, Methods for predicting the behavior of pre-stressed concrete members and structures.

Chandra Kishen J M

Nilson, A. H., Darwin, D. and Dolan, C. W., Design of concrete structures, McGraw Hill, 2004,Lin and Burns, Design of Prestressed concrete structures, John Wiley and Sons, 2006,Agarwal and Shrikhande- Earthquake resistant design of structures, Prentice-Hall of India Pvt. Ltd. New Delhi, 2006.

CE 210 (JAN) 3:0

Structural Dynamics

Equations of motion. Degrees of freedom. D' Alembert principle. SDOF approximation to vibrating systems. Energy storage elements: mass, stiffness and damper. Undamped free vibration. Natural frequency. Damped free vibration. Critical damping. Forced response under periodic and aperiodic excitations. Support motions. Resonance. Impulse response and complex frequency response functions. Duhamel integral. Vibration isolation: FTR and DTR. Multi-DOF systems. Normal modes and natural frequencies. Orthogonality of normal modes. Natural coordinates. Uncoupling of equations of motion. Repeated natural frequencies. Proportional and non proportional damping. Damped normal modes. Principle of vibration absorber. Continuous systems. Vibration of beams. Forced response analysis by eigenfunction expansion. Moving loads and support motions. Effect of axial loads. Approximate methods for vibration analysis. Rayleigh's quotient. Rayleigh-Ritz method. Method of weighted residual. Method of collocation. Galerkin's method.

Manohar C S

Meirovich, L., 1984, Elements of vibration analysis, McGraw-Hill, NY,Clough R W and J Penzien, 1993, Dynamics of structures, McGraw-Hill, NY,Rao,S S 2004, Mechanical Vibrations, 4th Edition, Pearson Education, New Delhi.

CE 212 (JAN) 3:0

Computational Fluid Dynamics in Water Resources Engineering

Governing equations of fluid dynamics, numerical solution of ODEs, Classification of Quasi-Linear PDEs, classification of PDEs, Solution methods for Parabolic, Elliptic and Hyperbolic PDEs and their analysis. Curvilinear co-ordinates and grid generation. Introduction to finite difference, finite volume and finite elements method, Application of CFD to open channel flow, pipe flow, porous media and contaminant transport problems.

Mohan Kumar M S

Computational Fluid Dynamics: Applications in Environmental Hydraulics, edited by Paul D. Bates, Stuart N. Lane, Robert I. Ferguson, Wiley; 1st edition, 2007.,Computational Fluid Dynamics: A Practical Approach, by Jiyuan Tu, Guan Heng Yeoh, Chaoqun Liu, Elsevier, 2013.,Computational Fluid Dynamics in Drinking Water Treatment, by Bas Wols, IWA Publishing, 2011. Computational Fluid Dynamics for Engineers, By Andersson et al, Cambridge University Press, New York, 2012.,Fundamentals of Computational Fluid Dynamics, by Tapan K Sinha, University Press, 2004. Applied Numerical Analysis, by Curtis F. Gerald and Patrick O. Wheatley, Addison and Wesley, 1994

CE 213 (JAN) 3:0

Systems Techniques in Water Resources and Environmental Engineering

Optimization Techniques - constrained and unconstrained optimization, Kuhn-Tucker conditions, Linear Programming (LP), Dynamic Programming (DP), Multi-objective optimization, applications in water resources, water allocation, reservoir sizing, multipurpose reservoir operation for hydropower, flood control and irrigation. Review of probability theory, stochastic optimization. Chance constrained LP, stochastic DP. Surface water quality control. Simulation - reliability, resiliency and vulnerability of water resources systems.

Nagesh Kumar D

Loucks, D.P., Stedinger, J.R. and Haith, D.A., Water Resources Systems Planning and Analysis, Prentice Hall, Englewood Cliffs, N.J, 1981.,Vedula, S. and Mujumdar, P. P., Water Resources Systems: Modelling Techniques Tata-McGraw Hill, 2005.,Srinivasa Raju, K and Nagesh Kumar, D., Multicriterion Analysis in Engineering and Management, PHI Ltd., New Delhi, 2010.

CE 214 (JAN) 3:0

Ground Water Hydrology

Ground water and hydrological cycle. Ground water movement and balance. Ground water monitoring. Equations of flow. Well hydraulics - analysis of aquifer tests and models. Regional groundwater resource evaluation and numerical modeling. Groundwater recharge estimation. Base flow analysis and models. Ground water quality. Mass transport in ground water. Tracer tests and scale effects of dispersion. Solute transport modeling.

Sekhar M

Freeze, A. R. And Cherry, J. A. Groundwater, Prentice Hall, 1979.,Fetter, C. W. Applied Hydrogeology, Prentice Hall, 1988.,Domenico, P. A., and Schwartz, F. W. Physical and Chemical Hydrogeology, John Wiley, 1990,Fetter, C. W. Contaminant Hydrogeology, Prentice Hall, 1993.

CE 215 (JAN) 3:0

Stochastic Hydrology

Introduction to random variables, statistical properties of random variables. Commonly used probability distributions in hydrology. Fitting probability distributions to hydrologic data. Probability plotting and frequency analysis. Data generation. Modeling of hydrologic uncertainty - purely stochastic models, first order Markov processes. Analysis of hydrologic time series - auto correlation and spectral density functions. Applications to hydrologic forecasting.

Mujumdar P P

Bras, R.L. and Rodriguez-Iturbe, Random Functions and Hydrology, Dover Publications, New York, USA, 1993.,Hann, C.T., Statistical Methods in Hydrology, First East-West Press Edition, New Delhi, 1995.,Ang, A.H.S. and Tang, W.H.,Probabilistic concepts in Engineering Planning Design, Vol. 1, Wiley, New York, 1975.,Clarke, R.T., Statistical Models in Hydrology, John Wiley, Chinchester, 1994

CE 222 (JAN) 3:0

Fundamentals of Soil Behaviour

Identification and classification of clay minerals, expansive and collapsing soils; Concepts and measurements of matric and osmotic suction, Role of inter-particle forces and suction in effective stress, Role of clay mineralogy, inter-particle forces and suction in volume change, hydraulic conductivity and shear strength of soils

Sudhakar Rao M,Raghuveer Rao P

Mitchell, J. K. Fundamentals of Soil Behaviour, Wiley, 2005.,Yong, R. N. and Warkentin, B. P. Soil Properties and Behaviour, Elsevier, 1975, Lu, N. and Likos, W.J. Unsaturated Soil Mechanics, Wiley, 2004,Fredlund, D.G. and Rahardjo, H., Fredlund, M.D. Unsaturated Soil Mechanics in Engineering Practice, Wiley, 2012,Nelson, J.D. and Miller, D.J. Expansive soils- Problems and Practice in Foundation and Pavement Engineering. Wiley- Interscience Pub., 1992

CE 225 (JAN) 3:0

Engineering Rock Mechanics

Rock as an engineering material, Geological factors affecting rocks, Stress, Strain and Strength of rocks, Insitu stresses in rock, Intact Rock - Elastic Deformation, Discontinuities and deformability and strength of rock masses, permeability, anisotropy and in homogeneity in rocks, Stereonet Analysis, testing techniques, rock mass classification, Failure criteria for rock and rock masses, Rock mechanics interactions and rock engineering systems, Excavation and stabilization principles, rock slope stability, foundations on rock, rock blasting support and reinforcement, Underground excavation and stability, Urban tunnels, Problematic Rocks - Rock Engineering, Modern modelling techniques & analyses in rocks.

Sitharam G Thallak

Hudson J.A. and J.P. Harrison. Engineering Rock Mechanics: an Introduction to the Principles, 1997. Elsevier, Oxford,Goodman, R.E. Introduction to Rock Mechanics, John Wiley & Sons.,Engineering in Rocks for Slopes, Foundation and Tunnels, Editor T. Ramamurthy, Prentice Hall India Pvt. Ltd.,Additional Readings: Literature, related codes and manuals from International Society of Rock Mechanics, ASTM and Bureau of Indian Standards

CE 227 (JAN) 3:0

Engineering Seismology

Introduction to earthquake hazards. Strong ground motions, tsunamis, landslides, liquefaction. Overview of plate tectonics and earthquake source mechanisms. Theory of wave propagation. Body waves and surface waves. Concepts of seismic magnitudes and intensity. Seismic station. Sensors and data loggers, mechanical and digital sensors. Interpretation of seismic records – acceleration, velocity and displacement. Regional seismicity and earthquakes in India. Seismic zonation – scales, macro and micro, attenuation, recurrence relation. Seismic hazard analysis - deterministic and probabilistic. Site characterization – different methods and experiments. Local site effects, ground motion amplifications. Development of response/design spectrum. Liquefaction hazard assessments. Integration of hazards using GIS. risk and vulnerability Studies.

Anbazhagan P

Earthquake Engineering – From Engineering Seismology to Performance Based Engineering, Edited by Bozorgnia, Y. and Bertero, V.V., CRC Press Washington 2004.,Leon Reiter, Earthquake hazard Analysis – Issues and Insights, Columbia University Press New York 1990.,Steven L Kramer, Geotechnical Earthquake Engineering Pearson Education, 2003.

CE 228 (JAN) 3:0

Introduction to the Theory of Plasticity

1D plasticity and visco-plasticity; physical basis of plasticity; uniaxial tensile test & Bauschinger effect; structure of phenomenological plasticity theories; internal variables; yield criteria (Tresca, von Mises, Mohr-Coulomb, Drucker-Prager); geometry of yield surfaces; Levy-Mises equations; flow rules; plastic/ viscoplastic potentials; consistency condition; isotropic and kinematic hardening; Drucker's postulate; Principle of maximum plastic dissipation; associativity; convexity; normality; uniqueness; selected elastic-plastic boundary value problems (tension and torsion of tubes and rods, pressurized thin and thick spherical shells); collapse; advanced hardening models; introduction to computational plasticity; integration of plasticity models; return mapping; principle of virtual work;

Finite elements for plasticity

Ananth Ramaswamy

Chakrabarty, J. Theory of Plasticity, Butterworth, 2006,Calladine, C.R., Plasticity for Engineers, Woodhead, 2000,Lubliner J., Plasticity Theory, Dover, 2008

CE 230 (JAN) 3:0

Pavement Engineering

Introduction to pavement engineering: Design of flexible and rigid pavements; selection of pavement design input parameters, traffic loading and volume, material characterization, drainage, failure criteria: pavement design of overlays and drainage system: pavement performance evaluation: non-destructive tests for pavement: IRC, AASHTO design codes: maintenance and rehabilitation of pavements

Faculty CE

Rajib B Mallick and Tahar El-Korchi, Pavement Engineering, Principles and Practice, CRC Press, 2009,Huang, Y.H, Pavement Analysis and Design, Prentice-Hall, New Jersey, 1993.,E. J. Yoder, M. W. Witczak, Principles of Pavement Design, Wiley New York, 1975

CE 235 (JAN) 3:0

Optimization Methods

Basic concepts, Kuhn-Tucker conditions, linear and nonlinear programming, treatment of discrete variables, stochastic programming, Genetic algorithm, simulated annealing, Ant Colony and Particle Swarm Optimization, Evolutionary algorithms, Applications to various engineering problems.

Ananth Ramaswamy

Arora, J.S. Introduction to Optimization, McGraw-Hill (Int. edition)1989.,Rao, S.S., Optimization: Theory and Applications. Wiley Eastern, 1992 Current Literature.,-

CE 238 (JAN) 3:0

Structural Masonry

Masonry materials, Masonry characteristics, Compression failure theories, masonry in tension, shear and biaxial stress, laterally loaded un-reinforced walls, Strength of masonry arches, Design of reinforced and un-reinforced masonry structures.

Venkatarama Reddy B V

Hendry, A. W., Structural Masonry, MacMillan Press, 1998 Current literature,-,-

CE 239 (JAN) 3:0

Stochastic Structural Dynamics

Introduction to random variables and processes: probability, random variables. Transformations of random variables. Stationary, ergodic and non-stationary stochastic processes. Linear

transformation of stationary-ergodic stochastic processes. Normal Gaussian Stochastic processes. PSD functions. Wiener processes and an introduction to Ito calculus. Response of SDOF and MDOF oscillators under random inputs. Oscillators subject to white noise excitations. Input-output relations in time and frequency domains under the assumption of response stationarity. Handling non-stationarity in the response. level crossing and first passage problems. Nonlinear oscillators under random inputs: sources of non-linearity. Equivalent linearization and perturbation methods. Numerical integration and Monte Carlo simulations: Ito-Taylor expansions. Stochastic Euler and Heun methods. Higher order implicit and explicit methods. Errors in Monte-Carlo simulations. Variance reduction techniques.

Debasish Roy

Lin, Y K, Probabilistic Structural Dynamics, McGraw-Hill,Kloeden, P.E. and Platen, E., Numerical Solutions of Stochastic Differential Equations, Springer,Ghanem, R.G and Spanos, P D, Stochastic Finite Elements: A Spectral Approach, Springer-Verlag.

CE 248 (JAN) 3:0

Regionalization in Hydrology and Water Resources Engineering

Prediction in ungauged basins. Regional frequency analysis- probability weighted moments and its variations, stationary and non-stationary distributions, regional goodness-of-fit test. Approaches to regionalization of hydro-meteorological variables and extreme events. Regional homogeneity tests. Prediction of hydro-meteorological variables in gauged and ungauged basins, Estimation of probable maximum precipitation and probable maximum flood, and their use in hydrologic design.

Srinivas V V

Prerequisite : CE 203 Diekkrüger, B., Schröder, U., Kirkby, M. J., Regionalization in Hydrology, IAHS Publication no. 254, 1999.,Hosking, J. R. M., and Wallis, J. R., Regional Frequency Analysis: An Approach Based on L-Moments, Cambridge University Press, 1997.,Rao, A.R. and Srinivas, V.V., Regionalization of Watersheds - An Approach Based on Cluster Analysis, Series: Water Science and Technology Library, Vol. 58, Springer Publishers, 2008.

CE 267 (JAN) 3:0

Transportation Statistics and Micro-simulation

Role of statistics in transportation engineering; graphical methods for displaying transportation data; numerical summary measures; random variables in transportation; common probability distributions in transportation; use of sampling and hypothesis testing in transportation; use of ANOVA; regression models for transportation; Bayesian approaches to transportation data analysis; traffic micro-simulation models, analysing micro-simulation outputs, performance measures.

Ashish Verma

Spiegelman,C.H., Park, E.S. and Rilett, L.R. Transportation Statistics and Microsimulation, CRC Press, 2011.,Benjamin J.R. and Cornell, C. A. Probability, Statistics, and Decisions for Civil Engineers, McGraw-Hill Book Company, 1970,-

CE 271 (JAN) 3:0

Discrete Choice Modeling Methods for Transportation Planning

Individual choice theories; Binary choice models; Unordered multinomial choice models (multinomial logit and multinomial probit); Ordered response models (ordered logit, ordered probit, generalized ordered response); Maximum likelihood estimation; Sampling based estimation (choice-based samples and sampling of alternatives); Multivariate extreme value models (nested logit, cross-nested logit); Mixture models (mixed logit and latent class models); Mixed multinomial probit; Integrated

choice and latent variable models; Discrete-continuous choice models with corner solutions; Applications to travel demand analysis and transportation planning; Recent advances.

Prerequisites: Travel Demand Modeling F. Koppelman & C.R. Bhat. A Self-Instructing Course in Mode Choice Modeling: Multinomial and Nested Logit Models, 2006.,K. Train. Discrete Choice Methods with Simulation (2nd edition), Cambridge University Press, 2009.,M. Ben-Akiva & S.R. Lerman. Discrete Choice Analysis: Theory and Application to Travel Demand, MIT Press, 1985.

Chemical Engineering

M Tech programme in Chemical Engineering Duration 2 years 64 Credits		
Core: 17 Credits		
CH 201	3:0	Chemical Engineering Mathematics
CH 202	3:0	Numerical Methods
CH203	3:0	Transport Phenomena
CH 204	3:0	Thermodynamics
CH 205	3:0	Chemical Reaction Engineering
CH 206	1:0	Seminar Course
CH 207	1:0	Applied Statistics & Design of Experiments
Project: 32 Credits		
CH 299	0:32	Dissertation Project
Electives: A balance of 15 credits to complete the 64 credits of the M E programme, out of which a minimum of 9 credits are to be taken from the courses offered in the department.		

CH 201 (AUG) 3:0

Chemical Engineering Mathematics

Linear algebraic equations, linear operators, vector and function spaces, metric and normed spaces, existence and uniqueness of solutions. Eigen values and eigen vectors/functions. Similarity transformations, Jordan forms, application to linear ODEs, Sturm-Liouville problems. PDE's and their classification, initial and boundary value problems, separation of variables, similarity solutions. Series solutions of linear ODEs. Elemetary perturbation theory. References: Linear Algebra and its Applications, Gilbert Strang, Thompson (Indian edition). Mathematical Methods for Physicists, J. B. Arfken and H. J. Weber, Academic Press (Indian reprint). Mathematical Methods in Chemical Engineering, S. Pushpavanam, Prentice-Hall India. Advanced Mathematical Methods for Scientists and Engineers, C. M. Bender and S. A. Orszag, McGraw-Hill/Springer-Verlag (Indian/International student edition)

Prabhu R Nott

CH 202 (AUG) 3:0

Numerical Methods

Basics of scientific computing, basics of Matlab programming, solutions of linear algebraic equations, eigenvalues and eigenvectors of matrices, solutions of nonlinear algebraic equations, Newton-Raphson methods, function approximation, interpolation, numerical differentiation and integration, solutions of ordinary differential equations – initial and boundary value problems, solutions of partial differential equations, finite difference methods, orthogonal collocation.

Bhushan J Toley

1. Gupta S.K., Numerical Methods for Engineers, New Age International Publishers, 3rd edition, 2015
2. Chapra, S.C. and Canale, R.P., Numerical Methods for Engineers, McGraw Hill, NY, 6th edition, 2010
3. Beers, K.J., Numerical Methods for Chemical Engineering, Cambridge Univ. Press, Cambridge, UK 2010

CH 203 (AUG) 3:0

Transport Processes

Dimensional analysis and empirical correlations. Molecular origins of diffusion. Steady/unsteady shell balances in one/two dimensions. Solution of unsteady diffusion equation by similarity transform and separation of variables. Conservation laws and constitutive relations in three dimensions. Diffusion dominated transport. Fluid flow due to pressure gradients. Boundary layer theory for transport in forced convection. Natural convection. References: Bird, R.B, Stewart, W.E. and Lightfoot, E.N., Transport Phenomena, Wiley, 1994.L. G. Leal, Luminar Flow and Convective Transport Processes, Butterworth Heineman, 1992.

Kumaran V

CH 204 (AUG) 3:0

Thermodynamics

Classical thermodynamics: first and second laws, Legendre transforms, properties of pure substances and mixtures, equilibrium and stability, phase rule, phase diagrams, and equations of state, calculation of VLE and LLE, reaction equilibria, introduction to statistical thermodynamics.

References:
Tester, J.W., and Modell, M., Thermodynamics and its Applications, Third Edn, Prentice Hall, 1997.
Callen, H.B., Thermodynamics and an Introduction to Thermostatics, John Wiley & Sons, 1985.
McQuarrie, D.A., Statistical Mechanics, University Science Books, 2000.
Hill, T.L., An Introduction to Statistical Thermodynamics, Dover Publications, 1960

Ganapathy Ayappa

CH 206 (AUG) 1:0

Seminar Course

The course aims to help students in preparing, presenting and participating in seminars. The students will give seminars on topics chosen in consultation with the faculty.

Venugopal S

CH 235 (AUG) 3:0

Modeling in Chemical Enginereing

Model development principles; classification of models; modeling of complex situations of interest to chemical engineers through lumped and distributed parameter models, continuum models, population balance models, stochastic models, Monte Carlo methods, network models, percolation concepts, and fractal analysis of complex geometries. References: Lecture notes provided by Instructor.

CH 244 (AUG) 3:0

Treatment of Drinking Water

Availability of water, contaminants and their effects on human health, quality standards. Removal of contaminants by various processes: chlorination, filtration, coagulation and flocculation, reverse osmosis, adsorption and ion exchange. Rainwater harvesting
References:
Droste, R.L., Theory and Practice of Water and Wastewater Treatment, Wiley (Asia), 2004
Sawyer, C.N., McCarty, P.L., and Parkin, G.F., Chemistry for Environmental Engineering and Science, Fifth Edn, Tata McGraw Hill, 2004.
Lecture notes.

Kesava Rao K

CH 205 (JAN) 3:0

Chemical Reaction Engineering

Overview of Chemical Reaction Engineering, The Attainable Region theory, Analysis of Multiple Reactions and Design of Ideal Reactors, Non-Ideal Reactor Analysis, Thermodynamics and Kinetics of Reactions, Concepts in Catalysis, Multiphase Reactor Design, CFD for Reactive

Ganapathy Ayappa

Ming, D., Glasser, D., Hildebrandt, D., Glasser, B., and Metzger, M., Attainable Region Theory – An Introduction to Choosing an Optimal Reactor , Wiley 2016,. Doraiswamy, L.K., and Uener, D., Chemical Reaction Engineering – Beyond the Fundamentals , CRC press, 2014,Levenspiel, O., Chemical Reactor Omnibook , Print on demand at Lulu.com, 2013,. Chorkendorff, I., and Niemantsverdriet, J. W., Concepts of Modern Catalysis and Kinetics , Wiley 2005,Pangarkar, V. G., Design of Multiphase Reactors, Wiley 2014

CH 207 (JAN) 1:0

Applied Statistics and Design of Experiments

Introduction to probability and statistics; conditional probability; independence; discrete and continuous random variables and distributions; sampling distributions; confidence interval; application of parameter estimation and hypothesis testing: statistical inference for one sample and two samples; application of parameter estimation and hypothesis testing; statistical inference for two samples; analysis of variance; linear and non-linear regression; design of experiments; factorial experiments

Giridhar M

Montgomery,D.C. and Runger,G.C.,Applied Statistics and Probability for Engineers,5th ed.

CH 234 (JAN) 3:0

Rheology of Complex Fluids and Particulate Materials

Introduction to complex fluids: Polymeric fluids, Suspensions, Pastes, soft glassy materials; Dry granular materials; Flow phenomena in complex fluids: Shear thinning and thickening, Shear bands, Creep; Introduction to principles of rheology; Kinematics: Viscometric flows; Material functions: Rheometry in simple flows; Rheological models: Generalized Newtonian fluid, Models for viscoelasticity, Models for plasticity and viscoplasticity; Applications to simple flow problems.

Prabhu R Nott

Larson, R., The Structure and Rheology of Complex Fluids, Oxford, 1999,Bird, R. B., Armstrong, R. C. and Hassager, O., Dynamics of Polymeric Liquids - Vol.1 Fluid Mechanics, Wiley, 1987,Rao, K. K. and Nott, P. R., An Introduction to Granular Flow, Cambridge, 2008.

