BITS E591 Science and Technology Development I 4

BITS E592 Science and Technology Development II 4

This is a package of two courses in sequence, the second reinforcing the content of the first in scope or depth. Each one ends with a project report. These two courses will deal with issues relating to science and technology development. Towards this end, the method of teaching will heavily draw upon the examples as well as the requirement of project work consistent with the student's professional background. Thus, depending on the professional setting, the courses will cover various aspects of science and technology development in respect of science policy, R&D management, technology forecasting, science communication, science centres, rise of technological order, etc. While course No. I will aim at providing an integrated exposure to the student in the above context, course No. II will end up with analysis of a specific science and technology application situation for development.

BITS E593 Reading Course I 5

BITS E594 Reading Course II 5

BITS E611 Internship I 20

BITS E612 Internship II 20

Each of these courses will span a period of five and half months. Consistent with the student's Professional background and operational setting,the student will be required to carry out work-oriented projects. In their operation these courses will imitate internship under M.E.(Collaborative) programme, thus enabling the student to play the role of an understudy.

BITS E661 Research Methodology I 5

BITS E662 Research Methodology II 5

These two courses, to be offered in two consecutive semesters, are designed to impart training in methodology of research such as analysis of research problems, mathematical and statistical analysis of data, computer simulation methods, experimental techniques etc. The actual contents of these course will depend upon the needs and research goals of a particular student. A project report has to be submitted by each student at the end of each course.

The organization and evaluation of these courses would be achieved through seminars, group discussions, project reports etc. The courses will be conducted by a team of teachers.

BITS E793T Practice Lecture Series I 1

BITS E794T Practice Lecture Series II 1

BITS F110 Engineering Graphics 1 2 2

Introduction to AutoCAD basic commands; theory of projections; orthographic projections; isometric projections; projection of points, lines, planes and solids; section of solids; developments of surfaces; interpenetration of solids.

BITS F111 Thermodynamics 3 0 3

Course Description is same as given under ES C112

BITS F112 Technical Report Writing 2 0 2

Overview of communication, elements of effective writing, formal reports, types of reports, preparatory steps for writing reports, methods and sources of data, use of illustrations, oral presentation.

BITS F113 General Mathematics I 3 0 3

I. Review of coordinate geometry, Theory of equations, Progression and series, permutations and combinations, Binomial theorem, Functions: Trigonometric (with identities), Transcendental.

II. One Dimensional Calculus: Limit and continuity, Differentiation, Integration. Applications of derivatives and definite integration.

BITS F114 General Mathematics II 3 0 3

I. Polar coordinates, Function of several variables, Multiple integrals, Vector valued functions.

II. Complex functions and their analyticity.

III. First order and second order ordinary differential equations, Laplace transformations and its applications to ordinary differential equations.

BITS F201 Material Science and Engineering 3 0 3

Introduction on materials for engineering, structures of metals, ceramics and polymers; crystalline structure imperfections; amorphous and semi-crystalline materials (includes glasses, introduction to polymers); Correlation of structure to properties and engineering functions (mechanical, chemical, electrical, magnetic and optical); phase diagrams; Improving properties by controlled solidification, diffusion or heat treatment; Failure analysis and non-destructive testing; Types of materials (includes synthesis, Fabrication and processing of materials): Polymers and composites, Environmental degradation of materials (corrosion); Evolution of materials (functional materials, Biomimetic materials, energy saving materials etc); Criteria for material selection.

BITS F211 Introduction to IPR 1

Course description is same as given under BITS C211.

BITS F212 Introduction to Human Rights 1

Course description is same as given under BITS C212.

BITS F213 Introduction to Environmental Studies 1

Course description is same as given under BITS C213.

BITS F214 Science, Technology and Modernity 3 0 3

different critical approaches; practical criticism.

ENGL G551 Information Technology Lab I 5

(This course is specially designed to prepare the stream of input, viz. traditional English graduates, in the use of technology in communication).

This course is built around the theme of use of modern technology for the purpose of presentation and processing of information for effective communication within an organisation. Consistent with this theme, assignments would be drawn from the student's work environment and from one or more areas of the following: Computerized text processing; use of utility software packages for information processing and production; desk top graphics; desk top video; computerized graphics packages; office automation equipment such as electric typewriters; photography; equipment for projection and preparation of projection material; reprography equipment; duplication equipment; audio visual technology involving equipment such as video systems, audio systems and audio-visual recording equipment; techniques for display and exhibition of formatted information, etc. The course will be unstructured in nature and assignments may require study of the principles of the above areas, or the actual use of equipment and techniques.

ENGL G561 Information Technology Lab II 5

(This course is specially designed to prepare the stream of input, viz. traditional English graduates in the use of technology in communication)

This is a sequal to the first course of the same name. The theme of use of modern technology for the purpose of presentation and processing of information for effective communication within an organization would be further developed. However, assignments would invariably emphasize the integration between various technologies for totality of communication.

ENGL G571 Applied Communication I 5

(This course is specially designed to prepare the stream of input, viz. engineering and hard science graduates in communication methods)

Process of communication; elements of speech; role of body language; dyadic communication; participation in different types of discussion groups, audio-visual aids.

ENGL G581 Applied Communication II 5

(This course is specially designed to prepare the stream of input viz. engineering and hard science graduates, in communication methods)

Elements of effective writing; methods of written exposition; art of condensation; writing technical articles, research papers, proposals, reports, manuals and letters, preparation and use of graphic aids; mechanics of writing; technical editing.

ENGL G591 Project Formulation and Preparation 5

Course description is same as given under BITS G651.

ENGL G611 Twentieth Century English Literature 5

Margret Atwood, Tony Morrison, Samuel Beckett, Harold Pinter, Philip Larkin,Ted Hughes.

Engineering Science

ES C112 Thermodynamics 3 0 3

Concepts and laws of thermodynamics; macroscopic thermodynamic properties; application to closed and open system; microscopic approach to entropy; equations of state; thermodynamics of nonreacting mixtures.

ES C221 Mechanics of Solids 3 0 3

Fundamental principles of mechanics; introduction of mechanics of deformable bodies; forces and moments transmitted by slender members; stress and strain; stress-strain-temperature relations; torsion; stresses and defections due to bending; stability of equilibrium.

ES C222 Energy Conversion 3 0 3

Prerequisite: ES C231

Study of the technical and economic problems in energy conversion; electromechanical conversion principles and devices; present technology including technical and economic comparison of thermal, hydro, and nuclear methods; future energy technology including analysis of breeder concepts, fusion devices, MHD; solar energy; and fuel cells.

ES C231 Circuit Theory 3 0 3

Electrical circuits as analogous of nonelectrical systems-examples drawn from various disciplines; circuit models, equilibrium equations and their solutions; independent sources; exponential signals; steady-state of electrical circuits; linear dependence; mesh and nodal analysis, network theorems; energy and power.

ES C233 Logic in Computer Science 3 0 3

Role of logic in computer science. Propositional logic – syntax and well-formedness, semantics, satisfiability and validity, decision procedures. Predicate logic or first order logic – syntax, and semantics, satisfiability and validity, completeness and compactness, undecidability and incompleteness – Godel's incompleteness theorem. Verification – model checking, linear-time temporal logic and computational tree logic. Program verification – Hoare logic, proofs of correctness. Modal logic, logic programming.

ES C241 Electrical Sciences I 3 0 3

Introduction; basic circuit elements; sources (dependent and independent); Kirchoff's current and voltage law, source representation and conversion; Network theorems; response of RL, RC and RLC circuits; diodes and its applications; transistors - BJT & FETs; amplifiers: biasing and small signal analysis; OPAMPS; Digital Logic gates; Basics of Combinational and Sequential circuits.

PHY F111 Mechanics, Oscillations and Waves **3 0 3**

Course description is same as given under PHY C131.

PHY F112 General Physics **3 0 3**

Philosophy of Science; Newton's laws of motion; Work Energy, Impulse and Momentum; Equilibrium; Moment of a force; Rotation; Periodic motion; First law of thermodynamics; Second law of thermodynamics; Electromagnetic waves; Interference and diffraction; Polarization; Relativistic mechanics; Photons, Electrons and Atoms; Quantum Mechanics; Atoms, Molecules and Solids; Nuclear Physics.

PHY F211 Classical Mechanics **3 1 4**

Review of Newtonian mechanics, constraints and generalized coordinates, Lagrange's equation of motion, calculus of variation and principle of least action, central force motion, kinematics of rigid body motion, rigid body equations of motion, heavy symmetrical top, Hamilton's equations of motion, canonical transformations.

PHY F212 Electromagnetic Theory I **3 0 3**

Review of mathematics - scalar and vector fields, calculus of scalar and vector fields in Cartesian and curvilinear coordinates, Dirac delta function; Electrostatics - electric field, divergence & curl of electric field, electric potential, work and energy in electrostatics, conductors, electric dipole; Electrostatics in Matter - polarization and field of a polarized object, electric displacement, linear dielectrics; Magnetostatics - Lorentz force law, Biot-Savart law, divergence & curl of magnetic field, magnetic vector potential, magnetic dipole; Magnetostatics in matter - magnetization and field of a magnetized object, the H-field, linear & non-linear magnetic media; Electrodynamics - electromotive force, electromagnetic induction, Maxwell's equations in free space, plane wave solutions of Maxwell's equations in free space.

PHY F213 Optics **3 0 3**

Geometrical optics - light as rays, Fermat's principle, matrix methods in ray tracing; scalar wave theory of light, spatial and temporal coherence, theory of diffraction - Fresnel & Fraunhoffer diffraction, diffraction at rectangular and circular aperture, diffraction around opaque objects; crystal optics - electromagnetic wave propagation in anisotropic media, birefringence, e-m waves in nonlinear media, elements of nonlinear optics; scattering of light – Thomson and Rayleigh scattering; elements of modern optics - lasers and applications, holography, fiber optics, Fourier optics.

PHY F214 Electricity, Magnetism, and Optics Lab **0 2 2**

This lab will consist of experiments on electromagnetism, optics and lasers.

PHY F215 Introduction to Astronomy and Astrophysics **3 0 3**

Introduction and scope, telescopes, distance and size measurements of astronomical objects, celestial mechanics, the Sun, planets, planet formation, interstellar medium, star formation, stellar structure, stellar evolution, star clusters - open clusters, globular clusters, the Milky-Way galaxy, nature of galaxies - normal and active galaxies, Newtonian cosmology, cosmic microwave background radiation, the early universe.

PHY F241 Electromagnetic Theory II **3 1 4**

Maxwell's equations in matter, boundary conditions on electric and magnetic fields; energy of e-m fields and Poynting's theorem, linear momentum and angular momentum of e-m fields, Maxwell's stress tensor; electromagnetic waves in dielectric media – reflection, refraction and transmission at interfaces; wave propagation in metals – absorption and dispersion; guided waves; potential formulation of e-m fields, retarded potentials & Jefimenko's equations, Lienard-Weichert potentials and fields of a moving point charge; dipole radiation & radiation due to point charges; special theory of relativity, relativistic mechanics, relativistic electrodynamics.

PHY F242 Quantum Mechanics I **3 0 3**

Origin of the quantum theory - black body radiation, photoelectric effect, Compton scattering, electron diffraction, Bohr model of hydrogen atom, Frank-Hertz experiment, Bohr-Sommerfeld quantization condition; notion of wave function, statistical interpretation of the wave function, issues of normalization, the Heisenberg uncertainty relation; Schrodinger equation, stationary states and time independent Schrodinger equation, energy eigenvalues and eigenfunctions, one-dimensional problems – potential wells, potential barriers, the harmonic oscillator; Hilbert space formalism – state vectors, Dirac's bra-ket notation, observables as Hermitian operators, eigenvalues and eigenstates of Hermitian operators, the measurement postulate.

PHY F243 Mathematical Methods of Physics **3 0 3**

Tensor analysis in Cartesian and curvilinear coordinates; linear vector spaces, linear transformations and theory of matrices; functions of a complex variable, contour integration and applications; elements of calculus of variation; series solution of ordinary differential equations, special functions, Sturm-Liouville theory; Fourier integral; partial differential equations of physics, solution of partial differential equations by separation of variables method, the Green function method.

PHY F244 Modern Physics Lab **0 2 2**

This lab will consist of experiments on modern physics and electromagnetism.