CH 236 (JAN) 3:0

Statistical Thermodynamics

Introduction to ensembles, partition functions, relation to thermodynamics; imperfect gases; density distribution functions; integral equations and perturbation theories of liquids; lattice gas; Ising magnets; Bragg Williams approximation; Flory Huggins theory; Molecular modeling of intermolecular forces

Sudeep Punnathanam,Ganapathy Ayappa

McQuarrie, D.A., Statistical Mechanics, Viva Books, 2003.,Hill, T. L., An Introduction to Statistical Thermodynamics, Dover Publications, 1986,Chandler, D, Introduction to Modern Statistical Mechanics, Oxford University Press, New York, 1986

CH 245 (JAN) 3:0

Interfacial and Colloidal Phenomena

Interfaces, Young-Laplace and Kelvin equations for curved interfaces; interfacial tension and contact angle, measurement techniques; wetting and spreading; colloids: Intermolecular forces, London-van der Waals attraction, double layer repulsion, zeta potential, DLVO theory of colloidal stability; non-DLVO forces; surfactants; thermodynamics of self-assembly, phase diagrams; electro-kinetic phenomena; electrochemical systems

Sanjeev Kumar Gupta

Berg,J. C. An Introduction to Interfaces and colloids, The bridge to nanoscience, World Scientific, 2010.,. Israelachvili, J., Intermolecular and Surface Forces, Academic, Press, 3rd edition, 2011.,Hunter, R. J., Foundations of Colloid Science, Vol. I, II Oxford, University Press, 1986,Lecture notes given by instructor.

CH 248 (JAN) 3:0

Molecular Systems Biology

Various topics highlighting experimental techniques and modeling approaches in systems biology for problems ranging from molecular level to the multi-cellular level will be covered. Topics: Properties of biomolecules, Biomolecular Forces, Single molecule experimental techniques, Molecular motors, Molecular heterogeneity, Self-organization, Enzyme kinetics, Modeling cellular reactions and processes, Fluctuations and noise in biology, Cellular variability, Biological networks, Modeling dynamics of bioprocesses and cellular signaling

Rahul Roy

Philip Nelson, Biological Physics: Energy, Information, Life, W. H. Freeman, 2007,Edda Klipp, Wolfram Liebermeister, Christoph Wierling, Axel Kowald, Hans Lehrach, Ralf Herwig, 3. Systems Biology, Wiley-Vch, 2009,Uri Alon, An Introduction to Systems Biology: Design Principles of Biological Circuits, Chapman & Hall/CRC Mathematical & Computational Biology, 2006

CH 299 (JAN) 0:32

Dissertation Project

The ME project is aimed at training the students to analyze independently any problem posed to them. The project may theoretical, experimental, or a combination. In few cases, the project may also involve sophisticated design work. The project report is expected to show clarity of thought and expression, critical appreciation of the existing literature, and analytical, experimental or design skills.

Ganapathy Ayappa

Centre for Earth Sciences

M Tech Programme in Earth Science
Duration: 2 years: 64 Credits

Hard Core: 24 Credits (All courses are mandatory)

ES 201 2:1 Introduction to Earth System Science
ES 202 3:0 Geodynamics
ES 203 2:1 Introduction to Petrology
ES 204 3:0 Origin and Evolution of Earth
ES 205 3:0 Mathematics for Geophysicists
ES 206 3:0 Topics in Geophysics
ES 207 0:3 Earth Science Laboratories
CE 247N 3:0 Remote Sensing and GIS for Water Resources & Environmental Engineering

Project: 25 Credits

Electives: 15 Credits of which at least 9 credits must be from among the group electives listed below.

ES 208 3:0 Mantle Convection
ES 209 3:0 Biogeochemistry
ES 210 3:0 Tectonics and Crustal Evolution
ES 211 3:0 Applied Petrology
ES 212 3:0 Fluid dynamics of planetary interiors
ES 213 3:0 Isotope Geochemistry
ES 214 3:0 Topics on stratigraphy and geochronology

CE 247 (AUG) 3:0

Remote Sensing and GIS for Water Resources & Environmental Engineering

Basic concepts of remote sensing. Airborne and space borne sensors. Digital image processing. Geographic Information System. Applications to rainfall - runoff modeling. Watershed management. Irrigation management. Vegetation monitoring. Drought and flood monitoring, Environment and ecology. Introduction to digital elevation modeling and Global Positioning System (GPS). Use of relevant software for remote sensing and GIS applications.

Nagesh Kumar D

Lillesand T.M., and Kiefer R.W., Remote Sensing and Image Interpretation, John Wiley & Sons, 2000.,Sabins, F.F., Remote Sensing - Principles and Interpretation, Freeman & Co., New York, 1986.,Heywood, I., Cornelius, S., and Carver, S., An Introduction to Geographical Information Systems, Pearson Education, 1998.

ES 201 (AUG) 2:1

Introduction to Earth System Science

Role of geology in understanding the Earth system processes.Composition of Lithosphere, Atmosphere and Biosphere. Earth surface processes and its consequences, earth as a dynamic planet. Planetary bodies and formation of universe. Early atmosphere, evolution of atmosphere through time, evolution of hydrosphere and general circulation of ocean through time. Long and short term history of cryosphere, fossilization, reconstruction of geologic time. Geochemic origin of life, RNA world, Miller Urey Experiment, Evolution affecting Biosphere, Great oxygenation Event (GOE), Paleobiology: Microfossil chemistry. Indian climate present day and past, Global paleoclimatic record, Paleomonsoon record and the role of tectonics.

Practical: Project on the model of real-world ecosystems in order to understand how biotic and abiotic factors interact and to see how one type of ecosystem impacts other ecosystems

Prosenjit Ghosh

Merrits, D., Dewet, A., and Menking, K., Environmental Geology: An Earth System Science Approach, 1998.,Freeman, W.H.,

Jacobson, M.C., Charlson, R.J., Rodhe, H., and Orians, G.H., Earth System Science, Academic Press, 2000.,Merrits, D., Dewet, A., and Menking, K., Environmental Geology: An Earth System Science Approach, 1998

ES 202 (AUG) 3:0

Geodynamics

Introduction to processes shaping the earth; developing chronological constraints.Reference frames and map projections, shape of the earth, Earth's gravity field, geodesy, isostasy. Earth's magnetic field, paleomagnetism, geomagnetic reversals.Plate tectonics, evolution of landforms and global seismicity. Earthquake types and quantification, interpreting seismograms, seismic waves and earth's interior, earthquake source characterization, earthquake and faulting processes; types of faults and relation to stress fields, moment tensors and earthquake focal mechanisms.Effects of earthquakes, earthquakes in Indian context, Structure of the Earth's interior- density, seismic velocity, pressure and temperature.Lab and field components: Handling earthquake recorders and data acquisition, Seismic Analysis Code and GMT for analyzing and representing global seismicity data.

Kusala Rajendran

Fowler, C.M.R., The solid earth: An Introduction to Global Geophysics, Cambridge University Press, 2005.,Turcotte, D., and Schubert, G., Geodynamics, Cambridge University Press, 2nd edition, 2001.,Turcotte, D., and Schubert, G., Geodynamics, Cambridge University Press, 2nd edition, 2001.

ES 203 (AUG) 3:0

Introduction to Petrology

Theory: Rock forming minerals, textures of Igneous, metamorphic and sedimentary rocks, Micro-textures and reactions, using petrological datasets, rock types and tectonic settings, geothermometry and geobarometry, isochemical phase diagrams and its interpretations, linking petrology to geochronology, Geology of southern India and applications of petrology.

Sajeev Krishnan

Vernon R.H.,A practical guide to Rock Microstructure,Cambridge University Press,2004.,Deer

ES 204 (AUG) 3:0

Origin and Evolution of the Earth

Big Bang; origin of elements; early Solar System objects; bulk Earth composition; comparison of Earth and other Solar System objects; core-mantle differentiation; composition of the terrestrial mantle; mantle melting and geochemical variability of magmas; major, trace element and radiogenic isotope geochemistry; redox evolution of the mantle; evolution of the atmosphere and biosphere.

Ramananda Chakrabarti

Dickin, A. P., Radiogenic Isotope Geology, Cambridge University Press, 1995,Hugh Rollinson, Using Geochemical Data: Evaluation, Presentation and Interpretation, Longman Group, 1993,John D. Winter, Principles of Igneous and Metamorphic Petrology, 2nd edition, Pearson Prentice Hall, 2010,Charles H. Langmuir and Wally Broecker, How to build a habitable planet, Revised and expanded edition, Princeton University Press, 2012

ES 205 (AUG) 3:0

Mathematics for Geophysicists

Vector fields: basic vector algebra, line, surface and volume integrals, potential, conservative fields, gradient, divergence, curl, circulation, Stokes's theorem, Gauss's theorem, applications in fluid mechanics and electromagnetism, Kelvin's theorem, Helmholtz's theorem. Linear algebra: Matrices, operations, eigen components, systems of linear differential equations, examples. Partial differential equations: The diffusion equation, wave equation, Laplace's equation, Poisson's equation, similarity solutions, numerical solutions (simple examples with MATLAB), series solutions, spherical harmonic expansions. Dimensional analysis: Pi theorem, similarity, nondimensional formulation of geophysical problems, examples.

Binod Sreenivasan

Riley, K.F., Hobson, M.P., and Bence, S.J., Mathematical methods for physics and engineering, Cambridge University Press, 2006.,Panton, R.L., Incompressible flows, John Wiley & Sons, 2006.,Albarede, F., Introduction to geochemical modelling, Cambridge University Press, 1996. Lecture notes.

ES 208 (AUG) 3:0

Mantle Convection

Plate tectonics and mantle convection, Constraining mantle flow from seismic tomography, Maxwell viscoelastic material, Spherical harmonics, Mantle viscosity, Creep mechanisms, Governing equations, Constraints of mantle flow modeling: geoid and dynamic topography, Thermal evolution of the Earth, Convection in other planets.

Attreyee Ghosh

Schubert, G., Turcotte, D., and Olson, P., Mantle convection in the earth and planets, Cambridge University Press, 2001.,Turcotte, D., and Schubert, G., Geodynamics. Cambridge University Press, 2nd edition, 2001.,Fowler, C.M.R., The Solid Earth: An Introduction to Global Geophysics, Cambridge University Press, 2005.

ES 211 (AUG) 2:1

Economic minerals and tectonic processes

Theory: Theory: Ore bearing fluids, deposits related to ultramafic-mafic rocks, intermediate to felsic rocks, deposits related to metamorphism, epochs and role of plate tectonics.Distribution of mineral deposits and relation to tectonic processes. Mineral deposits in southern Indian tectonic environments. Magmatic fluids and hydrothermal deposits, mineral deposits in granites and pegmatites, magmatic deposits, mineralization within ancient plate boundaries.

Practical: Visit to a mine and sample collection, petrography and fluid-inclusion studies, EPMA and data processing

Sajeev Krishnan

Introduction to ore-forming processes by Laurence Robb, Blackwell Publishing,The geology of ore deposits by John M. Guilbert and Charles F. Park, Jr, Springer,Crustal Evolution and Metallogeny in India by Anupendu Gupta and Sanjib Chandra Sarkar, Cambridge University Press

ES 206 (JAN) 3:0

Topics in Geophysics

Earth's internal structure: composition vs mechanical properties, Geoid, GIA and viscosity, Stress and Strain from seismology perspective, Theory of Elasticity, Wave mechanics, Seismic tomography, Earth's free oscillations, Phase transformations within the Earth, Introduction to mineral physics,

Spherical harmonics, Heat: conductive, convective and radioactive heat flow, Heat flow in oceans and continents, Half space vs plate cooling models, Convection within mantle and core, Structure of mid-oceanic ridge system, Strength of continental lithosphere

Attreyee Ghosh

Fowler, C.M.R., The Solid Earth: An Introduction to Global Geophysics, 2nd edition, Cambridge University Press, 2005,Turcotte, D., and Schubert, G., Geodynamics, Cambridge University Press, 2002,Turcotte, D., and Schubert, G., Geodynamics, Cambridge University Press, 2002

ES 207 (JAN) 0:3

Earth Science Laboratory

Geochemical techniques; mineral chemical techniques; sedimentology techniques; computational techniques.

Reed, S.J.B., Electron Microprobe Analysis and Scanning Electron Microscopy in Geology, 2nd Edition, Cambridge University Press, 2010.,Reading material and notes.,Reading material and notes.

ES 209 (JAN) 3:0

Biogeochemistry

Geochemistry of the Earth, Big bang, Nucleosynthesis, origin of solar system, electronic structure of atoms, periodic tables, chemical bonds. Crystals, Ionic substitution, Isotope geo-chronometer, chemical reactions and stability of minerals, acids and bases, salts and their ions. Thermodynamics, mineral stability, clay minerals, carbonate minerals, oxidation-reduction reaction, isotope fractionation, mixing and dilution, rate of chemical processes, chemical weathering, chemical composition of surface water, stable isotope geochemistry Carbon cycling, other geochemical cycle (-P-N-S), ,Metabolism and geochemistry, Mineral-Microbe-Interaction, Bioweathering, Biomineralization, Environmental metagenomics, Economic Biogeochemistry.

Prosenjit Ghosh

Schlesinger, W.H., Biogeochemistry: An analysis of Global Change, Academic Press, 1997,Faure, G., Principle and application of inorganic geochemistry, Prentice Hall, 1991.,Andrew H. Knoll, A.H., Canfield, D.E., Konhauser, K.O., Fundamentals of Geobiology, 2012.

ES 210 (JAN) 3:0

Tectonics and Crustal Evolution

Introduction to the theory of plate tectonics, application to understanding the structure, evolution and dynamic processes of the earth. Plate motions on flat and spherical earth, evolution and stability of triple junctions, plate driving forces, seismicity and volcanism as a consequence of plate motions, evolution of landforms, mountain building, paleomagnetism and reconstruction of continental masses, plate tectonics through time. Evolution of Indian plate through time, dynamics of its plate boundaries; earthquakes as a tool to understand processes along plate boundaries.

Kusala Rajendran

Philip Keary, Keith A. Kelpeis and Frederick J. Vine, Global tectonics, Wiley-Blackwell, Third edition.,Fowler, C.M.R., The Solid Earth: An Introduction to Global Geophysics, Cambridge University Press, Second edition,Fowler, C.M.R., The Solid Earth: An Introduction to Global Geophysics, Cambridge University Press, Second edition

ES 212 (JAN) 3:0

Fluid dynamics of planetary interiors

Basic fluid dynamics - Navier-Stokes equation, vorticity equation, Kelvin's circulation theorem, energy and dissipation, helicity.

Rotation - Coriolis force, linear inertial waves, formation of Taylor columns, geostrophy, quasi-geostrophic approximation.

Stratification - Gravity waves, effect of rotation, Braginsky's theory of stratified outer core of the Earth.

Magnetic fields - Magnetohydrodynamic (MHD) equations, Lorentz force, low and high magnetic Reynolds number, Alfven waves, Magnetic-Coriolis (MC) waves, Rayleigh Benard convection with magnetic field and rotation, MHD of planetary cores.

Turbulence - Richardson's cascade, overview of classical theories, 2D turbulence, turbulence under moderate and rapid rotation, MHD turbulence, different lengthscales in planetary core turbulence.

Binod Sreenivasan

Davidson, P.A., Turbulence in rotating, stratified and electrically conducting fluids, Cambridge University Press, 2013.,Acheson, D.J., Elementary fluid dynamics, by, Oxford University Press, 1990,Journal papers

ES 213 (JAN) 3:0

Isotope Geochemistry

Nuclear systematics; decay mode of radionuclides; radioactive decay; Rb-Sr, Sm-Nd, Lu-Hf, Re-Os and U-Th-Pb systematics, U series disequilibrium, stable isotope fractionation, early Solar System processes, crust-mantle processes, aquatic processes, selected mass spectrometry techniques.

Ramananda Chakrabarti

Alan P. Dickin, Radiogenic Isotope Geology, Cambridge University Press, 1995,Gunter Faure and Teresa M. Mensing, Isotopes -principles and applications, 3rd edition, Wiley-India Edition,Research papers

ES 214 (JAN) 3:0

Topics in stratigraphy and geochronology

C-S-Sr isotope stratigraphy, time-series chemostratigraphic correlation, time-series Litho stratigraphic correlation, Biostraigraphic correlation, Magnetostratigraphy, Non-traditional isotope stratigraphy, Stratigraphy on Mars,Zircon texture, morphology, zoning, Zircon as an equilibrium mineral, U-Pb dating of Zircon, REE in zircon, Th/U ratio in Zircon, Hf in zircon, U-Pb dating methods, plotting and interpretation of ages, connecting age to tectonics

Sajeev Krishnan,Prosenjit Ghosh

Grastein,Ogg and Schmitz, The Geologic Time Scale 2012 2-Volume Set, 1st Edition,ISBN: 9780444594488,Ramkumar, M, Chemostratigraphy, Concepts, Techniques, and Applications, ISBM: 9780124199828, 2015,Simon L. Harley and Nigel M. Kelly, Zircon Tiny but Timely: Zircon Tiny but Timely , ELEMENTS, v. 3, p. (1): 13-18, February 2007,Zircon, John M. Hanchar and Paul W.O. Hoskin, editors, Reviews in Mineralogy and Geochemistry, Volume 53, 2003,Vance, D., Geochronology: Linking the Isotope Record With Petrology And Textures, Geological Society Special Publication

Mechanical Engineering

M Tech Programme
Duration: 2 years
64 credits

Hard Core: 19 credits

ME 201	3:0	Fluid Mechanics
ME 228	3:0	Materials & Structure Property Correlations
ME 240	3:0	Dynamics & Control of Mechanical Systems
ME 242	3:0	Solid Mechanics
ME 271	3:0	Thermodynamics
ME 297	1:0	Seminar Course
ME 261	3:0	Engineering Mathematics
		OR
MA 211	3:0	Matrix Theory
		OR
MA 251	3:0	Numerical Methods
		OR
PH 205	3:0	Mathematical Methods of Physics

OR
Any other course recommended by the department

Project: 27 Credits
ME 299 0:27 Dissertation Project
Electives: The balance of 18 credits required to make up a minimum of 64 credits to complete the M.E. Program.

ME 201 (AUG) 3:0

Fluid Mechanics

Fluid as a continuum, mechanics of viscosity, momentum and energy theorems and their applications, compressible flows, kinematics, vorticity, Kelvin's and Helmholtz's theorems, Euler's equation and integration, potential flows, Kutta-Joukowsky theorem, Navier-Stokes equations, boundary layer concept, introduction to turbulence, pipe flows.

Gaurav Tomar,Raghuraman N Govardhan,Jaywant H Arak

Kundu, P.K., and Cohen, I.M., Fluid Mechanics, Elsevier, 2005.,White, F.M., Fluid Mechanics, McGraw Hill, 1986.,Vennard, J.K., and Street, R.L., Elementary Fluid Mechanics, John Wiley, Sixth Edn. 1982

ME 228 (AUG) 3:0

Materials and Structure Property Correlations

Atomic structure of materials, atomic bonding, crystal structure. point, line and area defects in crystal structure. Solidification of metals, phase diagrams, Dislocation concepts of plastic deformation, critical resolved shear stress yeling interactions between dislocations and work hardening, Recovery, recrystallization and grain growth. Fracture-microscopic descriptions. Mechanisms of metal deformation, processing maps Concepts of bio-materials. Natural and synthetics, fracture and fatigue of bio-materials.

Namrata Gundiah,Satish V Kailas

Raghavan, V., Materials Science and Engineers, Prentice Hall, 1979. Davidge, R.W., Mechanical Behaviour of Ceramics, Cambridge University Press, 1986. Reed-Hill, R.E. and Abbaschian,,R., Physical Metallurgy Principles, PWS-Kent Publishing Com pany, 1992. Ratner B.D., Hoffman ,A.S., Schoen,F. J., Lemons, J. E., Biomaterials Science- An introduction to Materials in Medicine, Academic Press 1996.

ME 237 (AUG) 3:0

Mechanics of Microsystems (crosslisted as NE 211)

An overview of micro-systems and micro-fabrication, mechanics issues relevant to microsystems, scaling laws, materials properties and their role in micro-systems, lumped modeling of micro-systems. Coupled-simulations of multi-energy domain systems including electrostaticsmechanical, electro-thermal, thermo-mechanical, piezoelectric-mechanical, fluidic issues such as squeezed-film effects. Application of numerical techniques such as finite element and boundary element methods in solving steady-state and transient regimes. Case studies of selected Microsystems devices and systems. Introduction to biomechanics at the small sizes.

Ananthasuresh G K

Pre-requisite: Multi-variable calculus and numerical analysis. No prior background in micro-systems or mechanics,Pre-requisite: Multi-variable calculus and numerical analysis. No prior background in micro-systems or mechanics,Micro and Smart Systems,Wiley-India,2010

ME 238 (AUG) 3:0

Special Topics in Combustion

Review of combustion fundamentals – conservation equations, chemical kinetics, laminar premixed and diffusion flames, pollutant formation; combustion instability - basic concepts and mechanisms, acoustic-vortex-flame interactions, combustion instability and control, instability issues in industrial gas turbines and aero-engines; spray combustion, single component and multi-component droplet combustion; modeling of turbulent reacting flows, RANS and LES methods; laser diagnostic methods applied to reacting flows - PLIF, PIV, Raman, Rayleigh, LII, measurement of temperature, velocity, species and soot concentrations

Saptarshi Basu,Ravikrishna, R. V.

C. K. Law, Combustion Physics, Cambridge University Press, 2010 S. R. Turns, An Introduction to Combustion,,Concepts and Applications, McGraw Hill International, Third Edition, 2012. N. Peters, Turbulent Combustion,,Cambridge University Press, 2006. Katharina Kohse-Höinghaus and Jay Jeffries, Applied Combustion Diagnostics, Taylor and Francis, 2002.

ME 240 (AUG) 3:0

Dynamics and Control of Mechanical Systems

Representation of translation and rotation of rigid bodies, degrees of freedom and generalized coordinates, motion of a rigid body and multi-body systems, Lagrangian and equations of motion, small vibrations, computer generation and solution of equations of motion, review of feedback control, PID control, root locus, Bode diagrams, state space method, control system design and computer simulation.

Ashitava Ghosal

Greenwood, D.T., Principles of Dynamics, Second Edn., Prentice Hall, 1988. Haug, E.J., Computer Aided,Kinematics and Dynamics of Mechanical Systems, Vol. 1, Allyn and Bacon, 1989. Franklin, G.F., Powell, J.D., and,Abbas Emam i-Naeini, Feedback Control of Dynamic Systems, Addison W esley, 1987.

ME 242 (AUG) 3:0

Solid Mechanics

Analysis of stress, analysis of strain, stress-strain relations, two-dimensional elasticity problems, airy stress functions in rectangular and polar coordinates, axisymmetric problems, energy methods, St. Venant torsion, elastic wave propagation, elastic instability and thermal stresses.