PHY F266 Study Project **3**

Course description is same as given under BIO F266.

tural, transform based and topological strategies involving organic reactions, functional group interconversions, reconnection and disconnection approaches, acyclic, ring structure synthesis, rearrangement reactions pertaining to the synthesis of selected medicinally important compounds.

PHA G619 Screening Methods and Techniques In Pharmacology **5***

Biochemical assays, qualitative and quantitative estimation of receptor specific drugs, animal handling, breeding, nutrition and diet manipulation for testing, methods and techniques involved, therein. Design and development of new animal models and evaluation techniques for co-morbid illnesses and their standardization, toxicological, teratogenic, carcinogenic studies, data analysis, normalization in tabular and graphical formats.

PHA G621 Advanced Medicinal Chemistry **2 3 5**

Methods of synthesis; properties, uses, methods of assay and structure-activity relationship of non-mercurial diuretics, psychopharmacologicals, anti-cancer agents; chemistry of prostaglandins; some concepts of receptor theories, dose response curves, introduction to QSAR.

PHA G622 Chemistry of Natural Drugs & Macromolecules **3 2 5**

Size and shape of macromolecules, biomedical polymers, their structure, synthesis and function, chemistry of newer oral contraceptive agents, terpenes used as flavouring agents, newer phytochemical investigations in glycosides, alkaloids, etc.

PHA G632 Dosage Form Design **2 3 5**

A study of physical and chemical, pharmacological and biopharmaceutic factors involved in the design and stability of dosage forms; transport of drugs across biological membranes; absorption, distribution and elimination of drugs; formulation additives, closures and containers and sustained release dosage forms; microencapsulation; radio pharmaceuticals.

PHA G642 Laboratory Project **6**

Exercises illustrating principles discussed in theory courses.

PHA G645 Molecular Pharmacology **3 0 3**

Molecular basis of the action of drugs; the characteristics of interactions between drug molecules and substrates of drug action in the cell; molecular, biochemical and cell biological techniques; response of cells to pharmacologic agents.

Philosophy

PHIL C211 Introductory Philosophy **3 0 3**

An overview of some philosophical theories and issues both from India and the western world; nature and purpose of philosophy; theories of cosmology, metaphysics and epistemology; skepticism and its philosophical value; contemporary philosophy.

PHIL C221 Symbolic Logic **3 0 3**

A brief historical survey of the development of logic; nature and kinds of arguments; sentential connectives; symbolization of statements and arguments; truth tables, establishing validity of arguments by truth tables and different types of proofs, quantified statements; quantified arguments and their validity.

Physics

PHY C122 General Physics **3 0 3**

Philosophy of Science; Newtons laws of motion; Work Energy, Impulse and Momentum; Equilibrium; Moment of a force; Rotation; Periodic motion; First law of thermodynamics; Second law of thermodynamics; Electromagnetic waves; Interference and diffraction; Polarization; Relativistic mechanics; Photons, Electrons and Atoms; Quantum Mechanics; Atoms, Molecules and Solids; Nuclear Physics.

PHY C131 Physics I (Mechanics, Waves & Optics) **3 0 3**

Conservation Principles, Rotational Dynamics, Oscillations, Wave Motion, Reflection and Refraction, Interference, Diffraction, Polarisation.

PHY C132 Physics II (Electricity, Magnetism & Modern Physics) **3 0 3**

Electric Field, Magnetic Field, Electric Current, Electromagnetic Induction, Maxwell's Equations, Electromagnetic Waves, Bohr Atom, Atomic spectra, Wave Practicle Duality, Uncertainty Principle.

PHY C212 Classical Mechanics **3 0 3**

Dynamics of particles; generalized coordinates, Lagrange's and Hamilton's equations; rigid body dynamics; small oscillations; normal modes; canonical transformations; Poisson's brackets; action-angle variables.

PHY C221 Modern Physics **3 0 3**

Special theory of relativity; quantum mechanics and applications; atomic and molecular physics; statistical physics; nuclear physics.

PHY C231 Physics Project Laboratory **3***

The course includes projects involving laboratory investigation or laboratory development in physics. The course is normally available to students of second year or higher level. The course must coterminate with a project report.

PHY C232 Computational Physics **3 0 3**

Numerical solution of physics problems selected from the basic courses of Mechanics & Vibrations, Electricity of Magnetism, Optics and Modern physics. Various topics like Newton's equation of motion, damped, forced and coupled oscillations, electric fields and potential of charge distributions, interference and diffraction patterns for different slit geometry, energy eigen-

sign; implementation: languages, compilers, runtime environments and operating systems for embedded software; testing: methodologies, tests cases.

CS C441 Selected Topics from Computer Science 3 0 3

This course is primarily intended to introduce the students of computer science to topics, either in recent advances or of special interest. Topics may be taken from one or more of the areas like artificial intelligence, theory of computing, networking and distributed processing, digital control, information theory, super computers, special purpose architectures and language processors.

The course will be unstructured and operationally polarized depending upon the interests and pursuits of the professional in the discipline. Actual structuring will be announced from time to time.

CS C442 Advanced Algorithms and Complexity 3 0 3

Randomized algorithms (Las Vegas & Monte Carlo); basic tools from probability theory and probabilistic analysis required in algorithmic applications: game theoretic techniques; occupancy problems & tail inequalities; data structures for randomized algorithms: skip list & hash tables; randomized geometric & linear programming algorithms: convex hull, duality & diameter of a set; randomized graph algorithms: all-pairs shortest paths & minimum spanning trees; optimization problems: simplex algorithm & duality; primal-dual algorithm for shortest paths; NP-Completeness; the Classes P & NP, NP – hard problems, approximation algorithms.

CS C444 Real–Time Systems 3 0 3

Introduction to real-time systems, clock synchronization, task assignment and scheduling, programming language with real-time support, ADA, real-time communication protocols, real-time databases, fault tolerant techniques, reliability evaluation methods; case studies in real-time operating systems, simulation of real-time systems, embedded system programming.

CS C446 Data Storage Technologies and Networks 3 0 3

Storage Media and Technologies – Magnetic, Optical and Semiconductor media, techniques for read/write operations, issues and limitations. Usage and Access – Positioning in the memory hierarchy, Hardware and Software Design for access, Performance issues. Large Storages – Hard Disks, Networked Attached Storage, Scalability issues, Networking issues. Storage Architecture. - Storage Partitioning, Storage System Design, Caching, Legacy Systems. Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids. Storage QoS – Performance, Reliability, and Security issues.

CS C451 Combinatorial Mathematics 3 0 3

Advanced theory of permutations and combinations; elementary counting functions; theory of partitions; theorems on choice including Ramsey's theorem; the mobius function; permutation groups; Polya's theorem and Debrauijn's generalisation; graphical enumeration problems.

CS C453 Discrete Mathematical Structures 3 0 3

One or more of the interrelated topics will be covered from the following: graphs, designs, codes, shift register sequences, groups, fields, Boolean algebras, analysis of algorithms, Fast Fourier Transform etc. providing a fertile ground for interaction between mathematics and modern areas of computer science. The selection of the topics will depend upon the circumstance and current interest of faculty.

CS C461 Computer Networks 3 0 3

(Prerequisite: CS C372 Conc.)

Evolution of communication and computer networks, protocol layering, network reference models, multiple access protocols, local area networks, packet and circuit switching, switching fabrics, network performance analysis and simulation techniques; addressing, routing, flow and congestion control, IP protocol; Broadband Integrated Services Digital Network (B-ISDN); Asynchronous Transfer Mode (ATM) reference models; network interoperability, traffic management and quality of service in integrated network protocol design and implementation strategies.

CS C471 Computer Graphics 2 2 3

Generation of dots, lines, arcs and polygons; color graphics, shades and levels; image transformation, windowing and clipping; 2-D and 3-D graphics; data structures, algorithms and optimization methods; case studies using GKS, CORE, etc; graphic languages and compilers.

CS C481 Graphical User Interfaces 3 0 3

Concept of an User Interface; User Interface Management Systems; Interaction Styles; Event-driven programming; graphical user interface components and examples; emphasis will be on programming in GUI environments like MS Windows.

CS C491 Special Projects 3

Course description is same as given under BIO C491.

CS F111 Computer Programming 3 1 4

Basic Model of a Computer; Problem Solving-Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files.

Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded it-

EEE C444 Real–Time Systems **3 0 3**

Course description is same as given under CS C444.

EEE C452 Electromagnetic Fields & Microwave Engineering **3 0 3**

Electromagnetic waves; Maxwell's equations; Poynting theorem and wave equations; propagation of EM waves; transmission lines; microstrip lines; wave guides; cavities and antennas; microwave generators, microwave amplifiers; measurement at microwave frequencies.

EEE C453 Discrete Mathematical Structures **3 0 3**

Course description is same as given under CS C453.

EEE C461 Power Electronics **3 0 3**

PNPN devices, power transistor characteristics, rating and specifications; triggering mechanism and commutation circuits; controlled power rectifiers, Inverters (DC to AC converters), choppers (DC to DC Converters); speed control of DC motors, speed control of AC motors; other industrial applications of thyristors and power transistors; voltage regulation and starting of electrical drives; logic modules for static converters; introduction to application of microprocessors for electrical drives.

EEE C462 Advanced Power Systems **3 0 3**

Prerequisite: EEE C371 or INSTR C371

Symmetrical components, sequence impedances; fault calculations; short circuit studies; circuit breakers and their selections; power system stability, power system protection--generators, transformers and lines; waves on transmission lines, protective devices -- grounded and ungrounded systems.

EEE C471 Electronic Measurements and Instrumentation **3 0 3**

Elements of electronic measurement and instrumentation; signal sources; voltage and current measuring instruments; waveform analysis instruments; display and recording instruments; device testers, DC power supplies and IC regulators; bridge instruments; basic digital instruments, industrial electronic practices.

EEE C472 Satellite Communication **3 0 3**

Review of microwave communications and LOS systems; the various satellite orbits like GEO, MEO, LEO; the satellite link analysis and design; the communication transponder system like INSAT, INELSAT etc; the earth segment and earth station engineering; the transmission of analog and digital signals through satellite and various modulation techniques employed; the multiple access techniques like FDMA, TDMA, CDMA, DAMA, etc; the INSAT program; salient features of INSAT – systems and services offered; satellite services offered by INTELSAT, INMARSAT and future satellites like IRIDIUM etc; future trends in satellite communications.

EEE C491 Special Projects **3**

Course description is same as given under BIO C491.

EEE F111 Electrical Sciences **3 0 3**

Course covers basic passive circuit elements, dependent and independent sources, network theorems, circuit analysis techniques and response of first and second order circuits. Introduction to three - phase circuits, magnetic circuits, transformers, basics of rotating machines. Semiconductors - operation of diodes, zener diodes, bipolar junction transistors and field effect transistors. Biasing techniques and applications of diodes and transistors. Introduction to operational amplifiers and applications. Introduction to Digital Electronics.

EEE F211 Electrical Machines **3 1 4**

Transformer: Constructional features, equivalent circuit and phasor diagram - regulation and efficiency, parallel operation. Three phase transformer connections; Harmonic in transformers; Testing; Phase conversion; Autotransformer. D.C Machines: Construction, armature windings, armature voltage and torque equations, classification. D.C generators, performance characteristics; D.C motors - torque/speed characteristics, speed control and braking. Testing and efficiency. Induction machines: Constructional features and rotating magnetic field. Circuit model and phasor diagram.

Steady state characteristics. Testing, starting and speed control. Time harmonics and space harmonics. Wound rotor induction motors, Single phase induction motors - classification and equivalent circuit. Synchronous machines: Constructional features; synchronous generators and motors; equivalent circuit and phasor diagram; power and torque characteristics and capability curves. Parallel operation. Salient pole synchronous machine - phasor diagram and determination of synchronous reactances; starting and speed control of synchronous motors. Special machines- universal motors, Induction generators.

EEE F212 Electromagnetic Theory **3 0 3**

Course description is same as given under PHY F212 Electromagnetic Theory I.