Narasimhan R,Ramsharan Rangarajan

Fung, Y.C., Foundations of Solid Mechanics, Prentice Hall. Srinath,,L.S., Advanced Mechanics of Solids, Tata McGraw Hill.,Sokolnikoff, I.S., Mathematical Theory of Elasticity, Prentice Hall.

ME 243 (AUG) 3:0

Continuum Mechanics

Introduction to vectors and tensors, finite strain and deformation-Eulerian and Lagrangian formulations, relative deformation gradient, rate of deformation and spin tensors, compatibility conditions, Cauchy's stress principle, stress tensor, conservation laws for mass, linear and angular momentum, and energy. Entropy and the second law, constitutive laws for solids and fluids, principle of material frame indifference, discussion of isotropy, linearized elasticity, fluid mechanics.

Chandrashekhar S Jog

Malvern, L.E., Introduction to the Mechanics of a continuous medium , Prentice Hall, 1969. Gurtin, M.,,An Introduction to Continuum Mechanics, Academic Press, 1981,Hunter, S.C., Mechanics of Continuous Media, Ellis-Horwood, 1983.

ME 250 (AUG) 3:0

Structural Acoustics

Vibration and acoustic response of an infinite plate in contact with an acoustic half space to a line force (Crighton’s solution). Complex variables, integration with branch cuts. Fluid-structure coupling in 2-D flexible-walled waveguides using asymptotic expansions (rectangular and cylindrical geometries). Coupling of sound with flexible enclosures. Sound radiation from finite rectangular plates and cylindrical shells. Transform and Rayleigh integral methods. Coincidence and wave number spectra, wave impedance, radiation efficiency.

Venkata R Sonti

Pre-requisite: Consent of Instructor Junger, M.C., and Feit, D., Sound, Structures and their Interaction, MIT Press,,1986. Fahy, F.J., Sound and Structural Vibration, Academic Press, 1985. Cremer, L., Heckl, M., and Ungar, E. E.,,Structure-Borne Sound, Springer-Verlag, 1987.

ME 252 (AUG) 3:0

Mechanisms

Simple and complex mechanisms, kinematic analysis by graphical and algebraic methods. Complex number, vector, quaternion, tensor-based kinematics. Computer aided kinematics, modeling constraints and simulation. Rigid body guidance problem. Curvature theory in plane kinematics. Elements of line geometry and screw theory for rigid body motion in space.

Dibakar Sen

Hirschhorn, J., Kinematics and Dynamics of Plane Mechanisms, McGraw Hill, 1962. Haug, E.J., Computer Aided,Kinematics and Dynamics of Mechanical systems, Allyn and Bacon. Hunt, K.H., Kinematic,Geometry of Mechanisms, Clarendon Press.

ME 255 (AUG) 3:0

Principles of Tribology

Surfaces, theories of friction and wear, friction and wear considerations in design, viscosity, hydrodynamic lubrication, Reynolds equation, coupling of elastic and thermal equations with Reynolds equation. Elasto-hydrodynamic lubrication. Mechanics of rolling motion, hydrostatic lubrication, lubricants, tribometry, selection of tribological solutions.

Bobji M S

Halling, J. (ed.), Principles of Tribology, Macmillan, 1975. Seireg, A.A.,Friction and Lubrication in Mechanical Design, Marcel Dekker, 1998,Cameron, A., Principles of Lubrication, Longman, 1966.

ME 260 (AUG) 3:0

Topology Optimization

Hierarchy in structural optimization: topology, shape, and size. Michelle continua and truss/frame topology optimization. Design parameterization and material interpolation: ground structure method, homogenization-based method, density distribution, level-set methods, peak function methods, phase-field methods. Numerical methods for topology optimization: optimality criteria methods, convex linearization and method of moving asymptotes, dual algorithms, numerical issues in the implementation of topology optimization algorithms, applications to multi-physics problems, compliant mechanisms and material microstructure design. Manufacturing constraints, other advanced topics.

Ananthasuresh G K

Pre-requisite: ME 256. Background in finite element analysis is preferred.,. Bendsoe, M.P., and Sigmund, O., Topology Optimization:,Theory, Methods, and Applications, Springer, 2003. Contemporary literature.

ME 261 (AUG) 3:0

Engineering Mathematics

Vector and tensor algebra: Sets, groups, rings and fields, vector spaces, basis, inner products, linear transformations, spectral decomposition, tensor algebra, similarity transformations, singular value decomposition, QR and LU decomposition of matrices, vector and tensor calculus, system of linear equations (Krylov solvers, Gauss-Seidel), curvilinear coordinate transformations. Ordinary and partial differential equations: Characterization of ODEs and PDEs, methods of solution, general solutions of linear ODEs, special ODEs, Euler-Cauchy, Bessel's and Legendre's equations, Sturm-Liouville theory, critical points and their stability. Complex analysis: Analytic functions, Cauchy-Riemann conditions and conformal mapping. Special series and transforms: Laplace and Fourier transforms, Fourier series, FFT algorithms, wavelet transforms.

Gaurav Tomar,Venkata R Sonti,Chandrashekhar S Jog

Kryyzig E, Advanced Engineering Mathematics, C.R. W ylie, Advanced Engineering Mathematics,M.D. Greenberg, Advanced Engineering Mathematics, F. B. Hildebrand, Methods of Applied Mathematics,Bender and Orszag, Advanced Mathematical Methods for Scientists and Engineers"

ME 271 (AUG) 3:0

Thermodynamics

Concepts of thermodynamics, zeroth law, first law, properties of pure substances and mixtures, first order phase transitions, thermo-physical properties, energy storage, second law. Energy analysis of process and cycle, calculation of entropy and entropy diagrams, availability analysis, multi-phase multi-component systems, membrane equilibrium, phase equilibrium, chemical equilibrium.

Pradip Dutta,Ravikrishna, R. V.,Pramod Kumar,Sapta

Van Wylen, G.J., and Sonntag, R.E., Fundamentals of Classical Thermodynamics,, Wiley. Wark, K., Advanced Thermodynamics for Engineers,,McGraw Hill, 1995.

ME 285 (AUG) 3:0

Turbomachine Theory

Introduction to turbo-machines, mixing losses, review of vorticity, profile changes in contracting and expanding ducts. Brief review of diffusers, rotating co-ordinate system, total enthalpy, rothalpy, Euler turbine equation, velocity triangles. Specific speed and Cordier diagram, cascade aerodynamics. Elemental compressor stage, reaction work and flow coefficients. Equations of motion in axisymmetric flow, simple and extended radial equilibrium. Elemental axial turbine stage, radial and mixed flow machines, work done by Coriolis forces and by aerofoil action, the centrifugal compressor, vaned and vaneless diffusers.

Raghuraman N Govardhan,Jaywant H Arakeri

Sabersky, R.H., and Acosta, A., Fluid Flow: A First Course in Fluid Mechanics,Wilson, D.G., The Design of High Efficiency Turbomachinery and,Gas Turbine, MIT Press, 1984.

ME 289 (AUG) 3:0

Principles of Solar Thermal Engineering

Introduction, solar radiation – fundamentals, fluid mechanics and heat transfer, methods of collection and thermal conversion, solar thermal energy storage, solar heating systems, solar refrigeration, solar thermal elective conversion. Other applications.

Narasimham G S V L

Kreith, F., and Kreider, J.F., Principles of Solar Thermal Engineering, McGraw Hill, 1978. Duffie, J.A., and Beckm,an, W.A., Solar Engineering of Thermal Processes, John W iley and Sons, 1991. Meinel,,A.B., and Meinel, F.P., Applied Solar Energy.

ME 294 (AUG) 2:0

Applied Impact Mechanics of Solids

Appreciation of Impact Problems in Engineering, Impact Plasticity, Fracture, Comminution and Concussion; Elements of Elasto-dynamics, Vibration and Waves; Characteristics of Bulk Pand- S Waves in infinite media; Characteristics of Rayleigh Surface Wave; Reflection, refraction and absorption of stress waves; Dispersion, nonlinearity,(acousto-elasticity), searching for solitons

Yogendra Simha K R

Pre-requisite: ME 242 Solid Mechanics or Equivalent Timoshenko, S, P, and Goodier, J.N. Theory of Elasticity,,McGraw Hill, 1970 Simha, K R Y Fracture Mechanics for Modern Engineering Design Universities Press, 2001,Graff, K F., Wave Motion in Elastic Solids, Dover 1975

ME 296 (AUG) 3:0

STRUCTURAL FRACTURE MECHANICS

Introduction to fracture mechanics. Appreciation of structural mechanics and stability. Elastic buckling. Plastic collapse by hinge formation. Impact mechanics. Unstable fracture. Stability triad. Local material parameters: anisotropy, heterogeneity and residual stress. Global structural parameters: eccentricity, creep and thermal effects. Fatigue loading. Dynamic loading and ballistics.

Yogendra Simha K R

Broek D., Elementary Engineering Fracture Mechanics, Nijhoff 1985.,Kanninen, M.K., and Popellar, C.H., Advanced Fracture Mechanics, Oxford 1985.,Simha, K.R.Y., Fracture Mechanics for Modern Engineering Design, Universities Press 2001. Lakshmana Rao, C., Narayanamurthy, V., and Simha, K.R.Y., Applied Impact Mechanics, Ane Books 2016.

ME 297 (AUG) 1:0

Departmental Seminar

The student is expected to attend and actively take part in ME departmental seminars for one semester during his/her stay. A ‘pass’ in the course is obtained by attendance of at least 80%.

Faculty ME

Faculty Coordinator,Faculty Coordinator,Faculty Coordinator

ME 239 (JAN) 3:0

Modeling and Simulation of Dynamics Systems

Axioms of mathematical modeling, approximations and idealizations, fundamental balance laws, governing equations, state-space description, solution of ODEs, numerical methods for solutions of ODEs, explicit and implicit methods, error and accuracy, stability analysis of numerical solvers, stiff systems and stability, frequency domain in analysis of linear systems, FFT and power spectra, nonlinear systems, maps, bifurcations and chaos.

Rudra Pratap

Hirsh, M., and Smale, S., Differential Equations, Dynamical Systems and Linear Algebra, Academic Press, 1974. Farlow,S.J., Partial Differential Equations for Scientists and Engineers, Dover Publications Inc., 1993.,Pratap, R., Getting Started with MATLAB 7, Oxford University Press, 2006

ME 241 (JAN) 3:0

Experimental Engineering

Introduction to modeling of system response and sensor dynamics, Introduction to electronics, data acquisition and analysis, fluid velocity, stress, temperature measurement techniques. Experiments using photo-elasticity, universal testing machine, hot-wire anemometry, accelerometers.

Saptarshi Basu,Pramod Kumar,Namrata Gundiah

Doeblin, E.O., Measurement Systems: Application and design, McGraw Hill, 1990. Horowitz, P., and Hill, W.,,The art of electronics, Cambridge University Press, 1990.,Goldstein, R.J., Fluid mechanics measurements, Hemisphere Publishing Company, 1983.

ME 246 (JAN) 3:0

Introduction to Robotics

Robot manipulators: representation of translation, rotation, links and joints, direct and inverse kinematics and workspace of serial and parallel manipulators, dynamic equations of motion, position and force control and simulation.

Ashitava Ghosal

Ghosal, A., Robotics: Fundamental Concepts and Analysis,,Oxford University Press, 2006,Notes and recent research papers.

ME 249 (JAN) 3:0

Fundamentals of Acoustics

Fundamentals of vibration, vibrations of continuous systems (strings and rods), I-D acoustic wave equation, sound waves in ducts, standing waves and travelling waves, resonances, complex notation, harmonic solutions, concept of impedance. Kirchoff-Helmholtz Integral Equation, spherical coordinates, spherical harmonics, Green function (Dirichlet and Neumann), Sommerfeld radiation condition, sound radiation from simple sources, piston in a baffle, pulsating sphere, piston in a sphere, vibrating free disc, scattering from a rigid sphere. Near field and far field, directivity of sources, wave guides (phase speed and group speed), lumped parameter modeling of acoustic systems, sound in enclosures (rectangular box and cylinders), Laplace Transforms and PDEs, 1-D Green Function, octave bands, sound power, decibels. Brief introduction to diffraction, scattering, reflection, refraction.

Venkata R Sonti

Kinsler, L.E., Frey, A.R., Coppens, A.B., and Sanders,,J.V., Fundamentals of Acoustics,,John W iley, 1982. Williams, E., Fourier Acoustics

ME 251 (JAN) 3:0

Biomechanics

Bone and cartilage, joint contact analysis, structure and composition of biological tissues. Continuum mechanics, constitutive equations, nonlinear elasticity, rubber elasticity, arterial mechanics. Introduction to cell mechanics.

Namrata Gundiah

Humphrey, J.D., Cardiovascular Solid Mechanics,Springer-Verlag, 2002. Fung, Y.C., Biomechanics,,Springer-Verlag, 1990. Holzapfel, G. A., Nonlinear Solid Mechanics, W iley, 2000.

ME 253 (JAN) 3:0

Vibrations of Plates and Shells

Shell coordinates, infinitesimal distances in curved shells, equations of motion for general shell structures using Hamilton's principle, specialization to commonly occurring geometries, detailed study of flat plates, rings, cylindrical shells and spherical shells, natural frequencies and modes, Rayleigh-Ritz and Galerkin methods, response to various types of loads (point forces, moments, moving loads), transient and harmonic loads, combination of structures using receptance.

Venkata R Sonti

Pre-requisite: a full course in lumped system vibrations,Werner Soedel ,Vibrations of plates and shells,S.S. Rao Vibrations of continuous systems

ME 256 (JAN) 3:0

Variational Methods and Structural Optimization

Calculus of variations: functionals, normed vector spaces, Gateaux variation, Frechet differential, necessary conditions for an extremum, Euler-Lagrange multiplier theorem, second variations and sufficient conditions. Weak form of differential equations, application of Euler- Lagrange equations for the analytical solution of size optimization problems of bars and beams, topology optimization of trusses and beams applied to stiff structures and compliant mechanisms. Material interpolation methods in design parameterization for topology optimization, optimization formulations for structures and compliant mechanisms involving multiple energy domains and performance criteria. Essential background for Karush-Kuhn- Tucker conditions for multi-variable optimization, numerical optimization algorithms and computer programs for practical implementation of size, shape and topology optimization problems.

Ananthasuresh G K

Smith, D.R., Variational Methods in Optimization, Dover Publication, 1998. Haftka, R.T., and Gurdal, Z.,,Elements of Structural Optimization, Kluwer Academic Publishers, 1992.,Bendsoe, M.P., and Sigmund, O., Topology Optimization: Theory, Methods and Applications, Springer, 2003.

ME 257 (JAN) 3:0

Finite Element Methods

Linear finite elements procedures in solid mechanics, convergence, isoparametric mapping and numerical integration. Application of finite element method to Poisson equation, calculus of variations, weighted residual methods, introduction of constraint equations by Lagrange multipliers and penalty method, solution of linear algebraic equations, finite element programming.

Narasimhan R

Cook, R.D., Malkus, D.S., and Plesha, M.E., Concepts and Applications of Finite Element Analysis,,Third Edn, John Wiley, 1989.,Bathe, K.J., Finite Element Procedures, Prentice Hall of India, 1982.

ME 272 (JAN) 3:0

Thermal Management of Electronics

Structures of heat in electronic systems, review of heat transfer mechanisms with reference to electronic systems: foot prints, spreading resistance, design of fins, convection and radiation from electronic modules, jet impingement cooling, active cooling systems – adsorption, thermoelectric, phase change: current state of the art and future projections of thermal needs in electronics.

Pradip Dutta

Thermal Management of Electronic Systems, Vol. 1-4, ASME Press. Krauss, A.D., and Cohen, A.B.,,A.B., Thermal Management of Electronics, Hemisphere. ASME Trans. Journal of Electronic,Packaging IEEE Trans. on Components and Packaging Technologies.

ME 273 (JAN) 3:0

Solid and Fluid Phenomena at Small Scales

Intermolecular forces, surfaces, defects. Size- dependent strength, micro - mechanics of interfaces and thin films. Solvation forces, double layer forces, effect of physico-chemical forces on fluid flow at micron-scales. Slip boundary condition, friction and nano tribology. Nanoindentation, atomic force microscopy, micro-PIV and other characterizing techniques. MEMS, micro fluidics, microscopic heat pipes and other applications.

Raghuraman N Govardhan,Bobji M S

Israelachvili, J.N., Intermolecular and Surface Forces, Elsevier Publishing Company, 2003. Meyer, E.,,Overney, R.M., Dransfeld, K., et al., Nanoscience Firction and Rheology on the nanometer scale, 1998.,Karniadakis, G.E., and Beskok, A., Micro Flows, Springer Verlag, 2001.

ME 274 (JAN) 3:0

Convective Heat Transfer

Energy equation, laminar external convection, similarity solution, integral method, laminar internal convection, concept of full development heat transfer in developing flow, turbulent forced convection, free convection from vertical surface, Rayleigh-Benard convection.

Saptarshi Basu,Pradip Dutta,Pramod Kumar

Pre-requisite: ME 201 and ME 271 Kays, W.M., and Crawford,,M.E., Convective Heat and Mass Transfer, Tata-McGraw Hill. Bejan, A.,,Convective Heat Transfer, John W iley.

ME 282 (JAN) 3:0

Computational Heat Transfer and Fluid Flow

Mathematical description of fluid flow and heat transfer, conservation equations for mass, momentum, energy and chemical species, classification of partial differential equations, coordinate systems. Discretization techniques using finite difference methods: Taylor series and control volume formulations. Irregular geometries and body-fitted coordinate system. Applications to practical problems.

Pradip Dutta,Ravikrishna, R. V.,Ratnesh K Shukla,G

Pre-requisite: ME 201, ME 271 Patankar, S.V., Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, 1980,Anderson, D.A., Tannehill J.C., and Pletcher, R.H., Computational Fluid Mechanics and Heat Transfer, Hemisphere Publishing Corporation, 1984.,Versteeg, H.K., and Malalasekara, W., An Introduction to Computational Fluid Dynamics, Longman, 1995.

ME 284 (JAN) 3:0

Applied Combustion

Thermodynamics and Thermochemistry, Chemical equilibrium, adiabatic flame temperature, Chemical kinetics, Constant pressure and constant volume fixed-mass reactors, well-stirred reactor, Plug-flow reactor, Conservation Equations, Laminar Premixed and Diffusion Flames, Droplet Combustion, Introduction to Turbulent Combustion, Combustion in Gasoline and Diesel Engines, Combustion Chamber Design, Pollutant Formation, Exhaust after-treatment, Advanced Engine Concepts, Gas Turbine Combustors – design requirements, stability and emissions.

Ravikrishna, R. V.

An Introduction to Combustion, Stephen R. Turns, McGraw Hill, 2011. Combustion Engineering,,Kenneth W. Ragland and Kenneth M. Bryden, Taylor & Francis, 2011. Heywood, J.B., Internal,Combustion Engine Fundamentals, McGraw Hill Intl Edn, 1988.

ME 287 (JAN) 3:0

Refrigeration Engineering

Methods of refrigeration, vapour compression refrigeration-standard and actual vapour compression cycles, multipressure systems, compressors, condensers, expansion devices, evaporators, refrigerants and refrigeration controls, component matching and system integration, vapour absorption refrigeration thermodynamics, single stage, dual stage and dual effect systems. Selection of working fluids, design of generators and absorbers, non- conventional refrigeration systems, vapour jet refrigeration.

Narasimham G S V L

Stoecker, W.F., and Jones, J.W., Refrigeration and Air conditioning, Second Edn, Tata McGraw Hill, 1982.,Therlkeld, J.L., Therm al Environm ent al Engineering, Prentice Hall, Inc., Englewood Cliffs, New Jersey, 1970.,ASHRAE Handbooks (SI Editions): Fundam entals (2009), Refrigeration (2010).

ME 288 (JAN) 3:0

Air Conditioning Engineering

Properties of air-water mixtures, psychometric chart, air conditioning processes, enthalpy potential, cooling and dehumidifying coils, cooling towers, heat transfer in buildings, comfort air conditioning, cooling load calculations, air conditioning system, design of air delivery systems, clean rooms and laminar flow equipment, air conditioning controls, noise and vibration control in air-conditioned rooms.

Narasimham G S V L

Jones, W.P., Air Conditioning Engineering, Fifth Edn, Butterworth Heinemann, Oxford, 2001. Croom e, D.J. and Roberts, B.M., Airconditioning and Ventilation of Buildings, Second Edn, Pergamon Press, Oxford, 1981.,Haines, R.W., and Hittle, D.C., Control Syst ems for Heating, Ventilating, and Air Conditioning, Sixth Edn, Springer Science plus Business Media, Inc., NY, 2003,ASHRAE Handbooks (SI Editions): HVAC Applications (2007), Systems and Equipment (2008), Fundamentals (2009).

ME 295 (JAN) 3:0

Geometric Modelling for Computer Aided Design

Representation of curves and surfaces-parametric form, Bezier, B. Spline and NURBS, intersection of curves and surfaces, interpolation, topology of surfaces, classification, characterization, elements of graph theory, representation of solids: graph based models and point set models, Euler operators, boundary evaluation, computation of global properties of solids.

Dibakar Sen,Gurumoorthy B

Piegl, L., and Tiller, W., The NURBS Book, Springer-Verlag, 1995. Mantyla, M., An Introduction to Solid Modeling, Computer Science Press, 1988.,Carter, J.S., How Surfaces Intersect in Space – An Introduction to Topology, World Scientific, 1993.,Fom enko, A.T., and Kunii, T.L., Topological Modeling for Visualization, Springer - Verlag, 1997.

ME 298 (JAN) 3:0

Fluid Turbulence

Stability of fluid flows, transition to turbulence-introduction to turbulence, Reynolds averaged equations, statistical description of turbulence, vorticity dynamics, similarity methods, turbulent shear flows, Rayleigh Benard convention, modeling and numerical methods.

Jaywant H Arakeri

Pre-requisite: Consent of Instructor Tennekes H and Lumley J L,,A First Course in Turbulence, MIT 1972,Pope S.B., Turbulent Flows, Cambridge, 2000

ME 299 (JAN) 0:27

Dissertation Project

The M. E. Project is aimed at training students to analyse independently any problem posed to them. The project may be a purely analytical piece of work, a completely experimental one, or a combination of both. In a few cases, the project may also involve sophisticated design work. The project report is expected to show clarity of thought and expression critical appreciation of the existing literature and analytical and/or experimental or design skill.

Faculty ME

Faculty,Faculty,Faculty

Material Engineering

M. Tech. PROGRAMME MATERIALS ENGINEERING
(Duration : 2 Years, 64 credits)

Hard core (8 credits)

MT 202	3:0	Thermodynamics and Kinetics
MT 241	3:0	Structure and Characterisation of Materials
MT 243	0:2	Laboratory Experiments in Metallurgy

Soft core (9 credits): Any three out of the following eight courses

MT 203	3:0	Materials Design and Selection
MT 209	3:0	Defects in Materials
MT 220	3:0	Microstructural Design and Development of Engineering Materials
MT 231	3:0	Interfacial Phenomena in Materials Processing
MT 245	3:0	Transport Processes in Process Metallurgy
MT 252	3:0	Science of Materials Processing
MT 253	3:0	Mechanical Behaviour of Materials
MT 260	3:0	Polymer Science and Engineering – I

Project (32 credits)

MT 299 0:32 Dissertation Project
Electives (15 credits): At least 9 credits must be taken from the courses offered by the Department.