EEE F214 Electronic Devices **3 0 3**

Crystal structure and growth of semiconductor, electrical conduction in solids, Elementary quantum physics (Photoelectric effect, uncertainty principle, Schrodinger wave equation and tunneling), energy bands in solids, charge carriers in semiconductors, excess carriers in semiconductors, Fabrication of p-n junctions, equilibrium conditions, forward and reverse biased junctions, metal-semiconductor junctions Bipolar junction transistors, field effect transistors (JFET, HEMT, MOSFET), Special diodes (varactor diode, solar cell, LEDs, Tunnel diode and HBT), dielectric materials and insulation (Polarization mechanisms, frequency dependence, dielectric strength and insulation breakdown).

and Proca equations, Maxwell's equations and differential geometry; Lagrangian Formulation of particle mechanics, real scalar field and Noether's theorem, real and complex scalar fields, Yang-Mills field, geometry of gauge fields, cannonical quantization of Klein-Gordan, Dirac and Electromagnetic field, spontaneously broken gauge symmetries, Goldstone theorem, superconductivity.

PHY C415 General Theory of Relativity and Cosmology **3 1 4**

Review of relativistic mechanics, gravity as geometry, descriptions of curved space-time, tensor analysis, geodesic equations, affine connections, parallel transport, Riemann and Ricci tensors, Einstein's equations, Schwarzschild solution, classic tests of general theory of relativity, mapping the universe, Friedmann-Robertson-Walker (FRW) cosmological model, Friedmann equation and the evolution of the universe, thermal history of the early universe, shortcomings of standard model of cosmology, theory of inflation, cosmic microwave background radiations (CMBR), baryogenesis, dark matter & dark energy.

PHY C421 Quantum Mechanics II **3 0 3**

Prerequisite: PHY C321

Theory of scattering, phaseshift analysis; the S matrix, time- dependent and time-independent approaches to scattering theory; Born and Eikonel approximations; examples from typical potentials like square well, exponential and delta function potentials; resonances in potential scattering; Coulomb scattering problem and scattering from coulomb and nuclear fields; variational principle applicable in scattering theory; time-dependent perturbation theory; theory of angular momentum; identical particles and spin; Dirac and Klein Gordon equations.

PHY C422 Group Theory & Applications **3 0 3**

Abstract group theory; theory of group 141epresenttations, crystal- symmetry operators, the crystallographic point groups, elementary representations of the three-dimensional rotation group, crystal-field splitting of atomic energy levels, intermediate crystal- field case, weak-crystal-field case and crystal double groups, introduction of spin effects in the medium-field case, group theoretical matrix-element theorems, application of group theory to directed valence; full rotation group and angular momentum; quantum mechanics of atoms; molecular quantum mechanics; solid- state theory.

PHY C423 Special Topics in Statistical Mechanics **3 1 4**

The Ising Model – Definition, equivalence to other models, spontaneous magnetization, Bragg- William approximation, Bethe-Peierls Approximation, one dimensional Ising model, exact solution in one and two dimensions; Landau's mean field theory for phase transition – the order parameter, correlation function and fluctuation-dissipation theorem, critical exponents, calculation of critical exponents, scale invariance, field driven transitions, temperature driven condition, Landau-Ginzberg theory, two-point correlation function, Ginzberg criterion, Gaussian approximation; Scaling hypothesis – universality and universality classes, renormalization group; Elements of nonequilibrium statistical mechanics – Brownian motion, diffusion and Langevin equation, relation between dissipation and fluctuating force, Fokker-Planck equation.

PHY C432 Laser & Applications **3 0 3**

Properties of laser light, Theories of some simple optical processes, Basic principles of lasers, Solid-state lasers, Gas lasers, Semiconductor lasers, Free electron lasers, Liquid, Dye and Chemical lasers, Dynamics of laser processes, Advances in laser physics, Q-switching, Mode-locking (active and passive), Saturable absorbers, Kerr lens mode locking, Non-linear Optics, Laser Spectroscopy, Time resolved spectroscopy, Multi-photon spectroscopy.

PHY C441 Physics Laboratory **0 9 3**

Specially designed for M.Sc. (Hons.) Physics; cannot be taken by others under any circumstances. This laboratory course is designed only for M.Sc. (Hons) Physics students in order to develop competence in selected experiments in physics.

PHY C451 Materials Science **3 0 3**

Intrinsic and extrinsic semiconductors; Excess carriers in semiconductors; Material technology; Measurement of semiconductor properties; Theory of p-n junctions; Rectifiers; Transistors; Other semiconductor devices.

PHY C461 Process Analysis Instrumentation **3 0 3**

Course description is same as given under INSTR C392.

PHY C471 Astrophysics **3 0 3**

Celestial Mechanics; Solar System; Stars; Nebulae and Galaxies; Constellations; Cosmology; Techniques of Space-exploration; Latest discoveries and programmes for space exploration. Observation of heavenly bodies.

PHY C491 Special projects **3**

Course description is same as given under BIO C491.

PHY F110 Physics Laboratory **0 2 1**

An introductory experimental course covering experiments in Mechanics, Oscillations and Waves. In addition to performing classic experiments in physics, the course aims at strengthening experimental skills and ability to take proper measurements. The course should motivate students to enter the exciting world of experimental physics.

MGTS C481 Industrial Marketing **3 0 3**

Market/consumer orientation, marketing in industrial context, industrial market behaviour, organisational buying and buying behaviour, business forecasting and planning, product planning, new product development, pricing, distribution, management of communications, advertising & personal selling, management of sales force, corporate strategy and industrial marketing.

MGTS C482 Franchising **3 0 3**

History and Development, pros and cons of franchising, evaluating, purchasing and financing a franchise, preparations and guidelines for franchise operations, franchise agreement and manuals, international franchising.

MGTS C483 Marketing Research **3 0 3**

An examination of the concepts and practical methodology used in marketing research. An overview of marketing research process, with emphasis on research design; data instrument design; questionnaire formulation; sampling plans; data collection methods - interviewing, panels; data analysis and use of computer based information systems for marketing intelligence. Also Time-series & Regression based models of sales forecasting, control and evaluation of marketing function and survey methodology are covered.

Emphasis will be on cases and research projects.

MGTS C491 Special Projects **3**

Course description is same as given under BIO C491.

MGTS F211 Principles of Management **3 0 3**

Course description is same as given under MGTS C211.

MGTS G511 Advanced Marketing Theories and Advertisement **5**

Strategic planning, theory and methods with emphasis on customer, competitor industry and environmental analysis and its application to strategy development and choice. Marketing communication through advertising and related mass media and promotion campaigns and its influence on market and other organisation. Globalisation and marketing aspects.

MGTS G513 Public Programme Evaluation **5**

Value judgements & public choice, social welfare-Paretion Welfare Economics; market system, income distribution and government & the market. social cost benefit Analysis (SCBA):SCBA and public sector investment planning, efficiency pricing & the rational of new methodology, problems of pricing comparative advantage, social pricing; the application SCBA: economic pricing of factor of production, social pricing, distribution & public sector; management values of public sector undertakings.

MGTS G521 Business Policy-Structure and Organisation **5**

Frame-work of business dynamics; missions; objective and goals; social aspects of business policy; environmental analysis; the dynamic setting of business policy; internal analysis of resources - strength and weaknesses; strategic planning choice, implementation and evaluation; functional policies; orientation in special cases - MNC's high-tech companies, non-profit organisations etc.

MGTS G531 Recent Advances in Organisation Behaviour Theory **5**

Emerging challenges of human resource management- a futuristic perspective; unified global theory of management; empowerment; employeeship; entrepreneurship; organisation diagnosis and development; social system and organisational culture-both in the national and global context interpersonal and group dynamics; employee attitudes; leadership and decision making; motivating employees; quality of work life and socio - technical systems; dealing with subordinates, boss, peers, problem employees.

MGTS G541 Management Information and Decision Support Systems **5**

Course description is same as given under BITS G641.

MGTS G551 Frontiers in Financial Management **5**

Course description to be developed.

MGTS G561 Institutional Finance and Project Appraisal **5**

Mobilization of funds internally, externally, financial institutions and international financial institutions, financial and monetary framework of international financial management, foreign exchange markets and negotiations, project definition, preparation of feasibility assessment and selection, project reporting, conventional project appraisal - limitations, towards a new framework.

Management Systems

MGSYS C411 Marketing **2 2 4**

Definition and scope, consumer behaviour, competitive behaviour, demand estimation, new product introduction, product/brand management, pricing policies, channels of distribution, credit management, advertising and other sales promotion, positioning, marketing regulation, market research basics of industrial marketing.

MGSYS C421 Organization: Design and Process **2 2 4**

Organizational structural characteristics, efficiency, effectiveness and adaptability, structural characteristics

MF F366 Lab Project **3**

MF F367 Lab Project **3**

Course description is same as given under BIO F366 and BIO F367.

MF F376 Design Project **3**

MF F377 Design Project **3**

Course description is same as given under BIO F376 and BIO F377.

MF F411 Fluid Power Systems **3 1 4**

Introduction to Fluid power, advantages of fluid power, applications, Introduction to Pneumatics, Air preparation and Components, Pneumatics Circuits and Applications, Electro pneumatics, Electrical Controls for fluid power circuits, , Physical properties of hydraulic fluids, Energy and Power in Hydraulic Systems, Frictional Losses in Hydraulic Pipelines, Hydraulic Pumps, Hydraulic Cylinders and Cushioning Devices, Hydraulic Motors, Hydraulic Valves, Hydraulic Circuit Design and Analysis, Ancillary Hydraulic Devices, Hydraulic Conductions and Fittings, Maintenance of Hydraulic Systems, Use of PLC programming for interfacing pneumatics and Hydraulic Circuits.

MF F412 Automotive Systems **3 0 3**

Course description is same as given under MF C412.

MF F413 Mechanical Vibrations and Acoustics **3 0 3**

Course description is same as given under MF C413.

MF F414 Manufacturing Excellence **3 0 3**

Course description is same as given under MF C414.

MF F415 Noise Engineering **3 0 3**

Course Description is same as in MF C415.

MF F416 Work System Design **3 0 3**

Course Description is same as in MF C416.

MF F418 Lean Manufacturing **3 0 3**

Course description is same as given under MF C418.

MF F421 Supply Chain Management **4**

Course description is same as given under MBA C421.

MF F442 Advances in Materials Science **3 0 3**

Course description is same as given under ME C442.

MF F453 Industrial Relations **3 0 3**

Course description is same as given under CDP C364.

MF F463 Maintenance and Safety **3 0 3**

Course description is same as given under ENGG C242.

MF F471 Instrumentation and Control **3 0 3**

Course description is same as given under ET C341.

MF F472 Precision Engineering **3 0 3**

Course description is same as given under ME C472.

MF F473 Product Design and Development **3 0 3**

Course description is same as given under MF C473.

MF F474 Product Design and Development Projects **3**

Course description is same as given under MF C474.

MF F485 Sustainable Manufacturing **3 0 3**

Overview of sustainable manufacturing, 6R, WEEE, triple bottom concept of environment, economy and society, driver for, barriers to and stakeholders of sustainable manufacturing and their modelling, performance measures of sustainable manufacturing, evaluation of manufacturing systems based on environmental factors, eco-innovation and design for environment, recycling, remanufacturing, reuse, strategic and operational evaluation of technologies using life cycle management, environmental impact assessment models, end-of-life strategies, reverse logistics, sustainable product service systems, green factories.

MF F491 Special Projects **3**

Course description is same as given under BIO F491.

Management

MGTS C211 Principles of Management **3 0 3**

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

MGTS C233 Principles of Marketing for Engineers **3 0 3**

Prerequisite: MGTS C211- Principles of Management

Defining marketing for 21st century. gathering information and scanning the environment. conducting marketing research and forecasting demand, creating customer value satisfaction and loyalty, analyzing consumer markets, analyzing business markets, identifying market segments and targets, branding and positioning, setting product strategy, developing pricing strategies and programs, designing and managing value networks and channels, managing retailing wholesaling and logistics, designing and managing integrated marketing communications, managing mass communications, managing personal communications.

MGTS C322 Marketing **3 0 3**

Course description is same as given under FIN C431.

MGTS C351 Organisational Behaviour **3 0 3**

Course description is same as given under FIN C441.

Course Description for all On-campus Programmes

Analysis & Application Oriented Courses

AAOC C111 Probability and Statistics **3 0 3**

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

AAOC C221 Graphs and Networks **3 0 3**

Basic concepts of graphs and digraphs behind electrical communication and other networks behind social, economic and empirical structures; connectivity, reachability and vulnerability; trees, tournaments and matroids; planarity; routing and matching problems; representations; various algorithms; applications.