MT 202 (AUG) 3:0

Thermodynamics and Kinetics

Classical and statistical thermodynamics, Interstitial and substitutional solid solutions, solution models, phase diagrams, stability criteria, critical phenomena, disorder-to-order transformations and ordered alloys, ternary alloys and phase diagrams, Thermodynamics of point defects, surfaces and interfaces. Diffusion, fluid flow and heat transfer.

Abinandanan T A

C.H.P. Lupis: Chemical Thermodynamics of Materials, Elsevier Science, 1982.,P. Shewmon: Diffusion in Solids, 2nd Edition, Wiley, 1989.,A.W. Adamson and A.P. Gast: Physical Chemistry of Surfaces (Sixth Edition), John Wiley, 1997.

MT 206 (AUG) 3:0

Texture and Grain Boundary Engineering

Concepts of texture in materials, their representation by pole figure and orientation distribution functions. Texture measurement by different techniques. Origin and development of texture during material processing stages: solidification, deformation, annealing, phase transformation, coating processes, and thin film deposition. Influence of texture on mechanical and physical properties. Texture control in aluminium industry, automotive grade and electrical steels, magnetic and electronic materials. Introduction to grain boundary engineering and its applications.

S. Suwas

M. Hatherly and W. B. Hutchinson, An Introduction to Texture in Metals (Monograph No. 5), The Institute of Metals, London
V. Randle, and O. Engler, Introduction to Texture Analysis: Macrotexture, Microtexture and Orientation mapping, Gordon and Breach Science Publishers
F. J. Humphreys and M. Hatherly, Recrystallization and Related Phenomenon, Pergamon Press
P. E. J. Flewitt, R. K. Wild, Grain Boundaries

MT 208 (AUG) 3:0

Diffusion in Solids

Thermodynamics related to phase diagrams and driving force for diffusion, Points defects, Fick's laws of diffusion, atomic mechanism of diffusion, different types of diffusion coefficients and estimation methods, Kirkendall effect, Stable, unstable and multiple Kirkendall planes. Role of the Kirkendall effect on microstructural evolution, diffusion couple technique as a tool for materials design, Diffusion controlled growth mechanism of phases in various material systems used in electronic packaging, intermetallic superconductors, bond coats in jet engine applications, silicides, high entropy alloys etc.

Aloke Paul

Aloke Paul and Sergiy Divinski (Editors), Handbook of Solid State,Diffusion, Volume 1: Diffusion Fundamentals and Techniques, Volume 2:,Diffusion Analysis in Material Applications, Elsevier, 2017.,Aloke Paul, Tomi Laurila, Vesa Vuorinen, Sergiy Divinski, Thermodynamics,,Diffusion and the Kirkendall effect in Solids, Springer, 2014

MT 209 (AUG) 3:0

Defects in Materials

Review of defect classification and concept of defect equilibrium. Review of point defects in metallic, ionic and covalent crystals. Dislocation theory - continuum and atomistic. Dislocations in different lattices. Role of anisotropy. Dislocation kinetics. Interface thermodynamics and structure. Overview of grain boundaries, interphase boundaries, stacking faults and special boundaries. Interface kinetics: migration and sliding. Defect interactions: point defect-dislocation interaction, dislocation-interface interactions, segregation, etc.. Overview of methods for studying defects including computational techniques

S Karthikeyan

W.D. Kingery, H.K. Bowen and D.R. Uhlmann: Introduction to Ceramics, 2nd ed., John Wiley and Sons, 1976
D. Hull and D. J. Bacon: Introduction to dislocations, 4th ed., Butterworth-Heinemann, 2001.
D.A. Porter and K.E. Easterling: Phase Transformation in Metals and Alloys, 2nd ed. Chapman and Hall, 1992.
R.W. Balluffi, S.M. Allen, W.C. Carter: Kinetics of Materials, 1st ed. Wiley-Interscience, 2005.
J.P. Hirth and J.L. Lothe: Theory of Dislocations, 2nd ed., Krieger, 1982.
A. P. Sutton and R. W. Balluffi: Interfaces in Crystalline Materials, 1st ed., Oxford Univ. Press, 1995.

MT 218 (AUG) 3:0

Modeling and Simulation in Materials Engineering

Importance of modeling and simulation in Materials Engineering. nd numerical approaches. Numerical solution of ODEs and PDEs, explicit and implicit methods, Concept of diffusion, phase field technique, modelling of diffusive coupled phase transformations, spinodal decomposition. Level Set methods, Celula Automata,: simple models for simulating microstructure,. Finite element modelling,: Examples in 1D, variational approach, interpolation functions for simple geometries, (rectangular and triangular elements); Atomistic modelling techniques,: Molecular and Monte-Carlo Methods.

A N Choudhury

A.B. Shiflet and G.W. Shiflet: Introduction to Computational Science: Modeling and Simulation for the Sciences, Princeton University Press, 2006.

D.C. Rapaport: The Art of Molecular Dynamics Simulation, Cambridge Univ. Press, 1995.
K. Binder, D. W. Heermann: Monte Carlo Simulation in Statistical Physics, Springer, 1997.
K.G.F Janssens, D. Raabe, E. Kozeschnik, M.A. Miodownik, B. Nestler: Computational Materials Engineering: An Introduction to Microstructure Evolution, Elsevier Academic press, 2007.

MT 235 (AUG) 3:0

Corrosion Technology

Basic electrochemical principles governing corrosion. Types and mechanisms of corrosion. Advances in corrosion engineering and control. Anodic and Cathodic control-Biocorrosion, mechanisms and microbiological aspects. Corrosion under sub-soil and sea water conditions-Marine biofouling and biocorrosion with respect to industrial conditions. Methods of abatement.

K A Natarajan

M.G. Fontana: Corrosion Engineering, 3rd Edition, McGraw-Hill, N.Y., 1978.
Borenstein: Microbiologically Influenced Corrosion Handbook.

MT 241 (AUG) 3:0

Structure and Characterization of Materials

Bonding and crystal structures, Stereographic projection, Point and space groups, Defects in crystals, Schottky and Frenkel defects, Charged defects, Vacancies and interstitials in non stoichiometric crystals, Basics of diffraction theory, X-ray powder diffraction and its applications, Electron diffraction and Electron microscopy.

R Ranjan

A. R. West: Solid State Chemistry and its Applications, John Wiley
B. D. Cullity: Elements of x-ray Diffraction.
A. Kelly and G. W. Groves: Crystallography and Crystal Defects, Longman
M. D. Graef and M. E. Henry: Structures of Materials, Cambridge

MT 245 (AUG) 3:0

Transport Processes in Process Metallurgy

Basic and advanced idea of fluid flow, heat and mass transfer. Integral mass, momentum and energy balances. The equations of continuity and motion and its solutions. Concepts of laminar and turbulent flows. Concept of packed and fluidized bed. Non-wetting flow, Natural and forced convection. Unit processes in process metallurgy. Application of the above principles in process metallurgy.

Govind S Gupta

J. Szekely and N.J. Themelis, Rate Phenomena in Process Metallurgy, Wiley, New York, 1971,G.H. Geiger and D R Poirier: Transport Phenomena in Metallurgy, Addison-Wesley, 1980.,D.R. Gaskell: Introduction to Transport Phenomena in Materials Processing, 1991.,R.B. Bird, W.E. Stewart and E.N. Lightfoot: Transport Phenomena, John Wiley International Edition, 1960,F.M. White: Fluid Mechanics, McGraw Hill, 1994 Various research papers

MT 250 (AUG) 3:0

Introduction to Materials Science and Engineering

Compulsory for M.E. students who do not have BE Metallurgy; Compulsory for research students withoutmaterialsbackground

Bonding, types of materials, basics of crystal structures and crystallography. Thermodynamics, thermochemistry, unary systems. Methods of structural characterisation. Thermodynamics of solid solutions, phase diagrams, defects, diffusion. Solidification. Solid-solid phase Transformations. Mechanical behaviour: elasticity, plasticity, fracture. Electrochemistry and corrosion. Band structure, electrical, magnetic and optical materials. Classes of practical material systems: metallic alloys, ceramics, semiconductors, composites

S. Kumar

W.D. Callister: Materials Science & Engineering, Wiley (India) 2007

MT 253 (AUG) 3:0

Mechanical Behaviour of Materials

Theory of Elasticity. Theory of Plasticity Review of elementary dislocation theory. Deformation of single and polycrystals. Temperature and strain rate effects in plastic flow - strain hardening, grain size strengthening, solid solution strengthening, order hardening, precipitation hardening, dispersion strengthening. Strengthening by martensitic transformation, creep, fatigue and fracture.

Ramamurty U

Ramamurty U,Thomas H. Courtney, Mechanical Behaviour of Materials.,G.E. Dieter: Mechanical Metallurgy, McGraw-Hill, London (1988).

MT 260 (AUG) 3:0

Polymer Science and Engineering

Fundamentals of polymer science. Polymer nomenclature and classification. Current theories for describing molecular weight, molecular weight distributions. Synthesis of monomers and polymers. Mechanisms of polymerization reactions. Introduction to polymer processing (thermoplastic and thermoset). Structure, property relationships of polymers: crystalline and amorphous states, the degree of crystallinity, cross-linking, and branching. Stereochemistry of polymers. Instrumental methods for the elucidation of polymer structure and properties; basic principles and unique problems encountered when techniques such as thermal (DSC, TGA, DMA, TMA, TOA), electrical, and spectroscopic (IR, Raman, NMR, ESCA, SIMS) analysis GPC, GC-MS, applied to polymeric materials. Polymer Processing - Injection Molding, Extrusion, Compression Molding, Blow Molding, Casting and Spin Coat, Calendaring.

P C Ramamurthy and M Giridhar

G. Odian: Principles of Polymerization. McGraw Hill. 2nd Edition.. 1981.
N.A. Dotson. R. Galvan. R.L. Laurence and M. Tirrell: Polymerization Process Modeling. Wiley. 1995.
F.W. Billmeyer: Textbook of Polymer Science, Wiley. 1984.

MT 299 (AUG) 3:0

Dissertation Project

The M.E. Project is aimed at training the students to analyse independently any problem posed to them. The project may be a purely analytical piece of work. a completely experimental one or a combination of both. In a few cases. the project can also involve a sophisticated design work. The project report is expected to show clarity of thought and expression. critical appreciation of the existing literature and analytical and/or experimental or design skill.

FACULTY

MT 201 (JAN) 3:0

Phase Transformations

Overview of phase transformations, nucleation and growth theories, coarsening, precipitation, spinodal decomposition, eutectoid, massive, disorder-to-order, martensitic transformations. crystal interfaces and microstructure. topics in the theory of phase transformations: linear stability analysis, elastic stress effects, sharp interface and diffuse interface models of microstructural evolution.

Chandan Srivastava

Prerequisites: Basic courses on crystallography, thermodynamics, phase diagrams and diffusion.,D.A. Porter. and K.E. Easterling: Phase Transformations in Metal and Alloys, Van Nostrand, 1981.,A.K. Jena, and M. Chaturvedi: Phase Transformations in Materials, Prentice-Hall, 1993.,A.G. Khachaturyan: Theory of Structural Transformation in Solids, John Wiley, 1983.,R.E. Reed-Hill and R. Abbaschian: Physical Metallurgy Principles, P.W.S-Kent, 1992.

MT 213 (JAN) 3:0

Electronic Properties of Materials

Introduction to electronic properties; Drude model, its success and failure; energy bands in crystals; density of states; electrical conduction in metals; semiconductors; semiconductor devices; p-n junctions, LEDs, transistors; electrical properties of polymers, ceramics, metal oxides, amorphous semiconductors; dielectric and ferroelectrics; polarization theories; optical, magnetic and thermal properties of materials; application of electronic materials: microelectronics, optoelectronics and magnetoelectrics.

Subho Dasgupta

R. E. Hummel, Electronic Properties of Materials,S. O. Kasap, Principles of Electronic Materials and Devices,S. M. Sze, Semiconductor devices: Physics and Technology,D. Jiles, Introduction to the electronic properties of materials

MT 225 (JAN) 3:0

Deformation and Failure Mechanisms at Elevated Temperatures

Phenomenology of Creep, Microstructural considerations in metals, alloys, ceramics and composites. Creep mechanisms, Deformation mechanism maps, Superpasticity in metal alloys, ceramics and nanophase materials, Commercial applications and considerations, Cavitation failure at elevated temperatures by nucleation, growth and interlinkage of cavities.

The course will also include some laboratory demonstrations of the phenomena discussed in the class together with an appropriate analysis of the data.

Atul H Chokshi

Atul H Chokshi,J. P. Polreer, Creep of Crystals, Cambridge University Press, Cambridge, 1984,H. Riedel, .Fracture at High Temperatures, Springer Verlag, Berlin, 1987

MT 231 (JAN) 3:0

Interfacial Phenomena in Materials Processing

Materials and surfaces, Adsorption from solution, Thermodynamics of adsorption - surface excess

and surface free energy, Gibbs equation, adsorption isotherms, wetting, contact angle, Young's equation, Monolayer and interfacial reactions, Electrical phenomena at interfaces, electrochemistry of the double layer, electrokinetics, flocculation, coagulation and dispersion, Polymers at interfaces, Emulsions. Applications in Materials Processing.

Subramanian S

E. Matrijivic (Ed.): Surface and Colloid Science, Plenum, New York, 1982.,A.W. Adamson: Physical Chemistry of Surfaces, Wiley Interscience, New York, 1996.,J.S. Laskowski and J. Ralston (Ed.): Colloid Chemistry in Mineral Processing, Elsevier, New York, 1992.

MT 243 (JAN) 0:2

Laboratory Experiments in Materials Engineering

Experiments in Metallographic techniques, heat treatment, diffraction mineral beneficiation, chemical and process metallurgy, and mechanical metallurgy.

Faculty,Faculty,Faculty

MT 248 (JAN) 3:0

Modelling and Computational Methods in Metallurgy

Basic principles of physical and mathematical modelling. Similarity criteria and dimensional analysis. Detailed study of modelling of various metallurgical processes such as blast furnace, induction furnace, ladle steelmaking, rolling, carburizing and drying. Finite difference method. Solution of differential equations using various numerical techniques. Convergence and stability criteria. Assignments will be based on developing computer code to solve the given problem. Prerequisite: Knowledge of transport phenomena, program language

Govind S Gupta

Govind S Gupta,J.Szekely and N. J. Themelis: Rate Phenomena in Process Metallurgy, Wiley, New York, 1971,B. Carnahan, H. A. Luther, and J. O. Wikes: Applied Numerical Methods, John Wiley, NY 1969.

MT 255 (JAN) 3:0

Solidification Processing

Advantage of solidification route to manufacturing, the basics of solidification including fluid dynamics, solidification dynamics and the influence of mould in the process of casting. Origin of shrinkage, linear contraction and casting defects in the design and manufacturing of casting, continuous casting, Semi-solid processing including pressure casting, stir casting and thixo casting. Welding as a special form of manufacturing process involving solidification. Modern techniques of welding, the classification of different weld zones, their origin and the influence on properties and weld design. Physical and computer modeling of solidification processes and development of expert systems. New developments and their possible impact on the manufacturing technology in the future with particular reference to the processes adaptable to the flexible manufacturing system.

Abhik N Choudhury

Abhik N Choudhury,J. Campbell: Casting, Butterworth - Haneman, London, 1993,M.C. Flemings: Solidification Processing , McGraw Hill, 1974.

MT 256 (JAN) 3:0

Fracture

Review of elastic and plastic deformation. Historical development of fracture mechanics. Thermodynamics of fracture including Griffith theory. Linear elastic fracture mechanics. Irwin and Dugdale extensions. Stability of cracks. Crack resistance curves and toughening of brittle materials. Ductile failure. J-integral. Indentation failure. Environmental aspects of failure. Cyclic Fatigue. Methods to measure toughness. Fracture in thin films and interfaces. Toughening in hierarchical structures

Vikram Jayaram

B.R. Lawn: Fracture of Brittle Solids. Cambridge University Press (1993).,T.H. Courtney: Mechanical Behaviour of Materials. McGraw Hill (1990).,David Broek: Engineering Fracture Mechanics. . Sijthoff and Nordhoff , The Netherlands (1978).,Richard Hertzberg: Deformation & Fracture of Engineering Materials. John Wiley (1996).

MT 257 (JAN) 3:0

Finite Element Method for Materials Engineers

This course has been specially designed for those students, who did not get a chance to study FEM during undergrad, but want to use FEM as a tool to gain some insight into their project/research problems. The syllabus includes the following: Quick recap of relevant mathematical concepts. Introduction to fundamentals of elasticity and plasticity. Crystal plasticity. Philosophy of FEM. Fundamentals of FEM, such as concepts of meshing, stiffness matrix, interpolation functions. Residual methods, Rayleigh - Ritz method, Galerkin method. 1-D, 2-D and 3-D example problems in elasticity and heat transfer. Solving linear and non-linear structural, thermal and electrical problems using a commercial FEM software (mostly, ANSYS). Finite element crystal plasticity.

Praveen Kumar

Praveen Kumar,Cook, R. D., et al, Concept and Applications of Finite Element Analysis, John Wiley & Sons, 2002 (IV Edn).1.O.C. Zienkiewicz,,Reddy J. N. An Introduction to Finite Element Method, Tata McGraw-Hill, 3rd Edn., 2005.

MT 261 (JAN) 3:0

Organic Electronics

(Prerequisites: Polymer Science and Engineering and Semiconductor fundamentals)

Fundamentals of polymers. Device and materials physics. Polymer electronics materials, processing, and applications. Chemistry of device fabrication, materials characterization. Electroactive polymers. Device
physics: Crystal structure, Energy band diagram, Charge carriers, Heterojunctions, Diode characteristics. Device fabrication techniques: Solution, Evaporation, electrospinning. Devices: Organic photovoltaic device, Organic light emitting device, Polymer based sensors.Stability of organic devices.

Praveen C Ramamurthy

T. A. Skotheim and J. R. Reynolds (Editors): Handbook of Conducting Polymers (Third Edition) Conjugated Polymers: Theory, Synthesis, Properties and Characterization, CRC Press.,T.A. Skotheim and J. R. Reynolds (Editors): Handbook of Conducting Polymers (Third Edition) Conjugated Polymers: Processing and Applications Edited by Terje A. Skotheim and John R. Reynolds, CRC Press.,S-S. Sun and N. S. Sariciftci (Editors): Organic Photovoltaics - Mechanisms, Materials, and Devices, CRC Press.,D.A. Neamen: Semiconductor Physics and Devices Basic Principles, McGraw Hill.

MT 262 (JAN) 3:0

Concepts in Polymer Blends and Nanocomposites

Introduction to polymer blends and composites, nanostructured materials and nanocomposites, Polymer-polymer miscibility, factors governing miscibility, immiscible systems and phase separation, Importance of interface on the property development, compatibilizers and compatibilization, Blends of amorphous & semi-crystalline polymers, rubber toughened polymers, particulate, fiber reinforced composites. Nanostructured materials like nano clay, carbon nanotubes, graphene etc. and polymer nanocomposites. Surface treatment of the reinforcing materials and interface/interphase structures of composites / nanocomposites. Various processing techniques like solution mixing, melt processing. Unique properties of blends, composites/nanocomposites in rheological, mechanical, and physical properties and applications

Suryasarathi Bose

D.R. Paul and S. Newman: Polymer Blends, Vol 1&2 , Academic Press, 2000,L.A. Utracki: Polymer Alloys and Blends, Hanser, 2000,C. Chung: Introduction to Composites, Technomic, Lancaster, PA. 1998.,J. Summerscales and D. Short: Fiber Reinforced Polymers, Technomic. 1988,T.J. Pinnavia and G.W. Beall (Editors): Polymer-Clay Nanocomposites, Wiley, New York 2000. P.M. Ajayan, L.S. Schadler and P.V. Braun: Nanocomposite Science &Technology, Wiley-VCH, Weinheim, 2003.

MT 271 (JAN) 3:0

Introduction to Biomaterials Science and Engineering

This course will introduce basic concepts of biomaterials research and development including discussion on different types of materials used for biomedical applications and their relevant properties. Contents: Surface engineering for biocompatibility; Protein adsorption to materials surfaces; Blood compatibility of materials; Immune response to materials; Corrosion and wear of implanted medical devices; Scaffolds for tissue engineering and regenerative medicine; Concepts in drug delivery; Regulatory issues and ethics.

Kaushik Chatterjee

Kaushik Chatterjee,Ratner et al: Biomaterials science: An introduction to materials in medicine, 2nd edition, Elsevier Academic Press Current Research Literature,Ratner et al: Biomaterials science: An introduction to materials in medicine, 2nd edition, Elsevier Academic Press Current Research Literature

MT 299 (JAN) 0:32

Dissertation Project

The M.E. Project is aimed at training the students to analyse independently any problem posed to them. The project may be a purely analytical piece of work. a completely experimental one or a combination of both. In a few cases. the project can also involve a sophisticated design work. The project report is expected to show clarity of thought and expression. critical appreciation of the existing literature and analytical and/or experimental or design skill.

Faculty,Faculty,Faculty

Centre for Product Design and Manufacturing

M Des Programme
Product Design and Engineering
Duration: 2 years

Core Courses: 36 credits from the following pool

PD 201 2:1	Elements of Design
PD-202 2:1	Elements of Solid and Fluid Mechanics
PD 203 2:1	Creative Engineering Design
PD 205 2:1	Materials, Manufacturing and Design
PD 207 1:2	Product Visualization, Communication and Presentation
PD 209 3:0	Product Planning and Marketing
PD 211 2:1	Product Design
PD 212 2:1	Computer Aided Design
PD 216 2:1	Design of Automotive Systems
PD 218 2:1	Design Management
PD 219 0:3	Mini Design Project
PD 229 0:3	Computer Aided Product Design
PD 231 2:1	Applied Ergonomics
PD 235 2:1	Mechanism Design
PD 239 0:3	Design and Society

Project: 16 Credits

PD 299 0:16 Dissertation Project

Electives: The balance of credits to make up a minimum of 64 credits required to complete the programme may be chosen as electives from within or outside the department, with the approval of the DCC/ Faculty Advisor.

PD 201 (AUG) 2:1

Elements of Design

Visual language, visual elements, visual perception, visual deception. Universal principles of design. Theory of colour, studies in form, graphic compositions, grid structure, spatial analysis and organization. Visual expressions in nature.

Shivakumar N D

Young, F.M., Visual Studies, Prentice-Hall, USA.,Lidwell, W., Holden, K., and Butler, J., Universal Principles of Design, Rockport, USA.,Evans, P., and Thomas, M., Exploring the Elements of Design, Thomson, USA.

PD 202 (AUG) 2:1

Elements of Solid and Fluid Mechanics

Analysis of stress and strain, failure criteria, dynamics and vibrations. Control of engineering systems, elements of fluid mechanics drag and losses, thermal analysis, problems in structural and thermal design.

Gurumoorthy B,Jaywant H Arakeri

Shigley, J.E., Mechanical Engineering Design, McGraw Hill.,White, F.M., Fluid Mechanics, Tata McGraw Hill.,Gupta, V., Elements and Heat and Mass Transfer, Sage Publishers.

PD 203 (AUG) 2:1

Creative Engineering Design

Design: definitions, history and modern practice. Design and society, design and the product life cycle. Methodology for problem solving in engineering design: recognition, definition, analysis, synthesis, communication and presentation. Hands-on projects.

Amaresh Chakrabarti

Jones, J.C., Design Methods, John Wiley, 1981.,Cross, N., Engineering Design Methods, John Wiley, 1994.,Pahl, G., and Beitz, W., Engineering Design, Design Council, 1984.,Brezet and van Hammel, ECODESIGN – A promising approach to sustainable production and consumption, UNEP Manual

PD 205 (AUG) 2:1

Materials, Manufacturing and Design

Material usage and sustainability issues, concept or closed and open loop. Engineering materials, metals and their properties, uses, processing methods, design data and applications, material selection criteria, manufacturing and processing of materials. Plastics and composites, types, classification, properties, processing techniques and limitations, basics of reliability, failure and failure analysis.

Satish V Kailas

Dieter, G.E., Engineering Design – A Materials and processing approach, McGraw Hill, 1991.,Ashby, M.F., Materials selection in Mechanical Design, Pergamon press, 1992.,Patton, W.J., Plastics Technology, Theory, Design and Manufacture, Lenton Publishing Co.

PD 207 (AUG) 1:2

Product Visualization, Communication and Presentation

Object drawing fundamentals, theory of perspectives, exploded views, sectional views. Fundamentals of lighting, idea representation and communication methods and pitfalls. Materials, tools and techniques of representation in various media like pencil, ink, colour etc. Rendering techniques, air brush illustration. Idea documentation. Fundamentals of photography, video-graphy and digital media. Dark room techniques. Studio assignments in all the above topics. Mock-up modeling and simulation in various materials

Shivakumar N D

Geometry of design: Studies in proportion and composition, ISBN : 1568982496,Foundation of Art & Design 1856693759,Earle, J.E., Engineering Design Graphics, Addison Wesley, ISBN 020111318x

PD 209 (AUG) 3:0

Product Planning and Marketing

Corporate strategy for product planning, Introduction to marketing, new strategies, market identification, segmentation and entry, strategies. Consumer response measurement, perceptual mapping, brand equity, strategic product positioning. Estimation of sales potential, product launching and product life cycle, advertising basics, services and processes. Fundamentals of consumer behaviour.

Parameshwar P Iyer

Philip Kotler, Marketing Management,Merle Crawford, C., New Product management,Luck, David J., and Rubin, Ronald S., Marketing Research,Schiffman and Kanuk, Consumer Behaviour

PD 217 (AUG) 2:1

CAE in Product Design

Product development driven by concurrent engineering, role of Computer-Aided Engineering (CAE) in product design. Mathematical abstractions of products for functionality verification; lumped mass, finite element, boundary element, and statistical modeling procedures. Use of commercial finite element-based packages for design analysis and optimization.

Anindya Deb

Bathe, K.J., Finite Element Procedures, Prentice Hall, 1995.,Robert Cook, Finite Element Modeling for Stress Analysis, 1995.,Banerjee, P.K., Boundary Element Methods in Engineering Science, McGraw Hill.

PD 219 (AUG) 0:3

Mini Design Project

A project involving either the redesign of an existing product or conceptualization of a new product, considering functional, materials and manufacturing, ergonomic, aesthetic and marketing aspects. Product detailing using CAD/CAID tools. Presentation to mockup level with complete documentation for purposes of fabrication.

Faculty PD

1,2,3

PD 231 (AUG) 2:1

Applied Ergonomics

Introduction to ergonomics. Elements of anthropometry, physiology, anatomy, biomechanics and CTDs. Workspace, seating, hand tool design, manual material handling. Man-machine system interface, human information processing, displays and controls, compatibility. Environmental factors, cognitive ergonomics, principles of graphic user interface design, human error, product safety, product liability.

Dibakar Sen

Sanders and McCormick, Human Factors in Engineering and Design,,Seventh Edn, McGraw Hill, 1992.,Eberts, R.E., User Interface Design, Prentice Hall, 1994.

PD 232 (AUG) 2:1

Human Computer Interaction

Basic theories of visual and auditory perception, cognition, rapid aiming movement and their implications in electronic user interface design, Concept of user modelling, Multimodal interaction, Eye gaze and finger movement controlled user interface, Target prediction technologies in graphical user interface, usability evaluation, User study design, Basic principles of experiment design, Conducting t-test and one-way and repeated measure ANOVA, Parametric and nonparametric statistics, Interaction design for automotive and aviation environments, HCI in India, Writing International standards through ITU and ISO.

Pradipta Biswas

Shneiderman B "Designing the User Interface - Strategies for Effective Human-Computer Interaction. " Pearson Education,Buxton B., Sketching User Experiences: Getting the Design Right and the Right Design, Morgan Kaufmann,Field A. "Discovering Statistics Using SPSS." SAGE Publications Ltd., 2009,Biswas P., Inclusive Human Machine Interaction fir India, Springer 2014

PD 233 (AUG) 2:1

Design of Biomedical Devices and Systems

Medical Device Classification, Bioethics and Privacy, Biocompatibility and Sterilization Techniques,Design of Clinical Trials, Design Control & Regulatory Requirements, Introduction to specific medical technologies: Biopotentials measurement (EMG, EOG, ECG, EEG), Medical Diagnostics (In-vitro diagnostics), Medical diagnostics (Imaging), Minimally Invasive Devices, Surgical Tools and Implants, Medical Records and Telemedicine. The course will include guest lectures by healthcare professionals giving exposure to ummet needs in the healthcare technologies and systems.

Manish Arora

Paul H king, Richard C. Fries, Arthur T. johnson, Design of Biomedical Devices and Systems. Third edition, ISBN 9781466569133,Peter J. Ogrodnik, Medical Device Design:Innovation from Concept to Market, Academic Press Inc; ! edition(2012), ISBN- 10:0123919428,Stefanos Zenios, Josh Makower, Paul Yock, Todd J. Brinton, uday N. Kumar, Lyn Denend, Thomas M. Krummel,,Biodesign: the PRocess of Innovating Medical Technologies, Cambridbge University press; 1 edition(2009), ISBN- 10:0521517427

PD 211 (JAN) 2:1

Product Design

Semiotic studies – product semantics, syntactics, and pragmatics. Study of expressions, metaphors, feelings, themes. Study of product evolution, problem identification, design methods, design process, design brief, concept generation, concept selection, design and development, product detailing, prototyping, design evaluation.

Shivakumar N D

Papanek, V., Design for the Real World, Thames & Hudson, London.,Ulrich, K.T., and Eppinger, S.D., Product Design and Development,Tata McGraw Hill, India

PD 212 (JAN) 2:1

Computer Aided Design

CAD – modeling of curves, surfaces and solids manipulation of CAD models, features based modeling, parametric/ variational modeling, product data exchange standards. Introduction to CAID, surfaces. Interfacing for production and tool design, photo rendering and scanning, 3D animation and morphing, studio exercise in virtual products and systems.

Gurumoorthy B

Zeid, I.,,CAD/CAM,,McGraw Hill

PD 215 (JAN) 2:1

Mechatronics

Introduction to mechatronics – overview of mechatronic products and their functioning. Survey of mechatronical components, selection and assembly for precision-engineering applications. Study of electromechanical actuators and transducers. Load analysis and actuator selection for typical cases such as computer peripherals. Study of electronic controllers and drives for mechanical products. Interfacing of mechanical and electronic systems. Design assignments and practical case studies.

Manish Arora

Bolton, W Mechatronics, Longman, 2015,Kuo, B.C., D.C.Motors and Control systems, SRL Publishing Co., 1979.,Kuo, B.C., Step Motors and Control Systems, SRL Publishing Co., 1979.

PD 216 (JAN) 2:1

Design of Automotive Systems

Classification of automotive systems, interfacing of marketing, design and manufacturing, converting customer's needs into technical targets, vehicle design process milestones with a systems engineering approach, trade-off studies, manufacturing cost and economic feasibility analysis. Design tools such as reverse engineering, rapid prototyping, CAD/CAE, Taguchi methods, and FMEA. Styling concepts and features, ergonomics, packaging and aerodynamics. Review of vehicle attributes (NVH, durability, vehicle dynamics, crash safety, etc.). Overview of automotive technology (body, power train, suspension systems, etc.).

Ulrich, K.T., and Eppinger, S.D., Product Design and Development, Second Edn, Irwin McGraw Hill,Gillespie, T.D., Fundamentals of Vehicle Dynamics, SAE Inc..,Schwaller, A.E., Motor Automotive Technology, Third Edn, Delman Publishers

PD 218 (JAN) 2:1

Design Management

Designers' perspective of the market, designers and psychological issues, perception, errors in perception, designers' sources of product features: projective techniques to acquire product feature databases. Designer in a team: human resources issues a designer must know, designer and competition, collaboration and conflict management, designer in an organization, designer as an entrepreneur, designers' knowledge on intellectual property.

Gurumoorthy B

Oakley,M. (Ed),Design Management,– A Handbook of Issues and Methods,Blackwell Publication

PD 221 (JAN) 2:1

Methodology for Design Research

Introduction to design research, a methodology for design research and its components, types of design research, selecting criteria and its research methods, understanding factors influencing design and its research methods, developing design support and its research methods, evaluating design support and its research methods, associated exercises and tests.

Amaresh Chakrabarti,Pradipta Biswas

Blessing, L.T.M., Chakrabarti, A., and Wallace, K.M., An Overview of Design Studies in Relation to a Design Research Methodology.,Frankengerger and Badke-Schaub (Eds), Designers: The Key to Successful Product Development, Springer Verlag, 1998.,Current Literature including papers from Proceedings of the International Conference in Engineering Design, Prague, 1995

PD 229 (JAN) 0:3

Computer Aided Product Design

Project in re-engineering a product using computer tools for reverse engineering geometry and intent, design evaluation, modification and prototyping.

Ashitava Ghosal,Gurumoorthy B

1,2,3

PD 235 (JAN) 2:1

Mechanism Design

Machines and mechanisms, links, pairs, degrees of freedom, kinematic chain, inversions. Kinematic analysis of simple mechanisms by graphical and analytic methods, static force analysis. Dimensional synthesis of four bar mechanism, application of coupler curves for dwell mechanisms, two and three position rigid body guidance. Cams, displacement curves and profile generation. Gears, profiles, cycloidal and involute, contact ratio. Spur, bevel, helical, worm gearing. Analysis of gear trains, mechanisms for specific functions.

Dibakar Sen

Sandor, G.N., and Erdman, A.G., Advanced Mechanism Design, Volumes I & II, Prentice Hall of India Limited, New Delhi.,Hirschhorn, J., Kinematics and Dynamics of Plane Mechanisms, McGraw-Hill, 1962,Mabie, H.E., and Ocvirk, F.W., Mechanisms and Dynamics of Machinery, John Wiley and sons, New York.,Current Literature

PD 236 (JAN) 2:1

Embodiment Design

Embodiment methodology, basic components and interfaces, design for performance including strength, usability, maintenance and reliability, Design for manufacturing, assembly, packaging, distribution, services, cost and environmental impact. Dimensioning, tolerance and standards

Amaresh Chakrabarti,Dibakar Sen,Gurumoorthy B,Sati

Pahl, G and Beitz, W, Engineering design - A systematic Approach, Springer, 2007,karl T. Ulrich and Steven D. Eppinger,Product Design and Development. McGraw -Hill 2000,Ehrelspiel. K, and Lindemann U Cost efficient Design, Springer,,2007,Whitney, DE. Mechanical Assemblies and their Role in Product Development, ISBN 13: 978-0195157826

PD 239 (JAN) 0:3

Design and Society

Independent study/research on a chosen topic by students under the supervision of faculty

members. Presentation of seminar on work done. The course also includes invited seminars on various aspects of product design and marketing issues. The focus is on real life situations from practicing professionals.

Faculty PD

1,2,3

PD 299 (JAN) 0:16

Dissertation Project

Spread over 15 months, commencing immediately after the second semester. It involves complete design and prototype fabrication with full documentation.

Faculty PD

1,2,3

Centre for Sustainable Technologies

ST 202 (AUG) 3:0

Energy Systems and Sustainability

Basics of energy resources and systems, renewable energy technologies, climate change and sustainability, climate change mitigation options and low carbon future, energy technologies, economics, policies and programmes. Case studies on renewable energy projects

Dasappa S,Balachandra P

M. M. El-Wakil, Power Plant Technology, McGraw Hill.1984,Aldo Vieira Da Rosa, Fundamentals of Renewable Energy Processes , Elsevier, 2009.,Boyle, G., Everett, B. and Ramage, J., Energy Systems and Sustainability: Power for a Sustainable Future, Oxford University,Press, Oxford, UK, 2003. Cassidy, E., and Grossman, P., Introduction to Energy Resources, Cambridge University Press, 1998,IPCC, Renewable Energy Sources and Climate Change Mitigation - Special Report of the Intergovernmental Panel on Climate Change (IPCC), Cambridge University Press, New York, 2012, http://srren.ipcc-wg3.de/report/IPCC_SRREN_Full_Report.pdf

ST 203 (AUG) 3:0

Design, Technology and Sustainability

Development and sustainability: definitions, dimensions, interpretations, concepts, principles and indicators. Current issues and debates (case studies and assignment). Design and Technology: fundamentals, morphology, integrated life-cycle perspective. Appreciating design effectiveness, it's scientific, engineering and technological context. A systems view into social, environmental and economic implications delineating sustainability (& indicators) attributed to design/technology. Developing an integrated sustainability evaluation and forecasting model, and identification of appropriate interventions (design/technology mini-project).

Monto Mani

Bell, S., and Morse, S., Sustainability Indicators: Measuring the Immeasurable? Earthscan Publications, London, 2008,Elliott, J.A., An Introduction to Sustainable Development, Routledge, New York, 2002.,Mani, M., Ganesh, L.S., and Varghese, K., Sustainability and Human Settlements: Fundamental Issues, Modeling and Simulations, Sage Publications, New Delhi, Thousand Oaks, London, 2005,Meadows, D.H., Thinking in Systems: A Primer, Chelsea Green Publishing Company, White River Junction, VT, 2008,Papanek, V., Design for the Real World. Academy Chicago Publishers, Illinois, 2000. Technology Management Newsletter: www.techmotivator.iitm.ac.in

ST 204 (AUG) 1:1

Sustainable Energy and Environment lab

Energy conversion technologies, building comfort studies, water quality, building technologies

Monto Mani,Dasappa S,Chanakya H N,Venkatarama Redd

Current literature,Current literature,current literature

ST 210 (AUG) 3:1

Principles and Applications of GIS and Remote Sensing

Key concepts and principles of remote sensing, GIS and digital image processing. Tools to address environmental problems. Roles of professionals in managing environment in their respective areas

Ramachandra T V

Lillesand, T.M., and Kiefer, R.W., Remote Sensing and Image Interpretation, John Wiley & Sons, Inc., New York,Cambell, J.B., Introduction to Remote Sensing, Taylor and Francis,Jensen, J.R., Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice Hall, New Jersey,Burrough, P.A., Principles of Geographical Information System for Land Resource Assessment, Oxford University Press

ST 214 (AUG) 3:0

Mathematical Analysis of Experimental Data

Instrument characteristics for popular variables like length, pressure, temperature, velocity, force, density and torque.Systematic and random errors, calibration science and corrections at different scales of instrument,dimensional analysis leading to functionalities,critical and non-critical variables governing the process.Uncertainty analysis and curve fitting.Probability theory,sampling data, confidence levels,distribution of errors, Measurement Variability and Error;controlling and minimizing variabillity,replication,randomization, blocking and controls.Single factor experiments,randomized blocks,Latin square designs, Mathematical data analysis of data distribution,normal and t-distribution confidence interval and hypothesis testing Simple and multiple linear regressions.Mathematical analysis of experimental data from problems in fluid flow, heat transfer and combustion.

Dasappa S,Punit Singh,Lakshminarayana Rao M P

1.Enest O Doebelin,Engineering Experimentaton,McGraw-Hill International,2.G.Beckkwith and Lewis.N.Buck, Mechanical measurements,3.Box,G.E.P.,Hunter,W.G.,and Hunter,J.S.(1978),Statistics for experimenters:An Introduction to Design, Data Analysis,and Model Building, John Wiley & sons.Inc.ISBN:0-471-09315-7 4.Jack Philip Holman, Experimental methods for engineers,(2011),McGraw-HIll Series in Mechanical Engineering, Eight Edition

ST 201 (JAN) 3:0

Thermochemical and biological energy recovery from biomass

Biomass and its properties relevant for conversion processes. Thermochemical energy conversion processes and devices – stoves, combustors and gasifiers for heat, power and co-generation applications. Biological conversion techniques, processes and reactors. Efficiency, emissions. performance of end use devices and resource recovery options.

Dasappa S,Chanakya H N

Borman, G.L. and Ragland, K.W., Combustion Engineering, McGraw-Hill International Editions, Mechanical engineering series,. HS Mukunda, Understanding clean energy and fuels from biomass, Wiley India,Relevant papers from current literature.

ST 206 (JAN) 2:1

Environmental and Natural Resources Management

Principles of environmental management, principles of ecology, environment and environmental management, policies and legal aspect of environmental management, overview of environmental impact assessment (EIA). Preparation and review of environmental impact assessment report, environmental audit, life cycle assessment as EM Tool. Environmental management systems standards: ISO 14000 (EMS). Related issues in environmental management, environmental design and environmental economics.

Ramachandra T V

Kulkarni, V., and Ramachandra, T.V., Environmental Management, Capital Publishers, New Delhi, 2006,Lo, C.P., and Yeung, A.K.W., Concepts and Techniques of GIS, Prentice Hall of India Private Limited, New Delhi, 2002,. Kanholm, J., EMS Manual, 21 Procedures and Forms, AQA Press, USA, 2000,Holling, C.S., Adaptive Environmental Assessment and Management, John Willey & Sons, New York, 1987,Meadows, D.H., Meadows, D.L., and Randers, J., Beyond the Limits – Global Collapse or Sustainable Future, Earth Scan Publications Limited, London, 1992.

ST 207 (JAN) 3:0

Alternate Fuels for Reciprocating Engines

Internal combustion engine classification, operating cycles, performance of spark ignition and compression ignition engines. Properties of various liquid and gaseous fuels. Combustion characteristics and performance of these fuels in engines – power output, efficiency and emissions

Dasappa S

Heywood, J., Internal Combustion Engine Fundamentals, McGraw Hill Publication,Journal papers – SAE,IMechE – journal of power and energy, Automobile Engineering,Current literature

ST 209 (JAN) 2:0

Society and Technology

Understanding of technology for engineers, societal perspectives of technology, bridging the gap in understanding, overcoming conflicts in embedding technology in society, communicating technology, engaging in conversations and dialogue that help embed technology, planning sustainability into communicating technology, understanding existing perspectives of sustainability, merging it with the technical perspectives of sustainability, evolving communication that works for sustainable technologies, writing short texts and messages, peer group testing.

Chanakya H N,Anjula Gurtoo

Alley, M., The Craft of Scientific Presentations, Springer-Verlag, New York, Inc., 2003,Changing the Conversation: Messages for Improving Public Understanding of Engineering. Committee on Public Understanding of Engineering Messages. National Academy of Engineering. The National Academies Press, Washington,D.C, www.nap.edu , 2008,Diamond, J., Guns, Germs and Steel, W.W. Norton, 1997,Felt, U., The social and cultural tailoring of scientific knowledge in the public space, in M.E. GONCALVES (ed), Cultura cientifica e participaçao pública (Lisboa: Bertrand), 1999.,Ramakrishnan, P.S., Ecology and Sustainable Development – Working with knowledge systems, National Book trust, India, 2001

ST 213 (JAN) 3:0

Turbo machines in Renewable Energy

The objectives of the course is to refine turbo machinery designs in challenging operating conditions imposed by renewable energy sources characterized by variability(input/outputsides)and low intensity/enthalpy levels.concepts include Euler theory,velocity traingles,dimensional analysis,meanline/streamline theory,loss models,performance estimation,Cordier/nsds diagrams and others.Practical design approach from theory and experimental modules for incompressible fluids(hydro turbines, wind turbines,and liquid pumps)and compressible fluids (air,steam,and new working fluids for solar thermal and waste heat sources)Radial,diagonal and axial flow turbo machines with impulse and reaction physics.Discussion on innovative and unconventional turbo machines.

Punit Singh

1.DixonS.L and HallC.A,'Fluid Mechanics and Thermo Dynamics of Turbomachinery', 6th Edition,Elsevier,publication 2010,2.Neschleba M,'Hydraulic turbines-Their design and equipment', Atria Prage,1957,3.StepanoffA.J,'Centrifugal and Axial Flow Pumps,JohnWiley & Sons,Inc.,1957,4.Horlock J.H,'Axial Flow Compressors and Axial Flow Turbines,Fluid Mechanics and Thermodynamics',Butterworths,1958,5.Watson N and JanotaM.S, 'Turbocharging the Internal Combustion Engine',The Macmillan Press,1982 6.Balje O.E,'Turbo Machines-A guide to Design,Selection and Theory',John Willey & Sons 1981

Division of Interdisciplinary Research

Preface

The Division of Interdisciplinary Research consists of the Biosystems Science & Engineering, Department of Computational and Data Sciences, Centre for Contemporary Studies, Interdisciplinary Centre for Energy Research, Interdisciplinary Centre for Water Research, Centre for Nano Science and Engineering, Centre for Infrastructure, Sustainable Transportation and Urban Planning, Department of Management Studies, Robert Bosch Centre for Cyber Physical Systems and Supercomputer Education and Research Centre. The courses offered in the different departments of the Division have been reorganized after review and revision, and have been grouped department wise. These are identified by the following code.

BE	Biosystems Science & Engineering
ER	Energy Research
DS	Computational and Data Sciences
MS	Management Studies
NE	Nano Science and Engineering
UP	Infrastructure,Sustainable Transportation and Urban Planning

The first two digits of the course number have the departmental code as the prefix. All the Departments/ Centres of the Division provide facilities for research work leading to the degrees of M Tech, M Tech (Research) and PhD. There are specific requirements for completing a Research Training Programme for students registered for research at the Institute. For individual requirements, students are advised to consult the Departmental Curriculum Committee. The M Tech Degree Programmes are offered in Centre for Nano Science and Engineering, Department of Computational and Data Sciences. Department of Civil Engg and CiSTUP jointly offer an M Tech Programme in Transportation Engineering. Department of Management Studies offers a Master of Management. Most of the courses are offered by the faculty members of the Division, but in certain areas, instruction by specialists in the field and experts from industries are also arranged.