AAOC C222 Optimization **3 0 3**

Prerequisite: MATH C191 and MATH C192

Introduction to optimization; linear programming; simplex methods; duality and sensitivity analysis; transportation model and its variants; integer linear programming nonlinear programming; multi-objective optimization; evolutionary computation techniques.

AAOC C311 Data Processing **3 0 3**

Prerequisite: TA C162

Introduction to Data Processing; Files and File Structures; Indexing Techniques; Sorting, Searching and Merging Techniques; Introduction to Database Management Systems; Design of Information Systems; Emerging trends in Data Processing.

AAOC C312 Operations Research **3 0 3**

Prerequisite: AAOC C111

Introduction to operations research; dynamic programming; network models - including CPM and PERT; probability distributions; inventory models; queuing systems; decision making- under certainty, risk, and uncertainty; game theory; simulation techniques, systems reliability.

AAOC C321 Control Systems **0 3 3**

Prerequisites: (ES C241 or ENGG C111) and (MATH C191)

Mathematical models of physical systems, feedback characteristics of control systems, control system components, time response analysis, stability, frequency response, state-space analysis, compensation.

AAOC C322 Systems **3 0 3**

Prerequisite: ES C241 or ENGG C111

Systems and systems approach; signals and systems; modelling of physical systems and modelling of non-physical systems; continuous and discrete systems; time domain analysis; systems stability.

AAOC C341 Numerical Analysis **3 0 3**

Prerequisite : MATH C191 and MATH C192

Solution of non-linear algebraic equation; interpolation and approximation; numerical differentiation and quadrature; solution of ordinary differential equations; systems of linear equations; matrix inversion; eigenvalue and eigenvector problems; round off and conditioning.

Bioengineering

BENG C411 Anatomy, Physiology and Hygiene **2 3 3**

Course description is same as given underPHA C321.

BENG G511 Biomaterials **3 2 5**

Introduction to biomaterials, structure and characterizations of materials, metallic implant materials, ceramic implant materials, polymeric implant materials, composites as biomaterials, structure property relationship, tissue response to implants, certain aspects of different kinds of prostheses.

BENG G512 Biomechanics **3 2 5**

Introduction to biomechanics, kinematics, kinetics, anthropometry, muscle and joint biomechanics, electromyography, synthesis of human movement, muscle mechanics, kinesiology, biomechanics in sports.

BENG G521 Bioinformatics **3 2 5**

General search methods, means-ends analysis, problem reduction, goal tree, optimal search, dynamic programming principle, minimax procedure, alpha-beta pruning. Stastical preliminaries, sampling and sampling distribution, estimation, hypothes's testing. Scoring systems and comparison of two sequences. Global multiple alignment. Construction of polygenetic trees. Search in biological database, pattern discovery in set of sequences. Sequences and structure of macromolecules. Transcription and translation.

BENG G522 Biotransport Processes **3 2 5**

Introduction to basic principles of fluid mechanics and of energy and mass transport, with emphasis on applications to living systems. Mass, momentum and energy conservation, mass diffusion, convection and diffusion. Modelling of momentum, energy and mass transport processes in physiological systems. Boundary layer, Penetration, and compartment models; interphase transport. Applications to respiratory, circulatory and other systems.

BENG G531 Telemetry **3 2 5**

Major components and concerns of telemetry systems, including : sensors, signal conditioning and calibration, analogue-to-digital conversion, frame and packet construction, time and position determination, multiplexing,

payment system and security issues; Secure Transport Protocols, Secure Transactions, Secure Electronic Payment Protocol (SEPP), Secure Electronic Transaction (SET); Security features – certificates for authentication (SSL, third party certifications); security on Web servers and Enterprise Network. Emerging e-Businesses Scenario- Changing economic considerations; Emerging business opportunities and revenue models; emerging technologies; Social aspects.

ITEB G521 e-Business Technologies I 4

Overview of E-Business Architecture- DNA concept; Evolution of DNA – 3-tier and n-tier; Introduction to Presentation, Business and Data layers; HTTPS, Secure Socket Layer, Firewall, Proxy, Network Address Translator. Internet Servers – IIS, Netscape and Apache Servers; Installation, configuration and administration. Presentation Layer – HTML, DHTML, XML, CGI, Perl Script, Java Script; MS Platform – ASP, Active X controls, VB Scripts; SUN Platform- JSP, Java Applets. Business Layer - Technology/computing-COM/DCOM, COM+, CORBA, Java Servlets, EJB.

ITEB G522 e-Business Technologies II 4

Business Layer – Application servers- Weblogic, ATG Dynamo, Websphere, Coldfusion, iPlanet; Transaction Servers- MTS, Jaguar CTS, Tuxedo; MOM Servers-MSMQ, MQ Series, third party MOM servers. Data Layer – Data warehousing concepts; OLAP- concept and tools; XML support in ORACLE and SQL server; ADO, ODBC/JDBC, OLEDB. Case studies using Microsoft and Sun Technologies.

ITEB G621 Supply Chain Management 4

Customer driven strategies in production and distribution systems; Integrated production & distribution networks; SCM in the context of JIT and MRP-II; Distribution Resource Planning; Management of dealer networks; Total Quality Control & product innovation across the supply chain; Incoming logistics & supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; mathematical programming for SCM.

ITEB G542 Knowledge Management 3

Increasing knowledge work in organizations; technologies to support growth of knowledge work in organizations; scope, cost, efficiency and reliability of technologies to support knowledge work; role of knowledge in an enterprise; knowledge management process; knowledge management strategies; human aspects of knowledge management; knowledge management technologies; applications of technologies to be covered through cases, reading assignments and use of appropriate software.

ITEB G552 Change Management 3

Nature of organizational change; change management; change perspectives and paradigms; Action Research Teaming; Understanding the human change process; need and opportunity in change initiatives; teamwork; data based change process; motivating and enabling change; becoming an effective change leader; change management competencies and its development.

Japanese

JAP N101T Beginning Japanese 3 0 3

Basic Japanese scripts (Hiragana, Katakana and Kanji); constructing words using Hiragana and Katakana and understanding their meanings; forming sentences, understanding their meanings, learning the related Kanjis; listening and reading comprehension, conversion practice, revision and additional practice through audio cassettes.

Mathematics

MATH C191 Mathematics I (Advanced Calculus) 3 0 3

Functions and graphs; limit and continuity; applications of derivative and integral. Conics; polar coordinates; convergence of sequences and series. Maclaurin and Taylor series. Partial derivatives. Vector calculus in R^n; vector analysis; theorems of Green, Gauss and Stokes.

MATH C192 Mathematics II (Complex Variables and Linear Algebra) 3 0 3

Complex numbers, analytic functions, Cauchy's theorems; elementary functions; series expansions; calculus of residues and applications.

Vector space; basis and dimension; linear transformation; range and kernel of a linear transformation; row reduction method and its application to linear system of equations.

MATH C222 Discrete Structures for Computer Science 3 0 3

Introduction to discrete mathematical structures; Formal logic and predicate calculus; Sets, relations and functions; Proof techniques; Graphs and trees; Primes, factorization, greatest common divisor, residues and application to cryptology; Boolean algebra; Permutations, combinations and partitions; Recurrence relations and generating functions; Introduction to error-correcting codes; Formal languages and grammars, finite state machines.

MATH C231 Number Theory 3 0 3

Primes and factorization; division algorithm; congruences and modular arithmetic; Chinese remainder theorem Euler phi-function and primitive roots of unity; Gauss's quadratic reciprocity law; applications to periodic decimals and periodic continued fractions.

MATH C241 Mathematics III (Differential Equations) 3 0 3

Eigen-values and eigen-vectors. Inner product space and orthonormal bases. Elementary differential equa-

tions, Hypergeometric equations, Lengendre polynomials, Bessel functions; Fourier series; Sturm-Liouville problem, series solution for differential equation, systems of first order equations; Laplace transformation and application to differential equations; one dimensional wave equation, one dimensional heat equation & Laplace equation in rectangular form.

MATH C311 Algebra I **3 0 3**

Groups, subgroups, a counting principle, normal subgroups and quotient groups, Cayley's theorem, automprhisms, permutation groups, and Sylow's thorems.

Rings, ring of real quaternions, ideals and quotient rings, homorphisms, Eculidean rings, polynomial rings, and polynomials over the rational field.

MATH C312 Algebra II **3 0 3**

Prerequisite: MATH C311

Dual spaces, modules, fields, finite fields, extension of fields: algebraic extension, separable and inseparable extension, normal extension, sptitting fields, Galois extension, and Galois group.

The algebra of linear transformations, characteristic roots and characteristic vectors, canonical forms: triangular form, nilpotent form, and Jordan form.

MATH C321 Elementary Real Analysis **3 0 3**

Countability and uncountability of sets; real numbers; limits and continuity; compactness and connectedness in a metric space; Riemann integration; uniform convergence.

MATH C322 Measure and Integration **3 0 3**

Prerequisite: MATH C321

Lebesgue measure and integration in real numbers, Convergence and Convergence theorems, absolutely continuous functions, differentiability and integrability, theory of square integrable functions, and abstract spaces.

MATH C331 Introduction to Topology **3 0 3**

Metric Spaces; Topological Spaces – subspaces, Continuity and homoeomorphism, Quotient spaces and product spaces; separation Axioms; Urysohn's Lemma and Tietze extension Theorem; Connectedness; Compactness, Tychonoff's Theorem, Locally Compact Spaces; Homotopy and the fundamental group.

MATH C332 Introduction to Functional Analysis **3 0 3**

Prerequisite: MATH C321

Banach spaces; fundamental theorems of functional analysis; Hilbert space; elementary operator theory; spectral theory for self-adjoint operators.

MATH C352 Differential Geometry **3 0 3**

Prerequisite: MATH C321

Curve in the plane and 3D-space; Curvature of curves; Surfaces in 3D-space; First Fundamental form; Curvature of Surfaces; Gaussian and mean Curvatures; Theorema Egreguim; Geodesics; Gauss-Bonnet Theorem.

MATH C353 Statistical Inference and Applications **3 0 3**

(Prerequisite: AAOC C111 Probability and Statistics)

Review of elements of probability and statistical methods, Classical Decision theory including parametric and non-parametric methods for testing of hypotheses, Analysis of Variance: One way and two way classifications, Design of experiments: Analysis of Completely randomized design, Randomized block design and Latin square design with one or more missing values, Statistical Quality control for variables and measurements.

MATH C411 Complex Analysis **3 0 3**

A rigorous treatment of the theory of analytic functions of complex variables including Cauchy's theorems; maximum modulus theorem; the principles of argument; Jensen's formula; Mittag Lefler theorem; Weierstrass canonical products and analytic continuation.

MATH C412 Concepts of Geometry **3 0 3**

Euclidean geometry and non-Euclidean geometries; affine and projective geometry; synthetic projective geometry, duality, perspectiviy, projectivity, coordinatization; analytic projective geometry, polarities, involutions, conics, finite geometries and their applications.

MATH C413 Topological Groups **3 0 3**

Basic concepts and eamples; compact and locally compact groups; integration on locally compact groups; convolutions of functions and measures; representation theory; characters and duality theory; applications.

MATH C421 Combinatorial Mathematics **3 0 3**

Course description is same as given under CS C451.

MATH C422 Algebraic and Differential Topology **3 0 3**

Fundamental group; universal covering space; simplicial approximation; simplicial homology theory; differentiable structures and smoothness; ideas of curvature.

MATH C431 Distribution Theory **3 0 3**

Prerequisite: MATH C321

C-infinity functions, distributions and their derivatives; support, convolution and regularization; distributions of finite order; multiplication of distributions; Fourier transforms of distributions; temperate distributions and their Fourier transforms; fundamental solutions.

MATH C441 Discrete Mathematical Structures 3 0 3

Course description is same as given under CS C453.

MATH C451 Ordinary Differential Equations 3 0 3

Existence and uniqueness theorems; properties of linear systems; behaviour of solutions of nth order equations; asymptotic behaviour of linear systems; stability of linear and weakly nonlinear systems; conditions for boundedness and the number of zeros of the nontrivial solutions of second order equations; stability by Liapunov's direct method; autonomous and nonautonomous systems.