Prof. G Rangarajan
Chairman
Division of Interdisciplinary Research

Biosystems Science and Engineering

BE 206 (AUG) 3:0

Biology for Engineers•

The course provides an introduction to fundamental concepts in Biology for PhD students with little to no knowledge of Biology past 10th or 12th standard school curriculum. The course will aim to provide a basic introduction to modern biology, while covering the following topics: evolution, biomolecules, fundamentals of biochemistry, protein structure and function, basic molecular biology, genetics, and an introduction to the cellular architecture. A combination of theoretical concepts and basic experimental methodologies in biology will be discussed. In addition, an introduction to plant and human physiology will also be provided, which includes lectures on classification of tissues, basic human anatomy, and an in-depth discussion on neurophysiology. The concepts covered here will aid in the skill development required to study diverse problems in bioengineering.

Siddharth Jhunjhunwala,Aditya Murthy

B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, and P.Walter. Molecular Biology of the Cell, Garland Science, New York, 2007.,J. Kuriyan, B. Konforti, and D. Wemmer. The Molecules of Life: Physical and Chemical Principles, Garland Science, New York, 2012.,J. Kuriyan, B. Konforti, and D. Wemmer. The Molecules of Life: Physical and Chemical Principles, Garland Science, New York, 2012

BE 209 (AUG) 1:0

Digital Epidemiology

Epidemiology is the study of health and disease in populations. Google's Flu Trends, Flowminder, Healthmap, Biodiaspora are several examples of digital epidemiology already in play. Engineered systems that are built from and depend upon, the seamless integration of computational algorithms and physical components is how National Science Foundation defines the field of cyber physical systems (CPS). Digital Epidemiology can be viewed as a health care application of CPS. The foundations of CPS includes a focus on the modeling of dynamic systems with attention to integrating computing, communication and control in uncertain and heterogeneous environments. Modeling paradigms include linear and non-linear, stochastic, discrete-event and hybrid models that are analyzed by methods of optimization, probability theory and dynamic programming. The purpose of this course is to introduce this emerging discipline of digital epidemiology to students at IISc. This offering of the course will be limited to a class size of 20 students.

Ananthasuresh G K

Epidemiology, A Very Short Introduction, Rodolfo Saracci, Oxford University Press,The only prerequisite for this course is a reasonable preparation in computational mathematics,Statistical models in Epidemiology, D. Clayton and M. Hills, Oxford University Press

BE 208 (JAN) 3:0

Fundamentals of Bioengineering

This course will aim to introduce concepts in the interdisciplinary areas of bioengineering, biomedical engineering and biotechnology. The course is designed to be modular, with each module focusing on one of the following topics: introduction to mathematics and biology; polymer engineering; transport phenomena through polymeric matrices and its applications in drug delivery; biological and immune responses to polymeric implants; principles of tissue engineering; computational approaches to study biological phenomena; and bioprocess engineering that includes an introduction enzyme kinetics, metabolic pathways and bioreactors. Each module will include three didactic lectures (1.5 hours each) followed by one class discussing a recent journal article related to that module (1.5 hours).

Siddharth Jhunjhunwala

1. Biomedical Engineering: Bridging Medicine and Technology,W. Mark Saltzman,Cambridge University Press,2009,Introduction in biomedical engineering

Computational and Data Sciences

M Tech Programme
Duration: 2 years
64 Credits

Course structure:

Hard Core: 13 credits
Courses: 12 credits
Research Methods: 1 credit (soft skills course)
Soft Core: 10 credits minimum (atleast three courses)
Dissertation: 28 credits
Electives: 13 credits (Students may credit CDS electives/soft core or other department courses)

Total: 64 credits

Hard Core Courses (13 credits): All are compulsory

* DS 221 AUG 3:0 Introduction to Scalable Systems (VSS/YS/MJT)
* DS 284 AUG 2:1 Numerical Linear Algebra (MV/SA)
* DS 288 AUG 3:0 Numerical Methods (SG/PY)
* DS 294 JAN 3:0 Data Analysis and Visualization (PY/VB)
* DS 200 JAN 0:1 Research Methods (Faculty) – SOFT SKILLS COURSE

Soft Core Courses (10 credits): Minimum three courses out of six below

* DS 211 JAN 3:0 Numerical Optimization (SA/AM)
* DS 222 AUG 3:1 Machine Learning with Large Datasets (PPT)
* DS 256 JAN 3:1 Scalable Systems for Data Science (YS)
* DS 289 JAN 3:1 Numerical Solution of Differential Equations (AM/SA)
* DS 290 AUG 3:0 Modelling and Simulation (SR)
* DS 295 JAN 3:1 Parallel Programming (VSS)

Dissertation Project: DS 299 0:28 (0:4 Summer; 0:8 AUG; 0:16 JAN)

The balance of credits to make up the minimum of 64 required for completing the programme (all at 200 level or higher).

DS 221 (AUG) 3:0

Introduction to Scalable Systems

Architecture: computer organization, single-core optimizations including exploiting cache hierarchy and vectorization, parallel architectures including multi-core, shared memory, distributed memory and GPU architectures; Algorithms and Data Structures: algorithmic analysis, overview of trees and graphs, algorithmic strategies, concurrent data structures; Parallelization Principles: motivation, challenges, metrics, parallelization steps, data distribution, PRAM model; Parallel Programming Models and Languages: OpenMP, MPI, CUDA; Distributed Computing: Commodity cluster and cloud computing; Distributed Programming: MapReduce/Hadoop model.

Yogesh L Simmhan,Sathish S Vadhiyar

Consent from Advisor,Basic knowledge of system science,Basic data structures and programming,Basics of computer systems,Basic algorithms

DS 222 (AUG) 3:1

Machine Learning with Large Datasets

Streaming algorithms and Naive Bayes, fast nearest neighbor, parallel perceptrons, parallel SVM, randomized algorithms, hashing, sketching, scalable SGD, parameter servers, graph-based semi-supervised learning, scalable link analysis, large-scale matrix factorization, speeding up topic modeling, big learning and data platforms, learning with GPUs.

Partha Pratim Talukdar

Consent from Advisor,Prior exposure to machine learning,Basics of algorithms

DS 250 (AUG) 3:1

Multigrid Methods

Classical iterative methods, convergence of classical iterative methods, Richardson iteration method, Krylov subspace methods: Generalized minimal residual (GMRES), Conjugate Gradient (CG), Bi-CG method. Geometric Multigrid Method: Grid transfer, Prolongation and restriction operators, two-level method, Convergence of coarse grid approximation, Smoothing analysis. Multigrid Cycles: Vcycle, W-cycle, F-cycle, convergence of multigrid cycles, remarks on computational complexity. Algebraic Multigrid Method: Hierarchy of levels, Algebraic smoother, Coarsening, Interpolation, remarks on parallel implementation.

Sashikumaar Ganesan

Consent from Advisor,Good knowledge of Linear Algebra,Basic programming skill

DS 284 (AUG) 2:1

Numerical Linear Algebra

Matrix and vector norms, floating points arithmetic, forward and backward stability of algorithms, conditioning of a problem, perturbation analysis, algorithmic efficiency, Structured matrices, Solving linear systems, Gaussian elimination, LU factorization, Pivoting, Cholesky decomposition, Iterative refinement, QR factorization, Gram-Schmidt orthogonalization, Projections, Householder reflectors, Givens rotation, Singular Value Decomposition, Rank and matrix approximations, image compression using SVD, Least squares and least norm solution of linear systems, pseudoinverse, normal equations, Eigenvalue problems, Gershgorin theorem, Similarity transform, Eigenvalue & eigenvector computations and sensitivity, Power method, Schur decomposition, Jordan canonical form, QR iteration with & without shifts, Hessenberg transformation, Rayleigh quotient, Symmetric eigenvalue problem, Jacobi method, Divide and Conquer, Computing the Singular Value Decomposition, Golub-Kahan-Reinsch algorithm, Chan SVD algorithm, Generalized SVD, Generalized and Quadratic eigenvalue problems, generalized Schur decomposition (QZ decomposition), Iterative methods for large linear systems: Jacobi, Gauss-Seidel and SOR, convergence of iterative algorithms, Krylov subspace methods: Lanczos, Arnoldi, MINRES, GMRES, Conjugate Gradient and QMR, Pre-conditioners, Approximating eigenvalues and eigenvectors.

Murugesan Venkatapathi

Consent from Advisor,Basics of Matrix Algebra,Basics of Programming,Vectors and Vector Spaces

DS 288 (AUG) 3:0

Numerical Methods

Root finding: Functions and polynomials, zeros of a function, roots of a nonlinear equation, bracketing, bisection, secant, and Newton-Raphson methods. Interpolation, splines, polynomial fits, Chebyshev approximation. Numerical Integration and Differentiation: Evaluation of integrals, elementary analytical methods, trapezoidal and Simpson's rules, Romberg integration, Gaussian quadrature and orthogonal polynomials, multidimensional integrals, summation of series, Euler-Maclaurin summation formula, numerical differentiation and estimation of errors. Optimization: Extremization of functions, simple search, Nelder-Mead simplex method, Powell's method, gradient-based methods, simulated annealing. Complex analysis: Complex numbers, functions of a complex variable, analytic functions, conformal mapping, Cauchy's theorem. Calculus of residues. Fourier and Laplace Transforms, Discrete Fourier Transform, z transform, Fast Fourier Transform (FFT), multidimensional FFT, basics of numerical optimization.

Sashikumaar Ganesan

Consent from Advisor,Good knowledge of basic mathematics,Basic programming skill,Basic knowledge of multivariate calculus and elementary real analysis

DS 290 (AUG) 3:0

Modelling and Simulation

Statistical description of data, data-fitting methods, regression analysis, analysis of variance, goodness of fit. Probability and random processes, discrete and continuous distributions, Central Limit theorem, measure of randomness, Monte Carlo methods. Stochastic Processes and Markov Chains, Time Series Models. Modelling and simulation concepts,Discrete-event simulation: Event scheduling/Time advance algorithms verification and validation of simulation models. Continuous Simulation: Modelling with and Simulation of Stochastic Differential Equations.

Soumyendu Raha

Consent from Advisor,Basic course on numerical methods,Good knowledge of basic mathematics

DS 301 (AUG) 2:0

Bioinformatics

Biological Databases: Organisation, searching and retrieval of information, accessing global bioinformatics resources using internet links. Introduction to Unix operating system and network communication. Nucleic acids sequence assembly, restriction mapping, finding simple sites and transcriptional signals, coding region identification, RNA secondary structure prediction. Similarity and Homology, dotmatrix methods, dynamic programming methods, scoring systems, multiple sequence alignments, evolutionary relationships, genome analysis. Protein physical properties, structural properties – secondary structure prediction, hydrophobicity patterns, detection of motifs, structural database (PDB). Genome databases, Cambridge structure database, data mining tools and techniques, Structural Bioinformatics, Topics from the current literature will be discussed.

Debnath Pal,Sekar K

Consent from Advisors,Basic knowledge of mathematics,Basic knowledge of molecules

DS 200 (JAN) 0:1

Research Methods

This course will develop the soft skills required for the CDS students. The modules (each spanning 3 hours) that each student needs to complete include: Seminar attendance, literature review, technical writing (reading, writing, reviewing), technical presentation, CV/resume preparation, grant writing, Intellectual property generation (patenting), incubation/start-up opportunities, and academia/industry job search.

Debnath Pal,Phaneendra Kumar Yalavarthy

Consent from Advisor,Basic knowledge of english,Basic comprehension skills

DS 211 (JAN) 3:0

Numerical Optimization

Numerical properties of modified Newton, quasi-Newton, steepest descent, nonlinear conjugate gradient, trust-region methods for unconstrained optimization, line search methods for all problems, simplex, barrier, penalty, sequential quadratic programming, reduced gradient, augmented lagrangian, sequential linearly constrained, Convergence and numerical analysis of algorithms for unconstrained problems, Various methods for solving matrix problems that are relevant to the efficient solution of KKT systems and to solving the sequence of linear problems that arise in optimization algorithms, matrix factorization updating and the linear conjugate gradient algorithm, numerical optimality conditions for smooth optimization problems.

Atanu Kumar Mohanty,Sivaram Ambikasaran

Consent from Advisors,Basics of linear algebra,Basics of Numerical Methods

DS 252 (JAN) 3:1

Cloud Computing

Context: Shared/distributed memory computing; Data/task parallel computing; Role of Cloud computing.
Technology: Cloud Virtualization, Elastic computing; Infrastructure/Platform/Software as a Service (IaaS/PaaS/SaaS); Public/Private Clouds; Service oriented architectures; Mobile, Edge and Fog computing; Multi-clouds.
Application Design Patterns: Workflow and dataflow; Batch, transactional and continuous; Scaling, locality and speedup; Cloud, Mobile and Internet of Things (IoT) applications.
Execution Models: Synchronous/asynchronous patterns; Scale up/Scale out; Data marshalling/unmarshalling; Load balancing; stateful/stateless applications; Performance metrics; Consistency, Availability and Partitioning (CAP theorem).
Programming project using public Cloud infrastructure, e.g. Amazon AWS, Microsoft Azure Cloud resources provided.

Yogesh L Simmhan

Consent from Advisor,Data Structures, Programming and Algorithm concepts,Programming experience

DS 255 (JAN) 3:1

System Virtualization

Virtualization as a construct for resource sharing; Re-emergence of virtualization and it's importance

for Cloud computing; System abstraction layers and modes of virtualization; Mechanisms for system virtualization – binary translation, emulation, para-virtualization and hardware virtualization; Virtualization using HAL layer – Exposing physical hardware through HAL (example of x86 architecture) from an OS perspective; System bootup process; Virtual Machine Monitor; Processor virtualization; Memory Virtualization; NIC virtualization; Disk virtualization; Graphics card virtualization; OS-level virtualization and the container model; OS resource abstractions and virtualization constructs (Linux Dockers example) ; Virtualization using APIs – JVM example.

Lakshmi J

Consent from Advisor,Basic course on operating systems,Basic programming skill

DS 256 (JAN) 3:1

Scalable Systems for Data Science

Design of distributed program models and abstractions, such as MapReduce, Dataflow and Vertex-centric models, for processing volume, velocity and linked datasets, and for storing and querying over NoSQL datasets.
Approaches and design patterns to translate existing data-intensive algorithms and analytics into these distributed programming abstractions.
Distributed software architectures, runtime and storage strategies used by Big Data platforms such as Apache Hadoop, Spark, Storm, Giraph and Hive to execute applications developed using these models on commodity clusters and Clouds in a scalable manner.
This course has a hands-on project where students will work with real, large datasets and commodity clusters, and use scalable algorithms and platforms to develop a Big Data application.

Yogesh L Simmhan

Consent from Advisor,Data Structures and Algorithms (e.g. DS 221, E0 225, E0 251),Programming and Algorithm concepts with strong programming experience,Operating Systems/Distributed Systems (e.g. E0 253, E0 254, E0 264)

DS 260 (JAN) 3:0

Medical Imaging

X-ray Physics, interaction of radiation with matter, X-ray production, X-ray tubes, dose, exposure, screen-film radiography, digital radiography, X-ray mammography, X-ray Computed Tomography (CT). Basic principles of CT, single and multi-slice CT. Tomographic image reconstruction, filtering, image quality, contrast resolution, CT artifacts. Magnetic Resonance Imaging (MRI): brief history, MRI major components. Nuclear Magnetic Resonance: basics, localization of MR signal, gradient selection, encoding of MR signal, T1 and T2 relaxation, k-space filling, MR artifacts. Ultrasound basics, interaction of ultrasound with matter, generation and detection of ultrasound, resolution. Doppler ultrasound, nuclear medicine (PET/SPECT), multi-modal imaging, PET/CT, SPECT/CT, oncological imaging, medical image processing and analysis, image fusion, contouring, segmentation, and registration.

Phaneendra Kumar Yalavarthy

Consent from Advisor,Basic knowledge of system theory,Good knowledge of basic mathematics

DS 265 (JAN) 3:1

Deep Learning for Computer Vision

Computer vision – brief overview; Machine Learning – overview of selected topics ; Introduction to Neural Networks, Backpropagation, Multi-layer Perceptrons ; Convolutional Neural Networks ; Training Neural Networks ; Deep Learning Software Frameworks ; Popular CNN Architectures ; Recurrent Neural Networks ; Applications of CNNs- Classification, Detection, Segmentation, Visualization, Model compression ; Unsupervised learning ; Generative Adversarial Networks.

Venkatesh Babu R

Consent from Advisor,Basic knowledge of Computer Vision and Machine Learning,Proficiency in Python, C/C++

DS 289 (JAN) 3:1

Numerical Solution of Differential Equations

Ordinary differential equations: Lipschitz condition, solutions in closed form, power series method. Numerical methods: error analysis, stability and convergence, Euler and Runge-Kutta methods, multistep methods, Adams-Bashforth and Adams-Moulton methods, Gear's open and closed methods, predictor-corrector methods. Sturm-Liouville problem: eigenvalue problems, special functions, Legendre, Bessel and Hermite functions. Partial differential equations: classification, elliptic, parabolic and hyperbolic PDEs, Dirichlet, Neumann and mixed boundary value problems, separation of variables, Green's functions for inhomogeneous problems. Numerical solution of PDEs: relaxation methods for elliptic PDEs, Crank-Nicholson method for parabolic PDEs, Lax-Wendroff method for hyperbolic PDEs. Calculus of variations and variational techniques for PDEs, integral equations. Finite element method and finite difference time domain method, method of weighted residuals, weak and Galerkin forms, ordinary and weighted/general least squares. Fitting models to data, parameter estimation using PDEs.

Atanu Kumar Mohanty,Sivaram Ambikasaran

Consent from Advisors,Basic course on numerical methods,Good knowledge of basic mathematics

DS 291 (JAN) 3:1

Finite Elements: Theory and Algorithms

Generalized (weak) derivatives, Sobolev norms and associated spaces, inner-product spaces, Hilbert spaces, construction of finite element spaces, mapped finite elements, two- and three-dimensional finite elements,Interpolation and discretization error, variational formulation of second order elliptic boundary value problems, finite element algorithms and implementation for linear elasticity, Mindlin-Reissner plate problem, systems in fluid mechanics

Sashikumaar Ganesan

Consent from Advisor,Good knowledge of numerical analysis,Basic programming skill

DS 294 (JAN) 3:0

Data Analysis and Visualization

Data pre-processing, data representation, data reconstruction, machine learning for data processing, convolutional neural networks, visualization pipeline, isosurfaces, volume rendering, vector field visualization, applications to biological and medical data, OpenGL, visualization toolkit, linear models, principal components, clustering, multidimensional scaling, information visualization.

Phaneendra Kumar Yalavarthy,Faculty DS

Consent from Advisors,Basic knowledge of numerical methods,Good knowledge of basic mathematics

DS 295 (JAN) 3:1

Parallel Programming

Parallel Algorithms: MPI collective communication algorithms including prefix computations, sorting, graph algorithms, GPU algorithms; Parallel Matrix computations: dense and sparse linear algebra, GPU matrix computations; Algorithm models: Divide-and-conquer, Mesh-based communications, BSP model; Advanced Parallel Programming Models and Languages: advanced MPI including MPI-2 and MPI-3, advanced concepts in CUDA programming; Scientific Applications: sample applications include molecular dynamics, evolutionary studies, N-Body simulations, adaptive mesh reinements, bioinformatics; System Software: sample topics include scheduling, mapping, performance modeling, fault tolerance.

Sathish S Vadhiyar

Consent from Advisor,DS 221 Introduction to scalable systems,A graduate level course on algorithms,Fundamentals of MPI, OpenMP and GPU architectures

DS 299 (JAN) 0:28

Dissertation Project

This includes the analysis, design of hardware/software construction of an apparatus/instruments and testing and evaluation of its performance. The project work is usually based on a scientific/engineering problem of current interest. Every student has to complete the work in the specified period and should submit the Project Report for final evaluation. The students will be evaluated at the end first year summer for 4 credits. The split of credits term wise is as follows 0:4 Summer, 0:8 AUG, 0:16 JAN.

Faculty DS

Consent from Advisor,Literature review,Clear idea about the research project

DS 391 (JAN) 3:0

Data Assimilation to Dynamical Systems

Quick introduction to nonlinear dynamics: bifurcations, unstable manifolds and attractors, Lyapunov exponents, sensitivity to initial conditions and concept of predictability. Markov chains, evolution of probabilities (Fokker-Planck equation), state estimation problems. An introduction to the problem of data assimilation (with examples) Bayesian viewpoint, discrete and continuous time cases Kalman filter (linear estimation theory) Least squares formulation (possibly PDE examples) Nonlinear Filtering: Particle filtering and MCMC sampling methods. Introduction to Advanced topics (as and when time permits): Parameter estimation, Relations to control theory, Relations to synchronization.

Soumyendu Raha

Consent from Advisor,Good knowledge of basic mathematics,Basics of data science

DS 397 (JAN) 2:1

Topics in Embedded Computing

Introduction to embedded processing, dataflow architectures, architecture of embedded SoC platforms, dataflow process networks, compiling techniques/optimizations for stream processing, architecture of runtime reconfigurable SoC platforms, simulation, design space exploration and synthesis of applications on runtime reconfigurable SoC platforms, additional topics including but not limited to computation models for coarse grain reconfigurable architectures (CGRA), readings and case study of REDEFINE architecture, compiler back-ends for CGRAs.

Nandy S K

Consent from Advisor,Basic knowledge of digital electronics, computer organization and design,Basic knowledge of computer architecture, data structures and algorithms

Energy Research

ER 201 (AUG) 3:0

Renewable Energy Technologies

Energy is a critical component in the daily life of mankind. Historically, energy production technologies have shown a continual diversification depending on technological, social, economical, and even political impacts. In recent times, environmental and ecological issues have also significantly affected the energy usage patterns. Hence, renewable energy sources are occupying increasingly important part of the emerging energy mix. This course gives an introduction to key renewable energy technologies. Case studies will be discussed to emphasize the applications of renewable energy technologies. At the end of the course students should be able to identify where, how and why renewable energy technologies can be applied in practice.

Pradip Dutta,Praveen C Ramamurthy,Dasappa S

ER 202 (JAN) 2:1

Energy Conversion, Power Transmission and Distribution

Overview of primary and renewable energy sources, installed capacity and projected growth, applications, advantages and limitations. Energy conversion: Solar, wind, micro-hydro etc, system control requirements, grid connectivity issues. Recent advances in power transmission, introduction to EHV/UHV AC and DC transmission systems; present status and future growth. Design criteria for overhead transmission lines: general system design, methodology, components of HV transmission systems, types of conductors/accessories and bundle configurations, Transmission towers- calculations of clearances for power frequency, switching and lightning surges, right of way (ROW), earth wire/OPGW, selection of insulators for light, medium and heavy polluted areas, Up-gradation of existing transmission lines, Design considerations of HV Substations, Comparison of AIS, Hybrid-AIS and GIS, Insulation coordination for UHV systems, earthing and safety measures in UHV substations, Sub-station automation, power distribution, distribution reforms,SCADA.
Laboratory experiments on concepts in generation of primary and renewable energy sources, Assignments involving computation/simulation of ground end electric and magnetic fields, technical visits to Industry/HV Substation.