MATH C452 Partial Differential Equations 3 0 3

Non linear equations of first order, Charpits Method, Method of Characteristics; Elliptic, parabolic and hyperbolic partial differential equations of order 2, maximum principle, Duhamels principle, Greens function, Laplace transform & fourier transform technique, solutions satisfying given conditions, partial differential equations in engineering & science.

MATH C461 Integral Equations 3 0 3

Classification of integral equations; modelling of problems as integral equations; Volterra equations of the first and second kind; Green's functions; Fredholm equations with degenerate kernels and symmetric kernels; Fredholm equations of the second kind; existence of solutions; numerical solutions.

MATH C471 Nonlinear Optimization 3 0 3

Introduction; convexity and cones; Kuhun Tucker theory; unconstrained and constrained optimization; gradient methods; polynomial optimization; penalty function; generalized convex functions; duality in nonlinear programming; optimality criterion for generalised convex functions; fractional programming.

MATH C481 Commutative Algebra 3 0 3

Modules; direct sums and products; finitely generated modules, exact sequences; tensor product of modules; rings and modules of fractions; localization; Noetherian modules and primary decompositions; integral dependence and valuation theory; integrally discrete valuation rings and Dedekind domains; fractional ideals.

MATH C491 Special Projects 3

Course description is same as given under BIO C491.

MATH D021 Remedial Mathematics 5 0 5

Algebra: Number systems; quadratic equations; progression; permutations and combinations; binomial theorem; vectors, matrices and determinants. Coordinate Geometry: Systems of coordinates, equation of a line and a circle.

Trigonometry: Trigonometric functions, heights and distances; trigonometric identities; sum and product formulae; properties of triangles.

Calculus: Functions and graphs; limits; derivatives of simple functions and their applications; integral as antiderivative; methods of integration; definite integral.

MATH F111 Mathematics I 3 0 3

Course description is same as given under MATH C191.

MATH F112 Mathematics II

Course description is same as given under MATH C192.

MATH F113 Probability & Statistics 3 0 3

Course description is same as given under AAOC C111.

MATH F211 Mathematics III 3 0 3

Course description is same as given under MATH C241.

MATH F212 Optimization 3 0 3

Course description is same as given under AAOC C222.

MATH F213 Discrete Mathematics 3 0 3

Logic and methods of proof, Elementary Combinatorics, recurrence relations, Relations and digraphs, orderings, Boolean algebra and Boolean functions.

MATH F214 Elementary Real Analysis 3 0 3

Course description is same as given under MATH C321.

MATH F215 Algebra-I 3 0 3

Course description is same as given under MATH C311.

MATH F231 Number Theory 3 0 3

Course description is same as given under MATH C231.

MATH F241 Mathematical Methods 3 0 3

Integral Transforms: Fourier, Fourier sine/cosine and their inverse transforms (properties, convolution theorem and application to solve differential equation), Discrete Fourier Series, Fast Fourier transform, Calculus of Variation: Introduction, Variational problem with functionals containing first order derivatives and Euler equations, Variational problem with moving boundaries. Integral equations: Classification of integral equations, Voltera equations, Fredholm equations, Greens functions.

MATH F242 Operations Research 3 0 3

Course description is same as given under AAOC C312.

MATH F243 Graphs and Networks 3 0 3

Course description is same as given under AAOC C221.

Mechanical Engineering

ME C211 Applied Thermodynamics **3 0 3**

Thermodynamics of power developing and power absorbing reciprocating machines; vapour, gas and refrigeration cycles; regeneration, reheat, compound cycle modifications, combined gas turbine-vapour cycle, binary systems; thermodynamic relations; reactive systems; combustion, adiabatic flame temperature, dissociation, equilibrium.

ME C212 Transport Phenomena I **3 0 3**

Fundamentals of the momentum, heat and mass transfer; the control volume approach and integral equations; differential analysis for momentum, heat and mass transfer, and solutions for one- dimensional steady state situations; convective heat and mass transfer; dimensional analysis.

ME C312 Design of Machine Elements **3 0 3**

Fundamentals and principles of design; design and selection of machine elements such as shafts, bearings and gears etc; design of mechanisms.

ME C314 Power Plant Engineering **3 0 3**

Classification of power plants. Components and layout of; thermal, nuclear, hydro electric power plants. Site selection for various power plants. Combined cycle power plants. Magneto Hydro Dynamics (MHD) systems. Economics of power generation, economic loading of power stations. Load curve analysis; load factor, diversity factor. Power plant instrumentation and controls.

ME C331 Transport Phenomena II **3 2 4**

(For Mechanical Engineering)

Fundamental concepts of heat transfer; steady-state and unsteady- state heat conduction; analytical and empirical relations for forced and free convection heat transfer; heat exchanger analysis and design, heat transfer by radiation; elements of mass transfer; one dimensional compressible flow; flow in open channels, associated laboratory.

ME C332 Prime Movers and Fluid Machines **3 2 4**

Theoretical analysis of energy and momentum transfer between fluid and rotor; principles of axial, mixed and radial flow compressors, turbines and pumps; design considerations; cascade aerodynamics and performance limitations; applications to power plant systems, laboratory exercises in testing reciprocating machines; rotary machines and refrigeration plants.

ME C342 Production Techniques **3 2 4**

Analysis, economics and quality control of metal cutting, plastic working of metals, joining and casting processes, laboratory exercises in metal cutting, plastic working of metals, testing and inspection of weldments and castings.

ME C382 Computer Aided Design **3 0 3**

Course description is same as given under EA C342.

ME C392 Advanced Mechanics of Solids & Kinematics **3 0 3**

Energy methods; asymmetrical bending; curved beams; thick cylinders; contact stresses; introduction to mechanisms; velocity and acceleration analysis using vector polygon method; kinematics of cams & synthesis of cam profile; gear trains.

ME C412 Production Planning & Control **3 0 3**

Course description is same as given under ET C412.

ME C422 Dynamics of Machines & Vibration **3 0 3**

Dynamic force analysis in mechanisms; determination of flywheel size; balancing of rotating & reciprocating masses; whirling of shafts; forced vibration & vibration isolation; multi-degree freedom systems; systems with distributed mass & elasticity.

ME C432 Computer Aided Manufacturing **3 0 3**

Introduction, features of NC machine tools, NC part programming, CAM system devices, interpolators for manufacturing systems, control loops of NC systems, computerized numerical control, adaptive control systems, CAD to CAM, CAPP, industrial robots, computer aided production planning & control, computer aided inspection and quality control, CIM systems.

ME C441 Automotive Vehicles **3 0 3**

Internal combustion engines; vehicle performance; analysis and design of vehicle components. Experimental or theoretical investigation of problems selected from the field of automotive vehicles.

ME C442 Advances in Materials Science **3 0 3**

Deformation of materials, deformation at high temperatures and creep, recovery, recrystallization and grain growth, fracture of materials and fatigue failure, deterioration of materials, corrosion and oxidation, surface properties, surface energy and tribology, polymers and fibre reinforced polymeric composites, mechanical testings, nondestructive testing techniques.

ME C443 Quality Control, Assurance & Reliability **3 0 3**

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process.

ME C451 Mechanical Equipment Design **3 0 3**

Design analysis for additional machine elements; retainment of bearings and design of machine housing; introduction to techniques of optimisation reliability and value analysis; exercises in detail design; design solutions to meet specified functional requirements.

ME C452 Composite Materials and Design **3 0 3**

Introduction to composites, concepts of reinforcement, strengthening mechanisms, fibrous reinforcements, matrix materials, micro-mechanical aspects of composites, manufacturing methods, composite production design methods-design of tensile members, pressure vessels, storage tanks, and other chemical process equipment made of FRP, design of joints, damage of composites by impact, FRP grids, recent development in manufacturing of composites and technologies.

ME C461 Refrigeration and Air Conditioning **3 0 3**

Course description is same as given under CE C461.

ME C472 Precision Engineering **3 0 3**

Concept of accuracy, accuracy of numerical control systems, tolerances and fits, acceptance tests for machine tools, static stiffness and its influence on machining accuracy, inaccuracies due to thermal effects, influence of forced vibrations on accuracy, dimensional wear of cutting tools and its influences on accuracy, clamping and setting errors, location principles and errors due to location, surface roughness and microfinishing processes, dimensioning and dimensional chains, methods of improving accuracy and surface finish, thread and gear measuring instruments, coordinate measuring machines, introduction to computer aided tolerancing.

ME C481 Project Appraisal **3 0 3**

Prerequisite: ECON C212

Course description is same as given under ECON C411.

ME C491 Special Projects **3**

Course description is same as given under BIO C491.

ME F110 Workshop Practice **0 4 2**

Laboratory exercises for different manufacturing processes like machining on lathe, drilling, grinding, milling and shaper; sand moulding and casting; metal forming; joining processes like arc welding, gas welding, brazing and soldering; carpentry; fitting; use of metrology equipments in measurement; demonstrations on CNC machines and CNC part programming.

ME F211 Mechanics of Solids **3 0 3**

Fundamental Principles of mechanics; introduction of mechanics of deformable bodies; force and moment transmitted by slender members; stress and strain; stress-strain-temperature relations; torsion of circular member, stress and deflection due to bending, stability of equilibrium. Static failure criteria, ductile & brittle material; Dynamic failure criteria.

ME F212 Fluid Mechanics **3 0 3**

Fluid Statics; fundamentals of mass, momentum and energy transfer, control volume approach and integral equations. Differential analysis of mass, momentum and energy transfer, solutions for one dimensional steady state situations. Viscous and in-viscid flow. Dimensional analysis. Introduction to computational fluid dynamics.

ME F213 Materials Science & Engineering **2 0 2**

Introduction, Structure of Materials (Metal and Ceramics), Dislocations, heat treatment of steel and strengthening Mechanisms of Metals, Phase diagrams, Iron-carbide phase diagram, Phase transformation in Metals, Mechanical and thermal properties of Metals, Polymers (Structure, processes and properties), powder metallurgy.

ME F214 Applied Thermodynamics **3 0 3**

Availability and irreversibility, thermodynamic relations, gas and vapor cycles, combined power generation cycles, gas mixtures, refrigeration cycles, psychometrics and heat load calculations, gas turbine cycles , compressors, boilers and accessories

ME F215 Mechanical Engineering Laboratory **0 2 2**

The course shall aim to train the student in the skill of operation of instruments and equipments. Testing of mechanical properties like tensile testing, hardness, impact, bending of beams, spring testing, basic fluid mechanics experiments like measurements of pressure, temperature, viscosity, flow measurement, basic electrical & electronics like experiments on diodes, rectifiers, OPAMPS, dc motors, transformers, induction and synchronous motors.

ME F241 Machine Design & Drawing **3 1 4**

Fundamentals and principles of Design. Design and selection of Machine elements such as shafts, Screw fasteners, Welded joints, Springs, Brakes & Clutches, Bearings & Gears. Fundamentals of Machine Drawing; practices for Orthographic drawing of machine parts, sectional view, assembly drawing & exploded view.

ME F242 IC Engines **2 0 2**

Working cycles and operation of two stroke, four stroke SI and CI engine cycles. Ignition, combustion, alternative fuels, emission and their control.

ME F243 Production Techniques I **2 1 3**

Metal casting methods, patterns and molding, different types of casting processes, injection molding, die casting and casting defects. Casting analysis. Metal forming, different bulk metal forming processes like rolling, extrusion, forging and wire drawing. Metal forming pro-

cess analysis and forming defects. Welding, brazing and soldering, different techniques and welding defects. Welding analysis. Simple description of various machining operations, machine tools and cutting tool geometry. Limits & Fits and Metrology. Fabrication project.

ME F244 Kinematics & Dynamics of Machinery **3 0 3**

Kinematics of mechanism: introduction to mechanisms, position, displacement, velocity, acceleration analysis, Synthesis of mechanisms (Planer), cam design, Kinematics of gears (spur, helical, bevel and worm), gear trains, Dynamics of machines: static force analysis, dynamic force analysis (planar),dynamics of reciprocating engines, balancing, cam dynamics, flywheels, governors and gyroscopes.

ME F266 Study Project **3**

Course description is same as given under BIO F266.