Subba Reddy Basappa,Umanand L

None,None,None

Management Studies

Master of Management (M.Mgt) Program
Duration: 2 years

Hard Core: 24 credits

MG 201	3:0	Managerial Economics
MG 211	3:0	Human Resource Management
MG 212	2:1	Behavioral Science
MG 221	2:1	Applied Statistics
MG 232	3:0	Principles of Management
MG 241	3:0	Marketing Management
MG 251	3:0	Finance & Accounts
MG 261	3:0	Operations Management

Stream Core: 12 Credits (to be chosen from either one of the two streams)

Stream 1: Business Analytics Stream

MG 223	3:0	Applied Operations Research
MG 225	3:0	Decision Models
MG 226	3:0	Time Series Analysis and Forecasting
MG 265	2:1	Data Mining

Stream 2: Technology Management Stream

MG 271	3:0	Technology Management
MG 274	3:0	Management of Innovation and ntellectual Property
MG 281	3:0	Management of Technology for Sustainability
MG 298	2:1	Entrepreneurship for Technology Start-ups

Electives: 12 credits

Project: : **MG 299 0:16 Management Project**

Summer Internship: No credits. Every student is required to spend a minimum of eight weeks in an identified industrial enterprise or public sector organization during the summer period after the first two semesters. Alternatively students have the option to get exposure to business incubators, venture capital firms and successful start-ups.

MG 201 (AUG) 3:0

Managerial Economics

Introduction to managerial economics, demand theory and analysis, production theory, cost theory, market structure and product pricing, Pricing of goods and services, pricing and employment of inputs. Micro and macro economics, national income accounting, GDP measurement, inflation and price level, aggregate demand and supply, fiscal and monetary policy.

Balasubrahmanya M H

Allen, Bruce et al: Managerial Economics: Theory, Applications, and Cases, WW Norton, 6th Edition, 2005.,Kishore G. Kulkarni and Edwin G. Dolan, Understanding Macroeconomics, Horizon Textbook Publishing, LLC, 4th Edition, 2007.,Wilkinson, Nick, Managerial Economics: A Problem-Solving Approach, Cambridge University Press, 2005.

MG 202 (AUG) 3:0

Macroeconomics

Macroeconomics: Overview, national income accounting, measurement of GDP in India, inflation and its measurement, price indices in India, aggregate demand and aggregate supply. India's macroeconomic crisis: causes and dimensions. Keynesian Theory, money and banking. How banks create money. Monetary Policy: Its instruments and uses, monetary policy in India, monetarism, supply side fiscal policies, Philipp's curve and theory of rational expectations. Case studies on macroeconomic issues.

Balasubrahmanya M H

Ministry of Finance: Economic Survey, Government of India, Recent Issues.,Froyen, Macroeconomics: Theories and Policies, Pearson Education, 2005.,Reserve Bank of India: Annual Reports.

MG 212 (AUG) 2:1

Behavioral Science

Understanding human behaviour; functionalist, cognitive, behaviouristic and social learning theories; perception; learning; personality; emotions; defense mechanisms; attitude; communication; decision making; groups and social behaviour; intra-personal and inter-personal differences; managing conflicts.

Anjula Gurtoo

Luthans, F, Organizational Behaviour, McGraw-Hill, 1988. Weiten, Wayne, Psychology Applied to Modern Life, Books/Cole, 1986.,Munn, N.L., et al., Introduction to Psychology, (3rdEdn.), Oxford and IBH Publishing Company, 1975.,Makin P., Cooper C. and Cox C., Organizations and the Psychological Contract, University Press, 1999

MG 213 (AUG) 3:0

Organizational Behavior

Organization - its characteristics, objectives (nature of goals, independence and interdependence), structure (size, centralization, formalization, standardization), process (decision making, leadership motivation, etc., authoritative vs participative styles), technology. Organization and its environment, power dynamics, conflict management, organizational learning and growth, organizational development, interventions at job, individual, group and organizational levels.

Akhilesh K B

Babbit, H.R. et al, Organizational Behaviour, Prentice Hall, New Jersey, 1978.,Osborn, R.N. et al, Organizational Theory, John Wiley, New York, 1980.,Gerloff, E.A., Organizational Theory and Design, McGraw-Hill 1985.,Child, J, Organizations, Harper and Row 1985.

MG 221 (AUG) 2:1

Applied Probability and Statistics

Probability spaces, laws and calculations; distributions and moments of discrete and continuous univariate and multivariate random variables and vectors; binomial, Poisson, negative binomial, uniform, normal and gamma models. Poisson processes. Criteria and methods of estimation – UMVU, MM, ML. Testing statistical hypotheses – fixed and observed significance level testing. One and two sample problems for mean, variance and proportions – Z-test, t-test, chi-square-test, F-test, sign test, Wilcoxon rank–sum and signed-rank test. Chi-square-test of homogenity, independence and goodness-of-fit.

Mukhopadhyay C

Douglas C. Montgomery & George C. Runger, Applied Statistics and Probability for Engineers, Wiley India Pvt. Ltd., Fifth Edition, 2014,David Freedman, Robert Pisani & Roger Purves, Statistics, Viva Books Pvt. Ltd., Fourth Edition, 2010.,Kai Lai Chung, Elementary Probability Theory with Stochastic Processes, Narosa Publishing House, Third Edition, 1974.

MG 225 (AUG) 3:0

Decision Models

Analytical hierarchy process: structuring of a problem into a hierarchy consisting of a goal and subordinate features of the problem, and pairwise comparisons between elements at each level. Goal programming: Pareto optimality, soft constraints, identifying the efficient frontier, duality and sensitivity analysis. Data envelopment analysis: relative efficiency measurements, DEA model and analysis, graphical representation, and dual DEA model. Agent based modeling: complex adaptive systems, emergent structures and dynamic behaviors. Discrete event simulation: random number generators and generating random variates. Selecting input probability distributions and output data analysis. Neural networks: neuron model and network architecture, perceptron learning rule, and back propagation. Support vector machines: Learning methodology, linear learning machines, kernel-induced feature spaces.

Parthasarathy Ramachandran

Saaty, T. L., The Analytic Hierarchy Process, McGraw-Hill, 1990.,Rardin, R. L., Optimization in Operations Research, Pearson, 2005.,Law, A. M. and Kelton, D. W., Simulation Modeling and Analysis, McGraw-Hill, 1991.,Mitchell, T., Machine learning, McGraw-Hill, 1997.

MG 226 (AUG) 3:0

Advanced Analytics

Review of multiple linear regression - variable selection, regression diagnostics. Introduction to generalized linear models - likelihood inference, deviance, model checking.

Logistic regression - models for log-odds, estimation and hypothesis testing, residual analysis and goodness-of-fit, polytomous and ordinal responses, propensity scores.

Survival analysis - censored data, models and estimates for survival functions and hazard functions, proportional hazards and partial likelihood, semi-parametric models for regression, inference and model checking.

Multivariate analysis – multivariate Normal distribution and its properties, one two and multisample problem for multivariate Normal distribution, multivariate analysis of variance, principal component analysis, factor analysis.

Mukhopadhyay C

Hosmer David W. and Lemeshow Stanley. Applied Logistic Regression. Third Edition. 2013. Wiley.,Klein John P. and Moeschbergerer Melvin L. Survival Analysis: Techniques for Censored and Truncated Data. Second Edition. 2003. Springer.,Johnson Richard A. and Wichern Dean W. Applied Multivariate Statistical Analysis. Sixth Edition. 2007. Pearson,Michael H. Kutner, Christopher J. Nachtsheim, John Neter & William Li, Applied Linear Statistical Models, McGraw-Hill International Edition, Fifth Edition, 2005.

MG 232 (AUG) 3:0

Principles of Management

Scientific techniques of management, Evolution of management thought, contributions of Taylor, Gilbreth, Henri Fayol and others. Levels of authority and responsibilities. Types of managerial organizations, line, staff, committee, etc. Social responsibilities of management, internal and external structure of organizations, charts and manuals, formulation and interpretation of policy, Issue of instructions and delegation of responsibility, functional team-work, standards for planning and control.

Yadnyvalkya

Harold Koontz and Heinz Weihrich, Essentials of Management – An International Perspective, Tata McGraw Hill Education

Pvt. Ltd., New Delhi, 8th Edition, 2009.,Charles W.L. Hill, Steven L McShane, Principles of Management – Special Indian Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2009.,Govindarajan M, and Natarajan S., Principles of Management, Eastern Economy Edition, PHI Learning Pvt. Ltd., New Delhi, 2009.

MG 242 (AUG) 3:0

Strategic Management

Strategic management process, challenge of globalization, strategic planning in India. Corporate governance, board of directors. Role and functions of top management. Environmental scanning; industry analysis; internal scanning; organizational analysis. Strategy formulation: situation analysis and business strategy, corporate strategy, functional strategy, strategy implementation and control, strategic alternatives. Diversification, mergers and acquisition

Parthasarathy Ramachandran

R. Srinivasan, Strategic Management – The Indian Context, Prentice-Hall of India, 5th Edition, 2014.,R. Srinivasan, Case Studies in Marketing – The Indian Context, Prentice-Hall of India, 6th Edition, 2014.,None

MG 244 (AUG) 3:0

Services Marketing

Basic issues, conceptual framework, service strategy, service design and mapping, perceived service quality. SERVQUAL Customer satisfaction, product support services. Pricing. After service strategy, customer retention and relationship marketing. Service profitability and loyalty.

Srinivasan R

R. Srinivasan, Services Marketing, Prentice-Hall of India, 4th Edition, 2014.,R. Srinivasan, Case Studies in Marketing – The Indian Context, Prentice-Hall of India, 5th Edition, 2012.,None

MG 245 (AUG) 3:0

Business and Technology Strategy

This course will cover business strategy and its relationship to the technology strategy of firms. This course will cover the processes that firms use to set business strategy, the elements of sound business strategy, the linkage between strategy, technology, plans and execution. The course will cover topic including Competitive position and differentiation; Scale and scope within an industry; Setting vision and long term plans for growth; Expansion of scope through mergers, acquisitions, joint ventures; Creating uncontested market space; Following up strategy with plans, setting up measures of success; Aligning resources and addressing constraints; and Designing organizational structures to support the strategy.

The second half of the course will cover technology strategy in relation to business strategy. Technology continues to be the driver of innovation across many industries. Leaders need to understand the strategic importance of technology for their firms and how to manage this asset to drive innovation and new opportunity. This part of the course will cover including Alignment of business strategy and technology strategy; Disruptive business strategies driven by technology; Managing technological change; and Organization structures to support strategic technologies.

Parthasarathy Ramachandran

Michael E. Porter, Simon & Schuster, The Competitive Strategy: Techniques for Analyzing Industries and Competitors, New edition (26 December 2003), ISBN-10: 0743260880,HBR's 10 Must Reads on Strategy, Harvard Business Review Press; Edition (7 February 2011), ISBN-10: 1422157989,Srinivasan, R., Strategic Management: The Indian Context, PHI Learning Private Limited-New Delhi; Fifth edition (2014), ISBN-10: 8120350308,Scott Shane, Technology Strategy for Managers and

Entrepreneurs, Pearson Education (2014), ISBN-10: 93325366195.,M.A. Schilling, Strategic Management of Technological Innovation, McGraw Hill Education (India) Private Limited; 2nd edition (9 July 2007), ISBN-10: 0070667128

MG 251 (AUG) 3:0

Finance and Accounts

Nature and purpose of accounting, financial statements: learning, understanding the basic financial statements. Preparation of P and L account, balance sheet, basic accounts and trial balance. Income measurement, revenue recognition, depreciation accounting. Cash flow statements. Analysis and interpretation of financial statements; concepts and elements of cost, activity based costing. CVP analysis, break-even point, marginal costing, relevant costing.

Cost analysis for decision making: opportunity cost concept, dropping a product, pricing a product, make-or-buy and product mix decisions. Joint products, by-products. Process costing. Standard costing, budgeting – flexible budget, master budget, zero based budgeting. Overview of Financial Management, time value of money, fund and cash flow statement, risk and return. Working capital management: estimating working capital, financing working capital, receivables management, inventory management, cash management, money markets in India.

Capital Budgeting: appraising long term investment projects, make vs. buy investment decisions, estimating relevant cash flow. Capital Structure: Estimation of cost of debt, cost of equity, overall cost of capital, CAPM. Capital structure planning: Capital structure policy and target debt equity structure, EBIT-EPS analysis. Leasing. Introduction to valuation of firm. Introduction to derivatives.

Parthasarathy Ramachandran

Anthony and Reece, Accounting Principles, AITBS, Sixth Edition, 1998,S.K. Bhattacharyya and John Dearden, Accounting for Management, Vikas Publishing House, Third Revised Edition, 1998.,Horngren, Foster and Dattar, Cost Accounting, PHI Publication, Tenth Edition.,Brearly R. and Myers S, Principles of Corporate Finance, McGraw-Hill, New Delhi, Fifth Edition.,Prasanna Chandra, Financial Management: Theory and Practice, Tata McGraw-Hill, Fifth Edition.

MG 261 (AUG) 3:0

Operations Management

Introduction to Production/Operations Management (P/OM), P/OM strategy, forecasting, process management, facility layout, capacity planning and facility planning, aggregate planning, material requirement planning, scheduling, inventory management, waiting line, project management, management of quality. Introduction to simulation and to supply chain management.

Mathirajan M

Stevenson, William, J., Production/Operations Management. 6th Edition. Irwin/McGraw-Hill.,Krishnaswamy, K.N. and Mathirajan, M., Cases in Operations Management, Prentice-Hall of India Pvt. Ltd., New Delhi, 2008.,Heizer, J, and Render, B., Production and Operations Management – Strategies and Tactics, Allyn and Bacon.,Gaither N., and Frazier, G. Operations Management. 9th Edition, Cengae Learning India Pvt. Ltd. 2004.,Mahadevan, B. Operations Management: Theory and Practice, 2nd Edition, Pearson, 2007.

MG 265 (AUG) 3:0

Data Mining

Introduction to data mining. Data mining process. Association rule mining: Apriori and FP tree. Classification: ID3, C4.5, Bayes classifier. Clustering: K-means, Gaussian mixture model. Bayesian belief networks. Principal component analysis. Outlier detection.

Parthasarathy Ramachandran

Jiawei Han and Micheline Kamber, Data Mining: Concepts and Techniques, Morgan Kaufman Publishers 2001.,Richard J. Roiger and Michael W Geatz, Data Mining: A Tutorial-Based Primer, Addison-Wesley 2003,Mehmed Kantardzic, Data Mining: Concepts, Models, Methods and Algorithms, Wiley, 2003

MG 271 (AUG) 3:0

Technology Management

Definition of technology, technological transformation process, adaption. Adaption and innovation experiences in selected developed and developing countries. Technology transfer and its relation to technology transformation, diffusion and commercialization, rural technology management. Forward and backward integration. Some concepts in relation to technology management – productivity, employment, human resource and organizational development and corporate strategy.

MOT scope and focus, measuring technology content and intensity, organizing the high technology enterprise. Concurrent engineering and integrated product development, managing technology based projects, technology evaluation and selection, leading technology teams.

Akhilesh K B

Thahaman, H.J., Management of Technology, New Jersey: John Wiley & Sons, 2005.,Betz Frederick, Strategic Technology Management, New York: McGraw Hill, 1994.,Day, G.S., Schoemaker, J.H.P., and Gunther, E.R., Wharton on Managing Emerging Technologies, New York: John Wiley & Sons, 2000.

MG 272 (AUG) 3:0

R & D Management

Strategic human resources; understanding and managing R&D personnel, selection, recruitment and human resource policies suitable for different kinds of establishments. Leadership, uncertainty, creativity and innovation; creative processes, group interaction, problem solving, organizational climate, team building. Individual, interpersonal and group factors, neurotic teams, organizational development, organizational structures and functioning, competence building at the individual, group and organizational levels. Evaluation of R&D Projects; pre-initiation evaluation, need, risks associated with project selection.

Akhilesh K B

Hawthorne E.P., Management of Technology, McGraw-Hill, 1978.,Beattie, C.J. & Reader, R.D., Quantitative Management in R&D, Chapman and Hall, 1971.,Gibson J.E., Managing Research and Development, Wiley & Sons Inc., New York, 1983.

MG 273 (AUG) 3:0

Change Management

Foundational skills - Numeric data, language data and image data analysis, verbal and non-verbal communication skills, presentation techniques to equip oneself to drive change. Introduction - What is Change Management? How is it related to Project Management? Elements of Change Management, Prevalent Change Management Models. The Change - Why Change? Examples of 10x change – big-bang disruption. Customer Focus – Trigger for Change - Evolution of Customer Satisfaction Concept, Three stages of customer focus, Market-in versus Product-out approach. Leadership for Transformation - Identifying need for change, how to create future concepts, examples of leadership roles in driving change, addressing obstacles to change. Infrastructure for Driving Change - Goal setting, Organizational setting, Training and Education, Promotional Activities, Diffusion of success stories, Awards and incentives, Monitoring and diagnosis. Hoshin Management - Strategic planning, deployment, monitoring and control, checking and acting, diagnosis, contrast

with MBOs. Life-cycle of change management: Two examples - Detailed case study discussions (including one on IT), walking through various phases of change with an appreciation of how the infrastructure for driving change helps and the role of leadership in the Plan, Do, Check, Act cycle. Developing a unique organizational capability - customer focus, continuous improvement, driving total organization participation, organization skill development, establishing an organizational network for learning.

Parthasarathy Ramachandran

Downes, Larry and Nunes, Paul, Big Bang Disruption, Penguin Books, 2014.,Grove, Andrew S, Only the Paranoid Survive, Profile Books, 1996.,Liker, Jeffery K, The Toyota Way, McGraw Hill, 2004.,Shiba, Shoji and Walden, David, Breakthrough Management, CII, 2006.,Shiba, Shoji and Walden, David, Four Practical Revolutions in Management, Productivity Press, 2012.

MG 298 (AUG) 3:0

Entrepreneurship for Technology Start-ups

Opportunity recognition, new product development, business models, marketing and positioning, business plans and financial requirements, finance and venture capital. The entrepreneurial team, managing strategy and innovation. IPR and contracts. Developing a personal entrepreneurship strategy.

Parameshwar P Iyer

Thomas W. Zimmer and Norman M. Scarborough, Essentials of Entrepreneurship and Small Business Management, Prentice Hall of India, New Delhi, 2005.,Tom Peters., The Circle of Innovation, Alfred A. Knopf, New York, 1997.,John Drew., Readings in International Enterprise, Routledge, London, 1995.,Prem Vrat, K.K. Ahuja, and P.K. Jain., Case Studies in Management, Vikas Publishing House, New Delhi, 2002.

FL 141 (JAN) 3:0

Preliminary Course in Russian

Phonetics, speech patterns, tables, lexical and grammatical exercises and dialogues

Yadnyvalkya

I.S. Krishtofova and T.S. Gamzkova, Russian Language For All.,L. Muravyova, Verbs of Motion in Russian, Russian Language Publishers, Moscow, Third Edition.,L.I. Pirogova, Conjugation of Russian Verbs, Russky Yazyk Publishers, 1988.,Bagga R.S. and Menon R.N. Russian Language, Russian Language Publishers, Moscow.

MG 211 (JAN) 3:0

Human Resource Management

Historical development - welfare to HRM in India. Personnel functions of management. Integrated HRPD system, human resource planning, job analysis, recruitment and selection, induction, performance appraisal and counseling, career planning and development, assessment center, wage and salary administration, incentives, benefits and services. Labour legislation - Industrial Disputes Act, Indian Trade Unions Act, Industrial Employment (Standing Orders) Act, dealing with unions, workers participation and consultation, grievance handling, employee relations in a changing environment, occupational health and safety, employee training and management development, need analysis and evaluation, managing organizational change and development. Personnel research, human resource management in the future.

Akhilesh K B

DeCenzo and Robbins, Personnel and Human Resource Management, Prentice Hall, 1988.,Werther and Davis, Human Resources and Personnel Management, McGraw-Hill, 1996.,Beardwell and Holden, Human Resource Management, Macmillan, 1995,Akhilesh and Nagaraj, HRM 2000, Wiley Eastern, 1990.

MG 222 (JAN) 3:0

Regression and Time Series Analysis

Simple and multiple linear regression modeling, general linear hypotheses testing, and prediction; multiple and partial effects and correlations; residual analysis; dummy variable techniques (analysis of covariance). Classical decomposition of time series into trend, cyclical, seasonal and irregular components. Elementary trend modeling - growth models, polynomial and logistic trends. Stationary stochastic processes - auto-covariance and partial auto-correlation functions; MA, AR and ARMA models – Impulse Response Function, Auto Correlation Analysis and forecasting. Stochastic trends – unit root tests, ARIMA modeling, forecasting. Seasonality modeling – SARIMA models.

Mukhopadhyay C

Michael H. Kutner, Christopher J. Nachtsheim, John Neter & William Li, Applied Linear Statistical Models, McGraw-Hill International Edition, Fifth Edition, 2005.,Peter J. Brockwell & Richard A. Davis, Introduction to Time Series and Forecasting, Springer (India) Pvt. Ltd., Second Edition, 2006, Springer-Verlag.,None

MG 223 (JAN) 3:0

Applied Operations Research

Introduction to management decision making and operations research. Fundamentals of linear programming. Alternative ways of formulating practical linear programming models. Their advantages and disadvantages. Case studies and applications of linear programming. Solution approaches, implications of sensitivity analysis. Transportation and assignment programming. Sensitivity analysis in transportation programming; integer programming formulations and applications. Basics of heuristic optimization. Dynamic programming. Applications of dynamic programming [Entire course will use real-life business applications].

Mathirajan M

Anderson, Sweeny, and Williams, An Introduction to Management Science: Quantitative Approaches to Decision Making, 11th Edition, South Western. 2005.,Taylor, Introduction to Management Science, 10th Edition, Pearson, 2010.,Hillier, Introduction to Management Science, 4th Edition, McGraw-Hill/Irwin. 2010.,Ravindran, A., Phillips, D.T. and Solberg J.J., Operations Research – Principles and Practice, 2nd Edition, 2000, John Wiley and Sons. 2000.

MG 241 (JAN) 3:0

Marketing Management

Marketing function, marketing concept, relationship with other functions, relevance, marketing environment, markets. Consumer behavior, market segmentation, marketing planning, marketing mix, Product policy, new products, product life cycle. Pricing, distribution. Advertising and promotion. Marketing organization. Sales forecasting. Management of sales force, marketing control.