ME F311 Heat Transfer **3 1 4**

Fundamental concepts of heat transfer; steady state and unsteady- state heat conduction; analytical and empirical relations for forced and free convection heat transfer; heat exchanger analysis and design, heat transfer by radiation; associated laboratory.

ME F312 Advanced Mechanics of Solids **3 0 3**

Generalized Hooke's law; Energy methods; torsion of non-circular members; shear center and asymmetrical bending; curved beams; thick cylinders; plates and shells; contact stress.

ME F313 Production Techniques II **3 1 4**

Metal cutting theory. Analysis, economics and quality control of metal cutting, laboratory exercises in metal cutting and fabrication project. Different machine tools their description and operation. Non-traditional machining processes. Micro-manufacturing technologies. Introduction to computer aided manufacturing (CAM), CNC machines and CNC part programming.

ME F341 Prime Movers & Fluid Machines **2 1 3**

Theoretical analysis of energy and momentum transfer between fluid and rotor; principles of axial, mixed and radial flow compressors, turbines and pumps; design considerations; cascade aerodynamics and performance limitations; applications to power plant systems; model similitude for turbo-machines; Introduction to fluid power system, laboratory exercises in testing reciprocating machines, rotary machines and fluid power system.

ME F342 Computer Aided Design **3 1 4**

CAD software and CAD hardware. Mathematical modeling of parametric curves, surfaces and solids, and their computer simulation on spreadsheets and using specialized solid modeling packages. CAD/CAM data exchange. Introduction to finite element analysis and FEM practice on a specialized CAE package. Rapid prototyping. Students will be required to do several assignments and one CAD project.

ME F343 Mechanical Vibrations **3 0 3**

Small oscillations of linear dynamical systems, free and forced vibrations of single and multi-degree-of-freedom systems, normal modes and orthogonality relations, generalized co-ordinates and Lagrange's equations, matrix formulation, eigenvalue problem and numerical solutions, transient response of one-dimensional systems, approximate energy methods, continuous system, vibration of string, rods, bars and beams. Introduction to control systems.

ME F344 Engineering Optimization **2 0 2**

Linear programming methods, simplex method, transportation model and its variants, queuing systems, PERT/CPM, Optimal problem formulation, engineering optimization problems, single variable optimization algorithms, multivariable optimization algorithms, constrained optimization algorithms.

ME F366 Lab Project **3**

ME F367 Lab Project **3**

Course description is same as given under BIO F366 and BIO F367.

ME F376 Design Project **3**

ME F377 Design Project **3**

Course description is same as given under BIO F376 and BIO F377.

ME F411 Fluid Power Systems **3 1 4**

Introduction to Fluid power, advantages of fluid power, applications, Introduction to Pneumatics, Air preparation and Components, Pneumatics Circuits and Applications, Electro pneumatics, Electrical Controls for fluid power circuits, , Physical properties of hydraulic fluids, Energy and Power in Hydraulic Systems, Frictional Losses in Hydraulic Pipelines, Hydraulic Pumps, Hydraulic Cylinders and Cushioning Devices, Hydraulic Motors, Hydraulic Valves, Hydraulic Circuit Design and Analysis, Ancillary Hydraulic Devices, Hydraulic Conductions and Fittings, Maintenance of Hydraulic Systems, Use of PLC programming for interfacing pneumatics and Hydraulic Circuits.

ME F412 Production Planning and Control **3 0 3**

Course description is same as given under me C412.

ME F413 Nonlinear Vibrations **3 0 3**

Introduction, sources of nonlinearity, examples, qualitative analysis: phase plane, singular points, stability of singular points, Forced response, Perturbation methods: straightforward expansion, the method of multiple scales, harmonic balance, method of averaging, Nonlinear normal modes, Nonlinear Multiple-DOF Systems, Bifurcations, Centre manifold reduction,

Flouquet Theory, Chaos Theory, Melnikov Criterion, Applications to vehicle dynamics, structures and microsystems etc. Use of softwares for simulations and numerical solutions.

ME F415 Gas Dynamics **3 0 3**

Introduction to Gas Dynamics, Basic equations of compressible flow, Wave propagation, Steady one-dimensional flow (Varying-area adiabatic flow), Normal shock waves, Oblique shock and expansion waves, Prandtl-Meyer Flow, Flow with Friction and Heat Transfer, Potential equation for compressible flow, Similarity rule.

ME F416 Reverse Engineering and Rapid Prototyping **3 0 3**

Introduction to reverse engineering, methodologies and techniques for reverse engineering, reverse engineering hardware and software, selecting reverse engineering system, introduction to rapid prototyping, relationship between reverse engineering and rapid prototyping. Reverse engineering in automotive engineering, aerospace engineering, medical device industry. Legal aspects and barriers for reverse engineering. Project work.

ME F417 Advanced Metal Forming **3 0 3**

The stress and strain tensors in macroscopic plasticity and failure criteria for metal forming, effective stress and effective strain, flow rules for plastic deformation and principle of normality. Work hardening, determination of work hardening exponent. Plastic instability and effect of inhomogeneity on uniform strain. Strain rate and temperature effects on plastic deformation and flow stress, super-plasticity, temperature rise during metal forming. Ideal work and redundant work. Slab, upper-bound, slip-line field and finite element methods of analysis of various bulk and sheet metal forming processes. Bulk and sheet metal formability tests and forming limit diagram. Sheet metal properties and plastic anisotropy.

ME F418 Rocket and Spacecraft Propulsion **3 0 3**

Thrust and specific impulse. Compressible flows. Detailed analysis of liquid, solid and hybrid propulsion systems. Includes propellants, injection systems, combustion and chemical equilibrium, thrust chambers, nozzles and plumes. Electro-thermal thrusters. Plasmas and electromagnetic thrusters.

ME F419 Total Product Integration Engineering **3 0 3**

Quality design across global supply chain. Robust product architecture for market variety and technology advances. Product development risk management.

ME F420 Power Plant Engineering **3 0 3**

Course description is same as given under ME C314.

ME F423 Micro Fluidics and its Application **4***

Course description is same as given under EA C417.

ME F432 Computer Aided manufacturing **3 0 3**

Course description is same as given under ME C422.

ME F433 Solar Thermal Process Engineering **3 1 4**

Fundamentals of solar energy, earth-sun angles, solar spectrum, solar radiation, measurement and estimation of solar energy on horizontal and tilted surface, conversion routes and technologies, Standards and Performance Testing, thermal utilization of solar energy, modes of heat transfer and equations for performance calculations of systems- conduction, convection and radiation of heat, Flat plate collectors, solar concentrator systems, geometric optics, tracking methods, thermal analysis, energy storage, materials and properties, solar process loads and system calculations for time dependent loads, Life cycle cost analysis and economic analysis for various applications of solar thermal processes, solar water heating, space heating and cooling in Buildings, Industrial process heating, solar air-conditioning and refrigeration, Use of Simulation tools for performance simulation and Project Assignments, solar thermal power generation, Role of Govt., policies and plans.

ME F441 Automotive Vehicles **3 0 3**

Course description is same as given under ME C441.

ME F443 Quality Control, Assurance and Reliability **3 0 3**

Course description is same as given under ME C443.

ME F451 Mechanical Equipment Design **3 0 3**

Course description is same as given under ME C451.

ME F452 Composite Materials & Design **3 0 3**

Course description is same as given under ME C452.

ME F461 Refrigeration and Air conditioning **3 0 3**

Course description is same as given under CE C461.

ME F472 Precision Engineering **3 0 3**

Course description is same as given under ME C472.

ME F481 Project Appraisal **3 0 3**

Course Description is to be developed.

ME F482 Combustion **3 0 3**

Fuels, Combustion, Adiabatic Flame Temperature, Chemical Kinetics, Chain Reactions, Conservation Equations for Reacting Flows, Laminar and Turbulent Premixed Flames, Diffusion Flames, Droplet and Particle Combustion, Emissions, Applications.

ME F483 Wind Energy **3 0 3**

Historic development of wind energy technology, basic principles of wind energy conversion, different types of wind machines and their performances, wind rotor aerodynamics and its application in the turbine design, statistical methods of measurement and analysis of wind spectra for energy use, developing models for es-

timating the wind energy potential of a prospective site, Constructional features of various systems and subsystems of a Wind Energy Conversion System(WECS), Features of wind farms, performance models of WECS, Optimal matching of WECS, environmental aspects of wind energy conversion, Economics of wind energy conversion.

ME F484 Automotive Technology **3 0 3**

Historic development of wind energy technology, basic principles of wind energy conversion, different types of wind machines and their performances, wind rotor aerodynamics and its application in the turbine design, statistical methods of measurement and analysis of wind spectra for energy use, developing models for estimating the wind energy potential of a prospective site, Constructional features of various systems and subsystems of a Wind Energy Conversion System(WECS), Features of wind farms, performance models of WECS, Optimal matching of WECS, environmental aspects of wind energy conversion, Economics of wind energy conversion.

ME F485 Numerical Techniques for Fluid Flow and Heat Transfer **3 0 3**

Introduction to CFD, Partial Differential Equation (PDE): Physical classifications, Mathematical Classifications, Well posed problem. Basic of Discretization Methods: Finite difference method, Truncation error, consistency, error and stability analysis, convergence, various discretization schemes. Introduction commercial software: OpenFOAM or Fluent. Application of numerical methods to selected model equations: Wave equation, Heat equation, Laplace's equations. Solution of Navier-Stokes equation for incompressible flows.

ME F491 Special Projects **3**

Course description is same as given under BIO F491.

ME G511 Mechanisms & Robotics **2 3 5**

Classification of robots & manipulators; fields of application; synthesis of planar & spatial mechanisms; methods of function & path generation; coupler curve synthesis; linkages with open loop; actuators & drive elements; microprocessor application and control of robots.

ME G512 Finite Element Methods **5**

Fundamental concepts, matrix algebra and gaussian limination, one-dimensional problems, trusses, two-dimensional problems using constant strain triangles, axisymmetric solids subjected to axisymmetric loading, two-dimensional isoparametric elements and numerical integration, beams and frames, three-dimensional problems in stress analysis, scalar field problems, dynamic considerations, pre-processing and post processing.

ME G513 Heating and Cooling of Buildings **3 2 5**

Introduction to HVAC design, basic scientific principles, climatic conditions, building heat transmission surfaces, infiltration and ventilation, heating loads, heat gains and cooling loads, HVAC psychometrics, codes and standards for HVAC systems design, acoustics and vibration, human comfort, air distribution, duct system design, fans and central air systems, air system heating and cooling, air cleaning and filtration, introduction to electrical systems, controls for air distribution systems.

ME G514 Turbomachinery **3 2 5**

Introduction, thermodynamics, gas turbine plants, steam turbine plants, fluid dynamics, dimensional analysis and performance parameters, flow through cascades, axial turbine stages, high temperature turbine stages, axial compressor stages, centrifugal compressor stages, radial turbine stages, axial fans and propellers, centrifugal fans and blowers, and wind turbines.

ME G515 Computational Fluid Dynamics **3 2 5**

Philosophy of computational fluid dynamics (CFD), governing equations of fluid dynamics, mathematical behavior of partial differential equations, basics of the numerics : basic aspects of discretization, grids with appropriate transformations, and simple CFD techniques, applications, numerical solutions of quasi-one-dimensional nozzle flows, numerical solution of a two-dimensional supersonic flow, incompressible couette flow, and supersonic flow over a flat plate, advanced topics in CFD.

ME G516 Energy Systems Engineering **5**

Basic concepts of energy conversion, generation of electrical and thermal energy, transmission and distribution of electrical energy, load management, detailed analysis of utilization of thermal energy in : boilers, furnaces, compressors, heat transfer equipments, and HVAC systems, energy audit, waste heat recovery systems, cogeneration, demand side management, and management and organization of energy saving projects.

ME G521 Mechanical System Design **3 2 5**

Concept of system design; modeling of structural and kinematic systems, and determination of system characteristics; reliability of systems; design of machine elements for specified reliability; concepts of optimization; techniques of design optimization for linear and non-linear problems.

ME G532 Machine Tool Engineering **3 2 5**

Design principles of machine tools; stiffness and rigidity of separate construction elements and their combined behaviour under load; design of stepped and stepless drives; electrical, mechanical and hydraulic drives; design of bearings and sideways; machine tool controls; machine tool dynamics; recent developments in machine tool design.