Srinivasan R

Phillip Kotler, Marketing Management - Analysis, Planning and Control, 13th Edition, Prentice-Hall of India, 2014.,R. Srinivasan, Case Studies in Marketing – The Indian Context, Prentice-Hall of India, 6th Edition, 2014.,None

MG 246 (JAN) 3:0

Customer Segmentation and Insights

Develop a deep actionable understanding of customers using a disciplined approach to give companies a competitive advantage using customer research, analytics and experimentation. Numeric data, language data and image data analysis, verbal and non-verbal communication skills, and presentation techniques. What is Customer Segmentation? How is it useful for organizations? What are Customer Insights? What are "product-out" verses "market-in" approaches? What is a "purchase journey?" What is Customer Experience Management? Illustrated with examples. How to get a holistic picture (360o view) of the customer base? Collecting quantitative and qualitative (emotions) data about customers. How is customer segmentation done using data analytics? Illustrative examples. What are the different stages in the purchase journey? How do we know which of these "touchpoints" are of value (moments of truth) to target customer segments? How does one benchmark with competition? Some practical approaches to connect with customers to get insights. Determining the "latent needs" of the customer by using image and language data (Voice of Customer), art of active listening and observing customer behavior. Developing the Kano Questionnaire, Conducting the Kano survey. Analyzing the Kano results including cross-tabulation of customer attributes, developing product/ service concepts (experiments), conducting a pilot, evaluating the effectiveness of the experiments. What are the tools available to deliver a differentiated customer experience at those "moments of truths?" How does "digital" play a role in enhancing customer experience?

Parthasarathy Ramachandran

McDonald, Emma K, Wilson, Hugh N, and Konus, Umut: Better Customer Insight, HBR September 2012.,Shen, Diane: Developing and Administering Kano Questionnaires on Kano's Methods for Understanding Customer-defined Quality, Center for Quality of Management Journal, Fall 1993.,Shiba, Shoji and Walden, David (2006): Breakthrough Management, CII.,Shiba, Shoji and Walden, David (2012): Four Practical Revolutions in Management, Productivity Press.

MG 274 (JAN) 3:0

Management of Innovation and Intellectual Property

Organizational and technological innovation – definition of innovation vs inventions, role of organizational design and processes – strategic role of intellectual property protection in case studies, the R&D value chain, stage gates, differences in priority with the R&D value chain, NPD - international, national, organizational, individual actors, organizations and vehicles to manage intellectual property, critical steps in managing R&D, process management during stage gates for patent searches, technology landscaping, specification writing, timeline management, rights and responsibilities in competitive technology environments, innovative inventions, commercial potential, processes to enhance technological know-how transfer, open source approach, incubators, assessing patent value, information technology support systems in managing innovation and intellectual property, prior art laboratories sessions and working with a client.

Parthasarathy Ramachandran

Trott, P., Innovation Management and New Product Development, Financial Times, Pitman Publishing, GB, 1998.,Petrusson, U., Intellectual Property and Entrepreneurship, Creating Wealth in an Intellectual Value Chain, CIP Working Paper Series, Centre for Intellectual Property Studies, Gotenburg, Sweden, 2004.,Rivette, K.G. & Kline, D., Rembrandts in the Attic, Unlocking the Hidden Value of Patents, Harvard Business School Press, Boston, Massachusetts, 2000.

MG 277 (JAN) 3:0

Public Policy Theory and Process

Introduction to policy; conceptual foundations; practice of policy making; theories: social, institutional rational choice, punctuated equilibrium, and stages; frameworks and models; government and politics; rationality and governance; role of rules, strategies, culture and resources; member

dynamics (institutional and non-institutional); analysis: meta, meso decision and delivery levels.

Anjula Gurtoo

Weimer, D.L., and Vining A.R., Policy Analysis: concepts and practice, Prentice Hall, New Jersey, 2004.,Lindbhlom, C.E., and Woodhouse, E.J., The policy making process, Prentice Hall, 1993.,None

MG 281 (JAN) 3:0

Management of Technology for Sustainability

Concepts of sustainability and sustainable development. Components of sustainability (social, economic, environmental). Linkages between technology and sustainability. Sustainability proofing of technology life cycle. Frameworks for measuring sustainability. Indicators of sustainability. Interactions between energy and technology and their implications for environment and sustainable development. Technological innovations for sustainability. Sustainable innovations – drivers and barriers. Policy and institutional innovations for sustainability transition.

Balachandra P

Dorf, Richard C., Technology, humans, and society: toward a sustainable world, Academic Press, 2001.,Rogers, P.P., Jalal, K.F. and Boyd, J.A., An Introduction to Sustainable Development, Earthscan, London, 2007.,Weaver, P., Jansen, L., Grootveld, G.V., Spiegel, E.V. and Vergragt, P., Sustainable Technology Development, Greenleaf Publishing, Sheffield, 2000.

MG 286 (JAN) 3:0

Project Management

The systems approach, project organization, work definition, scheduling and network analysis, PERT and CPM, resource–constrained scheduling, project costing and assessment, project control and management, software for project management, management of hi-tech projects, including software projects, quality and risk management.

Parameshwar P Iyer

Iyer, Parameshwar P., Engineering Project Management with Case Studies, Vikas Publishing, New Delhi, 2009.,Project Management Institute, USA. A Guide to the Project Management Body of Knowledge. Newton Square, PA. 1996.,Meredith, J.R., and Mantel, S.J. Jr., Project Management: A Managerial Approach, John Wiley and Sons, NY, 1995.

MG 299 (JAN) 0:16

Management Project

The project work is expected to give intensive experience for a student with respect to industrial organizations or institutions in the context of chosen field of specialization. Students are encouraged to carryout individual project works.

Parthasarathy Ramachandran

None,None,None

Nanosicence and Engineering

M Tech Degree Programme
Centre for Nano science and Engineering
Duration: 2 years

Departmental Core 28 credits

Course	Credits	Title
NE 215	3:0	Applied Solid State Physics
NE 241	3:0	Materials Synthesis: Quantum Dots to Bulk Crystals
NE 205	3:0	Semiconductor Devices and IC Technology
NE 213/E7 213	3:0	Introduction to Photonics
NE 211	3:0	Micro/Nano Mechanics
NE 202	1:1	Micro and Nano Fabrication
NE 201	2:1	Micro and Nano Characterization
NE 221	2:1	Advanced MEMS Packaging
NE 222	3:0	Micromachining for MEMS Technology
NE 100	1:0	Technical Writing and Presentation
NE 101	1:0	Entrepreneurship, Ethics and Societal Impact

Project

NE 299	**0:27**	**Project Work**
	0:03	**May-July**
	0:09	**August–December**
	0:15	**January June**

Electives: The balance of 9 credits to make up the minimum of 64 credits required to complete the M Tech Programme at CeNSE. Electives from within/outside the department can be taken with the approval of the DCC/Faculty advisor.

NE 101 (AUG) 1:0

Entrepreneurship, Ethics and Societal Impact

This course is intended to give an exposure to issues involved in translating the technologies from lab to the field. Various steps and issues involved in productization and business development will be clarified, drawing from experiences of successful entrepreneurs in high technology areas. The intricate relationship between technology, society and ethics will also be addressed with illustrations from people involved in working with the grass root levels of the society.

Navakanta Bhat

Lecture notes,-,-

NE 200 (AUG) 2:0

Technical Writing and Presentation

This course is designed to help students learn to write their manuscripts,technical reports, and dissertations in a competent manner. The do's and dont's of the English language will be dealt with as a part of the course. Assignments will include writing on topics to a student's research interest, so that the course may benefit each students directly.

Shivashankar S A

Lecture notes,-,-

NE 201 (AUG) 2:1

Micro and Nano Characterization Methods

This course provides training in the use of various device and material characterization techniques. Optical characterization: optical microscopy, thin film measurement, ellipsometry, and Raman spectroscopy; Electrical characterization: Noise in electrical measurements, Resistivity with 2- probe, 4-probe and van der Pauw technique, Hall mobility, DC I-V and High frequency C-V characterization; Mechanical characterization: Laser Doppler vibrometry, Scanning acoustic microscopy, Optical profilometry, and Micro UTM; Material characterization: Scanning electron microscopy, Atomic force microscopy, XRD, and Focused ion beam machining.

Akshay Naik,Manoj Varma

Lecture notes hands-on training manuals,Hands-on training manuals,Handouts on detailed process flows and device characterization schedule

NE 202 (AUG) 0:1

Micro AND Nano Fabrication

This course is designed to give training in device processing at the cleanroom facility. Four specific modules will be covered to realize four different devices i) p-n junction diode, ii) MOS capacitor iii) MEMS Cantilever iv) Microfluidic channel.

Shankar Kumar Selvaraja,Sushobhan Avasthi

Handouts on detailed process flows and device characterization schedule,Marc J. Madou,Fundamentals of Microfabrication and Nanotechnology, CRC press, ISBN 9780849331800,,Research articles

NE 203 (AUG) 3:0

Advanced micro- and nanofabrication technology and process

Introduction and overview of micro and nano fabrication technology. Safety and contamination issues in a cleanroom. Overview of cleanroom hazards. Basic process flow structuring. Wafer type selection and cleaning methods. Additive fabrication processes. Material deposition methods. Overview of physical vapour deposition methods (thermal, e-beam, molecular beam evaporation) and chemical vapour deposition methods (PE-CVD, MOCVD, CBE, ALD). Pulsed laser deposition (PLD), pulsed electron deposition (PED). Doping: diffusion and ion implant techniques. Optical lithography fundamentals, contact lithography, stepper/canner lithography, holographic lithography, direct-laser writing. Lithography enhancement methods and lithography modelling. Non-optical lithography; E-beam lithography, ion beam patterning, bottom-up patterning techniques. Etching process: dry and wet. Wet etch fundamentals, isotropic, directional and anisotropic processes. Dry etching process fundamentals, plasma assisted etch process, Deep Reactive Ion Etching (DRIE), Through Silicon Vias (TSV). Isotropic release etch. Chemical-mechanical polishing (CMP), lapping and polishing. Packaging and assembly, protective encapsulating materials and their deposition. Wafer dicing, scribing and cleaving. Mechanical scribing and laser scribing, Wafer bonding, die-bonding. Wire bonding, die-bonding. Chip-mounting techniques.

Shankar Kumar Selvaraja

Marc J. Madou,Fundamentals of Microfabrication and Nanotechnology, CRC press, ISBN 9780849331800,VLSI Fabrication Principles Silicon Gallium Arsenide 2nd Edition , Sorab.K Gandhi Wiley India,Handouts and Lecture notes,,Research articles

NE 205 (AUG) 3:0

Semiconductor Devices and Integrated Circuit Technology

This is a foundation level course in the area of electronic device technology. Band structure and carrier statistics, Intrinsic and extrinsic semiconductor, Carrier transport, p-n junction, Metal-semiconductor junction, Bipolar Junction Transistor, Heterojunction, MOS capacitor, Capacitance-Voltage characteristics, MOSFET, JEFET, Current-Voltage characteristics, Light Emitting Diode, Photodiode, Photovoltaics, Charge Coupled Device Integrated circuit processing, Oxidation, Ion implantation, Annealing, Diffusion, Wet etching and dry plasma etching, Physical vapour deposition, Chemical vapour deposition, Atomic layer deposition, Photolithography, Electron beam lithography, Chemical mechanical polishing, Electroplating, CMOS process integration, Moore's law, CMOS technology scaling, Short channel effects, Introduction to Technology CAD, Device and Process simulation and modeling

Digbijoy N Nath

Streetman and Banerjee ,Solid State Electronic Devices, Prentice-Hall,-,-

NE 213 (AUG) 3:0

Introduction to Photonics

This is a foundation level optics course which intends to prepare students to pursue advanced topics in more specialized areas of optics such as biophotonics, nanophotonics, non-linear optics etc. Classical and quantum descriptions of light, diffraction, interference, polarization. Fourier optics, holography, imaging, anisotropic materials, optical modulation, waveguides and fiber optics, coherence and lasers, plasmonics.

Ambarish Ghosh,Manoj Varma

Bahaa Saleh and Malvin Teich, Fundamentals of Photonics, Wiley and Son (1991) Hecht E, Optics. Addison Wesley, 2001,-,-

NE 215 (AUG) 3:0

Applied Solid State Physics

This course is intended to build a basic understanding of solid state science, on which much of modern device technology is built, and therefore includes elementary quantum mechanics. Review of Quantum Mechanics and solid state physics, Solution of Schrodinger equation for band structure, crystal potentials leading to crystal structure, reciprocal lattice, structure-property correlation, Crystal structures and defects, X-ray diffraction, lattice dynamics, Quantum mechanics and statistical mechanics, thermal properties, electrons in metals, semiconductors and insulators, magnetic properties, dielectric properties, confinement effects

Akshay Naik,Shivashankar S A

Stephen Elliott, Physics and Chemistry of Solids John Wiley, 1998,S. M Lindsay, Introduction to Nanoscience, Oxford (2010),Hook and Hall Solid State Physics

NE 222 (AUG) 3:0

MEMS: Modeling, Design, and Implementation

This course discusses all aspects of MEMS technology – from modeling, design, fabrication, process integration, and final implementation. Modeling and design will cover blockset models of MEMS transducers, generally implemented in SIMULINK or MATLAB. Detailed multiphysics modeling may require COMSOL simulations. The course also covers MEMS specific micromachining concepts such asbulk micromachining, surface micromachining and related technologies, micromachining for

high aspect ratio microstructures,glass and polymer micromachining, and wafer bonding technologies. Specific case studies covered include Pressure Sensors, Microphone, Accelerometers, Comb-drives for electrostatic actuation and sensing, and RF MEMS. Integration of micromachined mechanical devices with microelectronics circuits for complete implementation is also dicussed.

G.K.Ananthasuresh, K.J.Vinoy, S. Gopalakrishnan, K.N.Bhat and V.K.Aatre. “Micro and Smart Systems- Technology and Modelling” John Wiley & Sons, Inc (2012),Marc J. Madou, "Fundamentals of Microfabrication and Nanotechnology - Volume II" CRC Press (2012) Chang Liu, “Foundations of MEMS” Pearson Education International (2006),Stephen D. Senturia, “Microsystem Design”, Kluwer Academic Publishers, 2001

NE 231 (AUG) 3:0

Microfluidics

This is a foundation course discussing various phenomena related to fluids and fluid-interfaces at micro-nano scale. This is a pre-requisite for advanced courses and research work related to micro-nano fluidics.Transport in fluids, equations of change, flow at micro-scale, hydraulic circuit analysis, passive scalar transport, potential fluid flow, stokes flow Electrostatics and electrodynamics, electroosmosis,electrical double layer (EDL), zeta potential, species and charge transport, particle electrophoresis,AC electrokinetics Surface tension, hysteresis and elasticity of triple line, wetting and long range forces, hydrodynamics of interfaces, surfactants, special interfaces Suspensions, rheology,nanofluidics, thick-EDL systems, DNA transport and analysis

Prosenjit Sen

Brian J. Kirby, Micro- and Nanoscale Fluid Mechanics, Cambridge University Press,P.-G. de Gennes, F. Brochard-Wyart, and D. Quere, Capillarity and Wetting Phenomena, Springer,R. F. Probstein, Physicochemical Hydrodynamics, Wiley Inter-Science

NE 241 (AUG) 3:0

Material Synthesis: Quantum Dots To Bulk Crystals

All device fabrication is preceded by material synthesis which in turn determines material microstructure,

properties and device performance. The aim of this course is to introduce the student to the principles that help
control growth. Crystallography ; Surfaces and Interfaces; Thermodynamics, Kinetics, and Mechanisms of Nucleation and Growth of Crystals ; Applications to growth from solutions, melts and vapors (Chemical vapor deposition an Physical vapor deposition methods); Stress effects in film growth

Srinivasan Raghavan

Ivan V. Markov, Crystal growth for Beginners, Fundamentals of Nucleation, Crystal Growth and Epitaxy, World Scientific, 1998.(548.5,N96),L.B.Freund, S.Suresh, Thin Film Materials – Stress, Defect Formation and Surface Evolution, Cambridge University Press, 2003. (621.38152 PO36),Milton Ohring, Material Science of Thin Films, Academic Press

NE 312 (AUG) 3:0

Nonlinear and Ultrafast Photonics

This is an intermediate level optics course which builds on the background provided in “Introduction to photonics” offered in our department. Owing to the extensive use of nonlinear optical phenomena

and Ultrafast lasers in various fields, we believe a good understanding of these principles is essential for students in all science and engineering disciplines, in particular students involved in the area of Photonics, RF and Microwave systems, Optical Instrumentation and Lightwave (Fiber-optic) Communications. In addition, this course intends to prepare students to pursue advanced topics in more specialized areas of optics such as Biomedical Imaging, Quantum optics, Intense field phenomena etc.

Supradeepa V R

. Robert W. Boyd, Nonlinear Optics, Elsevier (2003),Govind P. Agrawal, Nonlinear Fiber Optics, Elsevier (2007),Andrew M Weiner, Ultrafast Optics, Wiley (2008),Miscellaneous Research Articles and Reviews.

NE 200 (JAN) 2:0

Technical Writing and Presentation

This course is designed to help students learn to write their manuscripts,technical reports, and dissertations in a competent manner. The do's and dont's of the English language will be dealt with as a part of the course. Assignments will include writing on topics to a student's research interest, so that the course may benefit each students directly.

Shivashankar S A

The Elements of Style William Strunk Jr. and E.B. White 4th Edition Long man,Academic Writing Stephen Bailey 2nd Edition Routledge,The Elements of Technical Writing Gary Blake and Robert W Bly - Longman

NE 201 (JAN) 2:1

Micro and Nano Characterization Methods

This course provides training in the use of various device and material characterization techniques. Optical characterization: optical microscopy, thin film measurement, ellipsometry, and Raman spectroscopy; Electrical characterization: Noise in electrical measurements, Resistivity with 2- probe, 4-probe and van der Pauw technique, Hall mobility, DC I-V and High frequency C-V characterization; Mechanical characterization: Laser Doppler vibrometry, Scanning acoustic microscopy, Optical profilometry, and Micro UTM; Material characterization: Scanning electron microscopy, Atomic force microscopy, XRD, and Focused ion beam machining.

Akshay Naik,Manoj Varma

Lecture notes and hands-on training manuals,-,-

NE 202 (JAN) 0:1

Micro AND Nano Fabrication

This course is designed to give training in device processing at the cleanroom facility. Four specific modules will be covered to realize four different devices i) p-n junction diode, ii) MOS capacitor iii) MEMS Cantilever iv) Microfluidic channel

Shankar Kumar Selvaraja,Sushobhan Avasthi

Handouts on detailed process flows and device characterization schedule,-,-

NE 211 (JAN) 3:0

Micro/Nano Mechanics

This is a foundation level course in mechanics which will prepare students to pursue advanced studies related to mechanical phenomena at the micro and nano scales. Basics of continuum theory, continuum hypothesis, elasticity, thermoelasticity, fluid mechanics, heat conduction, electromagnetism, coupled thermal-elastic and electrostatic-elastic systems, MEMS and NEMS structures -- beams, plates, and membranes, scaling of mechanical properties and continuum limits, numerical methods for mechanical modelling, mechanics beyond continuum theory.

Akshay Naik,Prosenjit Sen

John A. Palesko and David H. Bernstein, Modeling MEMS and NEMS, Chapman and Hall/CRC,-,-

NE 221 (JAN) 2:1

Advanced MEMS Packaging

This course intends to prepare students to pursue advanced topics in more specialized areas of MEMS and Electronic packaging for various real time applications such as Aero space, Bio-medical, Automotive, commercial, RF and micro fluidics etc. MEMS – An Overview, Miniaturisation, MEMS and Microelectronics -3 levels of Packaging. Critical Issues viz., Interface, Testing & evaluation. Packaging Technologies like Wafer dicing, Bonding and Sealing. Design aspects and Process Flow, Materials for Packaging, Top down System Approach. Different types of Sealing Technologies like brazing, Electron Beam welding and Laser welding. Vacuum Packaging with Moisture Control. 3D Packaging examples. Bio Chips / Lab-on-a chip and micro fluidics, Various RF Packaging, Optical Packaging, Packaging for Aerospace applications. Advanced and Special Packaging techniques – Monolithic, Hybrid etc., Transduction and Special packaging requirements for Absolute, Gauge and differential Pressure measurements,Temperature measurements, Accelerometer and Gyro packaging techniques, Environmental Protection and safety aspects in MEMS Packaging. Reliability Analysis and FMECA. Media Compatibility Case Studies, Challenges/Opportunities/Research frontier.

Prosenjit Sen

Tai-Ran Hsu, MEMS PACKAGING, INSPEC, The Institution of Electrical Engineers, London,UK,2004,Tai-Ran Hsu, MEMS & MICRO SYSTEMS Design and Manufacture, Tata McGraw Hill, New Delhi,2002,John H Lau, Cheng Kuo Lee, C.S. Premchandran, Yu Aibin, Advanced MEMS Packaging, McGraw-Hill, 2010

NE 310 (JAN) 3:0

Photonics technology: Materials and Devices

Optics fundamentals; ray optics, electromagnetic optics and guided wave optics, Light-matter interaction, optical materials; phases, bands and bonds, waveguides, wavelength selective filters, electrons and photons in semiconductors, photons in dielectric, Light-emitting diodes, optical amplifiers and Lasers, non-linear optics, Modulators, Film growth and deposition, defects and strain, III-V semiconductor device technology and processing, silicon photonics technology, photonic integrated circuit in telecommunication and sensors.

Shankar Kumar Selvaraja

Saleh, B. E. A., and M. C. Teich. Fundamentals of Photonics. New York, NY: Wiley, 1991.,T. Tamir, Topics in Applied Physics Volume 7: Integrated Optics, Springer-Verlag Berlin.,Haus, H. A. Waves and Fields in Optoelectronics. Englewood Cliffs, NJ: Prentice-Hall.,Research articles,,Handouts and Lecture

NE 313 (JAN) 3:0

Lasers: Principles and Systems

This is an intermediate level optics course which builds on the background provided in “Introduction to photonics” offered in our department. Owing to the extensive use of lasers in various fields, we believe a good understanding of these principles is essential for students in all science and engineering disciplines.

Supradeepa V R

Anthony E. Siegman, Lasers, University Science Books (1986),OrazioSvelto, Principles of Lasers, Springer (2010),Miscellaneous Research Articles and Reviews.

NE 332 (JAN) 3:0

Physics and Mathematics of Molecular Sensing

This course presents a systematic view of the process of sensing molecules with emphasis on bio-sensing using solid state sensors. Molecules that need to be sensed, relevant molecular biology, current technologies for molecular sensing, modeling adsorption-desorption processes, transport of target molecules, noise in molecular recognition, proof-reading schemes, multi-channel sensing, comparison between in-vivo sensing circuits and solid state biosensors

Manoj Varma

Lecture notes and selected publications from recent literature. Familiarity with solution of ODEs and PDEs, knowledge of Matlab, Mathematica or an equivalent programming language, elementary probability theory,-,-

Acknowledgements :

Dr. Panner Selvam, Joint Registrar, Academic
Primary Data : K Chandra Naik, Academic Section