ME G533 Conduction and Radiation Heat Transfer 5*

Conduction: Steady and unsteady problems and their solutions in cartesian, cylindrical and spherical coordinates. Separation of variables. Duhamel's theorem. Laplace transform. Problems involving change of phase. Inverse heat conduction, Microscale heat transfer, Radiation: Radiative exchange among black and grey and spectral surfaces, Shape factors. Applications to cavities and enclosures. Integral equations approach. Radiation from gases, vapours and flames.

ME G534 Convective Heat and Mass Transfer 5*

Conservation equations, boundary layers, free convection, forced convection. Heat transfer in laminar and turbulent, internal as well as external flows, mixed convection. Combined convection and radiation. Boiling and Condensation. Molecular diffusion in fluids, mass transfer coefficient. Simultaneous heat and mass transfer; Applications.

ME G535 Advanced Engineering Mathematics 3 2 5

Boundary value problems; wave equations; nonlinear partial differential equations; calculus of variations; Eigen value problems; iteration problems including forward and inverse iteration schemes – Graham Schmidt deflation – simultaneous iteration method – subspace iteration – Lanczo's algorithm – estimation of core and time requirements.

ME G536 Thermal Equipment Design 5

Course description is to be developed.

ME G537 Cryogenic Engineering 5

Introduction to cryogenics and its applications, properties of cryogenic fluids, properties of materials at cryogenic temperature, gas-Liquefaction and refrigeration systems, gas separation, cryocoolers, cryogenic insulations, vacuum technology, instrumentation in cryogenics, safety in cryogenics.

ME G538 Toyota Production System 3 2 5

Birth of Toyota production system, house of Toyota production system, stability, standardization, just-in-time,jidoka, involvement, hoshin planning, Toyota culture, Toyota way, Case Studies.

ME G539 Computer Integrated Manufacturing 3 2 5

Computer Modeling for mass property analysis. Computer Numerical Control. Computer-aided Manufacturing, operation of CNC machine tools. Design of manufacturing work cells, Automated Manufacturing and Programmable Controller.

ME G611 Computer Aided Analysis and Design 2 3 5

Course description is same as given under CE G611.

ME G612 Plastics Engineering 3 2 5

General properties of Plastics, Mechanical Behavior of Plastics, Processing of Plastics like Extrusion, injection moulding, thermoforming, calendaring, rotational moulding, compression moulding, transfer moulding, analysis of polymer melt flow, rheological models for polymer melt flow, analysis of heat transfer during polymer processing, elastic behavior of polymer melts, testing methods of polymers like DSC, TGA, DMA, XRD etc. FRP composites, Properties of FRP composites in longitudinal and transverse directions, volume and weight fraction relationships of fibers, failure mechanisms, mechanical properties and fiber orientation effects, processing of composite materials, advancement of composite materials in applications like wind mill blades, bullet proof jackets, etc.

ME G621 Fluid Dynamics 2 3 5

Course description is same as given under CE G621.

ME G631 Advanced Heat Transfer 3 2 5

(= CHE G614)

Course description is same as given under CHE G614.

ME G641 Theory of Elasticity and Plasticity 3 2 5

Course description is same as given under CE G641.

Microelectronics

MEL G512 Optoelectronic Devices, Circuits and Systems 3 2 5

Course description is same as given under EEE G521.

MEL G531 Testable Design and Fault Tolerant Computing 3 2 5

Course description is same as given under CS G531.

MEL G532 Digital Signal Processing 3 2 5

Course description is same as given under EEE G572.

MEL G611 IC Fabrication Technology 3 2 5

Material properties; crystal growth and doping; diffusion; oxidation; epitaxy; ion implantation; deposition of films using CVD, LPCVD and sputtering techniques; wet and dry etching and cleaning; lithographic process; device and circuit fabrication; process modeling and simulation.

MEL G612 Integrated Electronics Systems Design 2 2 4

General architectural features of 8/16/32 bit microprocessors, programmers model of 8086, assembly language programming, hardware design around 8086, bus based systems design, system design around IBM PC, design of real-time systems, ASIC's development tools.

MEL G621 VLSI Design 3 2 5

Introduction to NMOS and CMOS circuits; NMOS and CMOS processing technology; CMOS circuits and logic design; circuit characterization and performance estimation; structured design and testing; symbolic layout systems; CMOS subsystem design; system case studies.

to cell cycle, Experiments related to hematology, DNA quantification from the plant organs; Water analysis.

BIO F111 General Biology **3 0 3**

Course description is same as given under BIO C111.

BIO F201 Introductory Biology **3 1 4**

Living systems and their properties; classification of organisms; biochemical pathways operative in organisms; introductory genetics, Introductory recombinant DNA technology, ecology and environmental scienes and related basic labs.

BIO F211 Biological Chemistry **3 0 3**

The molecular process of life presents us with a seemingly never ending succession of chemical mechanisms of almost incredible fascination. This course is introduced at the cellular and molecular level and focus upon bio -macromolecules, biosynthesis of macromolecules, energy yielding and requiring processes, genetic information etc. This would help going for higher level activities, appreciation of biochemical problems, evaluation and problem solving. It also includes theory of techniques used in biochemistry and related experiments.

BIO F212 Microbiology **3 1 4**

Introduction and classification of microbes; structure, physiology and genetics of microbial cell; isolation, cultivation, physiological and biochemical characterization of microbes; host parasite relationship; microbiology of soil, water and food; physical chemical methods of controlling microbes; antimicrobial drugs; clinical microbiology; and related lab components.

BIO F213 Cell Biology **3 0 3**

Types and properties of cells; microscopy; membrane structure, function and transport; endomembrane system and its functions; nuclear organization and functions; ribosomes and protein synthesis; cytoskeleton; cell communication; cell cycle, cell growth and cancer; apoptosis; techniques, related experiments and applications of cell biology.

BIO F214 Integrated Biology **3 0 3**

The Integrative Biology course is a course which bridges as well as opens new vistas to a student taking up bioogy. The course covers two tracks, essentially. The first track introduces the student to the ordering that helps biologists to actually study the vast diversity of the living world. This track would encompass questions related to the origin and evolutionary pathways followed in Nature, as well as the methods followed by biologists to systematically categorize and document them. The second track highlights the uses and applications of biology in everyday life – whether in the economic or in the social realms. Together, the course projects the subject in a way from which the student can choose and implement his biological knowledge vis-à-vis his/her interests.

BIO F215 Biophysics **3 0 3**

A study of molecules and their interaction forces; bioenergetics and physical techniques as applied to biological phenomena and related labs.

BIO F231 Biology Project Laboratory **3**

Course description is same as given under BIO C231.

BIO F241 Ecology and Environmental Sciences **3 0 3**

Biotic and abiotic components of environment; limiting factors; regional ecology; ecosystem productivity and trophism; population and community ecology; succession and evolution; pollution; environmental biotechnology; Indian environmental movement. Associated with related labs.

BIO F242 Introduction to Bioinformatics **3 0 3**

Introduction to genomic & Proteomics, Biological databases and data mining, sequence similarity search and sequence alignment algorithms, Phylogenetic tree construction algorithms, Protein structure predication and structure analysis, use of software package in Bioinformatics; Related lab components.

BIO F243 Genetics **3 0 3**

Facts and theories of heredity, their relation to the present state of biological theory in general; elements of population genetics; genetics and species concept and related labs.

BIO F244 Instrumental Methods of Analysis **1 3 4**

Principles, configuration, applications of instruments like mass spectrophotometer, NMR,UV, IR, X-ray apparatus, atomic spectrophotometer, Fluorescence Spectroscopy, gas chromatography, liquid scintillation spectrophotometer, laser device, high voltage electrophoresis, ultracentrifuge, DTA,TGA, Thermo Cycler-PCR, SDS-PAGE, ELISA etc. The course is specially designed for students in the first degree majoring in experimental sciences and would require groups of students to work with the above instruments in order to appreciate the potentiality of such modern instrumental methods of analysis.

BIO F266 Study Project **3**

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

BIO F311 Recombinant DNA Technology **3 0 3**

The course deals with theoretical aspects and lab exposure to selected experiments of recombinant DNA manipulation. Emphasis will be placed on procedures to create chimeric molecules using examples from actual experimental work. Vector designing, PCR, qPCR, DNA sequencing, in-vitro mutagenesis, cloning in prokaryotic and eukaryotic systems and whole genome

approaches will be covered with related lab components.

BIO F312 Plant Physiology **3 0 3**

Basic functional processes in plants; Plant tissue system, Plant-water relations, Gaseous exchange, Stomatal regulations, Mineral nutrition and absorption, Transport of material, Growth and development, Hormones and PGRs, Photoperiodism, Vernalization, Plant defense mechanisms, Stress Physiology and related lab components.

BIO F313 Animal Physiology **3 0 3**

Principles and concepts underlying the function of tissues and organ systems in animals, with emphasis on mammalian systems and integration of systems at the level of the whole organism. Several biological systems are considered, including respiratory, circulatory, nervous, endocrine, immune, excretory, muscles, skeletal and reproductive systems. Laboratory session will help to study function of any organ system; Related lab components.

BIO F314 Conservation Biology **2 1 3**

Biological diversity: its measurement, value and crisis; conservation at ecosystem, population and species levels; protection, management and res-toration of ecosystems; sustainable development and community-based conservation; conservation legislation. Course practicum will be effected through classroom and field activities.

(This course is introduced in the pool of discipline electives for M.Sc. (Hons.) Biological Sciences programme).

BIO F341 Developmental Biology **3 0 3**

Scope and problems in developmental biology; major model organisms (vertebrates, invertebrates and plants) and their life cycles; patterning and axis formation; morphogenesis; organogenesis; nervous system; germ cells and sex; cell differentiation and stem cells; growth, ageing and regeneration; applications of developmental biology. The course will emphasize universal principles that govern the process of development; Related lab components.

BIO F342 Immunology **3 0 3**

Introduction to immune system, cell mediated and humoral immunity, immune system in health and disease immunity to infectious diseases, immune mechanisms involved in cancer, immunodeficiency and autoimmunity. Vaccination and transplantation Immunology; Related lab components.

BIO F352 Cell and Tissue Culture Technology **3 1 4**

Theories and practices on *in vitro* techniques for plants and animals, development of normal and tumor cell lines, somatic hybridization, monoclonal antibody production, hairy root cultures, secondary metabolite production, scale-up strategies for large scale production of biomass.

BIO F366 Lab Project **3**

BIO F367 Lab Project **3**

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

BIO F376 Design Project **3**

BIO F377 Design Project **3**

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

BIO F411 Laboratory **0 9 3**

Specially designed for M.Sc. (Hons). Biological Sciences; cannot be taken by others under any circumstances.

This laboratory course is designed only for M.Sc.(Hons) Biological Sciences students and aims to expose the students to and build competence in selected techniques of modern biology.

BIO F413 Molecular Biology of Cell **3 0 3**

Course description is same as given under BIO C413.

BIO F417 Biomolecular Modelling **3 0 3**

Course description is same as given under BIO C417.

BIO F418 Genetic Engineering Techniques **1 3 4**

Course description is same as given under BIO C418.

BIO F419 Molecular Evolution **3 0 3**

Course description is same as given under BIO C419.

BIO F421 Enzymology **3 0 3**

Course description is same as given under BIO C421.

BIO F431 Reproductive Physiology **3 0 3**

Course description is same as given under BIO C431.

BIO F441 Biochemical Engineering **3 0 3**

Course description is same as given under BIO C441.

BIO F451 Bioprocess Technology **3 0 3**

Course description is same as given under BIO C451.

BIO F491 Special Projects **3**

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project

गोवा शिपयार्ड लिमिटेड
GOA SHIPYARD LIMITED
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रक्षा मंत्रालय
MINISTRY OF DEFENCE
वास्को-द-गामा, गोवा.
VASCO-DA-GAMA, GOA - 403 802, INDIA

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GSL CORPORATE IDENTITY NUMBER (CIN)
U63032GA1967GOI000077

पंजीकृत कार्यालय और यार्ड : वास्को-द-गामा, गोवा-४०३८०२.
Registered Office & Yard : Vasco-Da-Gama, Goa-403802, India

सभी उत्तर अध्यक्ष एवं प्रबंध निर्देशक को संबोधित करना है |
All replies to be addressed to the Chairman & Managing Director

CIN of GSL : U63032GA1967GOI000077

स्वच्छ भारत
एक कदम स्वच्छता की ओर

Our Ref. GSL/HR&A/L&D/Cert/01/HD

Date : 16.07.2015

TO WHOM-SO-EVER IT MAY CONCERN

This is to certify that **Mr. Mohit H.Deshmukh,** a student of second year Bachelor of Engineering (Honors) Mechanical Engineering of Birla Institute of Technology & Science, Pilani, Hyderabad Campus has undergone **'Industrial Training'** from 22.05.2015 to 16.07.2015 in Design/Technical Services Department in GSL.

We wish him all the success his further endeavors.

For **GOA SHIPYARD LIMITED**

GOA SHIPYARD LTD. VASCO-DA-GAMA

CHIEF GEN. MANAGER (HR & ADMN.)

16/7/15

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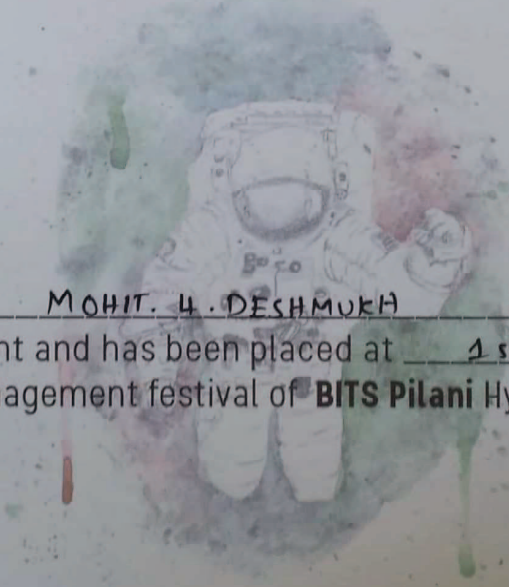
BITS Pilani
Hyderabad Campus

CERTIFCATE OF APPRECIATION

ATMOS



This is to certify that MOHIT. U. DESHMUKH has participated in the Prodigal designer event and has been placed at 1st postion, at **ATMOS'15**, the National Techno-Management festival of **BITS Pilani** Hyderabad campus.

PRESIDENT
(Student's Union)

TECHNICAL CONVENER

ASSOCIATE DEAN
(Student Welfare Division)

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This is to certify that Mr. Mohit Harishchandra Deshmukh, a student of Birla Institute of Technology and Science Pilani, Hyderabad Campus in B.E. (Hons.) – Mechanical Engineering is actively involved in the Project titled "Design and Analysis of Screw Turbines using Computational Fluid Dynamics". He completed the assigned work to our satisfaction. The project work output from the student is suitable for our industrial applications and the amount of effort put in by the student is commendable. I wish him all success in his future endeavours.

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12 Sep 17

Authorised Signatory

Birla Institute of Technology & Science, Pilani
Hyderabad Campus

Certificate of Participation

2nd National Conference
on
Design and Manufacturing Technologies for Product Life Cycle
(DPLC-2016)
March 19 & 20, 2016
Organized by:
Department of Mechanical Engineering,
Birla Institute of Technology & Science, Pilani, Hyderabad Campus

This is to certify that ~~Prof/Dr~~/Mr/~~Mrs~~ MOHIT DESHMUKH participated and presented a paper titled Smart solar tracking in the 2nd National Conference on Design and Manufacturing Technologies for Product Life Cycle (DPLC-2016) held at BITS-Pilani,Hyderabad Campus on March 19 & 20, 2016.

Organising Chairman

Organising Convener

innovate achieve lead

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National Conference on

SUSTAINABLE MECHANICAL ENGINEERING: TODAY AND BEYOND

SMETB 2017

March 25-26, 2017

Department of Mechanical Engineering, Tezpur University, Assam, India

This is to certify that Prof./Dr./Mr./Ms. Mohit Deshmukh *of* BITS Pilani, Hyderabad campus *participated and presented a paper titled* Performance investigation on sustainable screw turbine using computational fluid dynamics for micro and pico-hydro applications *in the* ***National Conference on SUSTAINABLE MECHANICAL ENGINEERING: TODAY AND BEYOND****, 2017 held at Tezpur University , Assam , India.*

SMETB 2017

(Dr. Partha P. Dutta)
Chairman

(Prof. Tapan K. Gogoi)
Organizing Secretary

(Dr. Seikh M. Kamal)
Joint Organizing Secretary

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ORACLE
Certified Associate

CERTIFICATE OF RECOGNITION

ORACLE
UNIVERSITY

Mohit Deshmukh

Oracle Certified Associate, Java SE 7 Programmer

THIS CERTIFIES THAT ABOVE NAMED IS
RECOGNIZED BY ORACLE CORPORATION AS AN
ORACLE CERTIFIED ASSOCIATE.

November 27, 2017

DATE

DAMIEN CAREY
SENIOR VICE PRESIDENT, ORACLE UNIVERSITY

25665761 1OCAJSE7

Semester-wise Pattern for Students Admitted to B.E. Mechanical Programme									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	ME	F213	Materials Science &		MGTS	F211	Principles of Management	3
			Engineering	2			Humanities Electives	3(min)
	ME	F212	Fluid Mechanics	3	ME	F241	Machine Design & Drawing	4
	ME	F211	Mechanics of Solids	3	ME	F242	IC Engines	2
	ME	F214	Applied Thermodynamics	3	ME	F243	Production Techniques I	3
	ME	F215	Mechanical Engineering Laboratory	2	ME	F244	Kinematics & Dynamics of Machinery	3
				19(min)				**18(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	1 to 4			Open/Humanities Electives	3 to 6
	ME	F311	Heat Transfer	4	ME	F341	Prime Movers & Fluid	
	ME	F312	Advanced Mechanics of				Machines	3
			Solids	3	ME	F343	Mechanical Vibrations	3
	ME	F313	Production Techniques II	4	ME	F342	Computer Aided Design	4
			Discipline Electives	6(min)	ME	F344	Engineering Optimization	2
							Discipline Electives	3(min)
				18/21				**18/21**
IV			Open Electives	7to13	BITS	F412	Practice School-II	20
			Discipline Electives	3(min)			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives	
							(6 to 9)	15 to 18
				10/16				**15/20**

Discipline Core - 48 Units (16 Courses)

Discipline Electives - 12 Units (4 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

MF F214	Applied Thermodynamics	3	0	3
MF F215	Mechanical Engineering Laboratory	0	2	2
MF F241	Machine Design & Drawing	3	1	4
MF F242	Manufacturing Management	2	0	2
MF F243	Manufacturing Processes	2	1	3
MF F244	Kinematics & Dynamics of Machinery	3	0	3
MF F311	Mechatronics & Automation	2	1	3
MF F312	Tool & Fixture Design	3	0	3
MF F313	Metal Forming & Machining	3	1	4
MF F341	Design of Machine Tools	3	0	3
MF F342	Computer Aided Design	3	1	4
MF F343	Casting & Welding	3	1	4
MF F344	Engineering Optimization	2	0	2
DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
BITS F415	Introduction To MEMS	3	1	4
ECON F411	Project Appraisal	3	0	3
ME F415	Noise Engineering	3	0	3
ME F416	Reverse Engineering and Rapid Prototyping	3	0	3
ME F416	Work System Design	3	0	3
ME F417	Advanced Metal Forming	3	0	3
ME F419	Total Product Integration Engineering	3	0	3
ME F432	Computer Aided Manufacturing	3	0	3
ME F443	Quality Control Assurance and Reliability	3	0	3
ME F484	Automotive Technology	3	0	3
MF F411	Fluid Power Systems	3	1	4
MF F412	Automotive Systems	3	0	3
MF F413	Mechanical Vibrations and Acoustics	3	0	3
MF F414	Manufacturing Excellence	3	0	3
MF F418	Lean Manufacturing	3	0	3
MF F421	Supply Chain Management			4
MF F442	Advances in Materials Science	3	0	3
MF F453	Industrial Relations	3	0	3
MF F463	Maintenance and Safety	3	0	3
MF F471	Instrumentation and Control	3	0	3
MF F472	Precision Engineering	3	0	3
MF F473	Product Design and Development	3	0	3
MF F474	Product Design and Development Projects	0	0	3
MF F485	Sustainable Manufacturing	3	0	3

MECHANICAL ENGINEERING

CORE COURSES		**L**	**P**	**U**
ME F211	Mechanics of Solids	3	0	3
ME F212	Fluid Mechanics	3	0	3
ME F213	Materials Science & Engineering	2	0	2
ME F214	Applied Thermodynamics	3	0	3
ME F215	Mechanical Engineering Laboratory	0	2	2
ME F241	Machine Design & Drawing	3	1	4
ME F242	IC Engines	2	0	2
ME F243	Production Techniques I	2	1	3
ME F244	Kinematics & Dynamics of Machinery	3	0	3
ME F311	Heat Transfer	3	1	4
ME F312	Advanced Mechanics of Solids	3	0	3
ME F313	Production Techniques II	3	1	4
ME F341	Prime Movers & Fluid Machines	2	1	3
ME F342	Computer Aided Design	3	1	4
ME F343	Mechanical Vibrations	3	0	3
ME F344	Engineering Optimization	2	0	2
DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
BITS F415	Introduction to MEMS	3	1	4
DE G513	Tribology	3	2	5
DE G514	Fracture Mechanics	3	2	5
DE G531	Product Design	3	2	5
ECON F411	Project Appraisal	3	0	3
ME F411	Fluid Power Systems	3	1	4
ME F412	Production Planning & Control	3	0	1
ME F413	Nonlinear Vibrations	3	0	3
ME F415	Gas Dynamics	3	0	3
ME F416	Reverse Engineering and Rapid Prototyping	3	0	3
ME F417	Advanced Metal Forming	3	0	3
ME F418	Rocket and Spacecraft Propulsion	3	0	3
ME F419	Total Product Integration Engineering	3	0	3
ME F420	Power Plant Engineering	3	0	3
ME F423	Microfluidics and Applications	3	0	3
ME F432	Computer Aided manufacturing	3	0	3
ME F433	Solar Thermal Process Engineering	3	1	4

ME F441	Automotive Vehicles	3	0	3
ME F443	Quality Control, Assurance and Reliability	3	0	3
ME F451	Mechanical Equipment Design	3	0	3
ME F452	Composite Materials & Design	3	0	3
ME F461	Refrigeration and Air conditioning	3	0	3
ME F472	Precision Engineering	3	0	3
ME F482	Combustion	3	0	3
ME F483	Wind Energy	3	0	3
ME F484	Automotive Technology	3	0	3
ME F485	Numerical Techniques for Fluid Flow and Heat Transfer	3	0	3
ME G511	Mechanism and Robotics	3	2	5
ME G512	Finite Element Methods	3	2	5
ME G514	Turbomachinery	3	2	5
ME G515	Computational Fluid Dynamics	3	2	5
ME G533	Conduction and Radiation Heat Transfer	3	2	5
ME G534	Convective Heat and Mass Transfer	3	2	5
MF F421	Supply chain management			4
MF F485	Sustainable Manufacturing	3	0	3
MST G522	Advanced Composites	3	2	5

PHARMACY

CORE COURSES		L	P	U
BITS F219	Process Engineering	2	1	3
PHA F211	Pharmaceutical Analysis	2	1	3
PHA F212	Dispensing Pharmacy	2	1	3
PHA F213	Microbiology	2	1	3
PHA F214	Anatomy, Physiology & Hygiene	2	1	3
PHA F215*	Introduction to Molecular Biology and Immunology	3	0	3
PHA F241	Pharmaceutical Chemistry	2	1	3
PHA F242	Biological Chemistry	2	1	3
PHA F243	Industrial Pharmacy	2	1	3
PHA F244	Physical Pharmacy	2	1	3
PHA F311	Pharmacology I	2	1	3
PHA F312	Medicinal Chemistry I	2	1	3
PHA F313	Instrumental Methods of Analysis	2	1	4
PHA F314	Pharmaceutical Formulations and Biopharmaceutics	2	1	3
PHA F341	Pharmacology II	2	1	3
PHA F342	Medicinal Chemistry II	2	1	3
PHA F343	Forensic Pharmacy	2	-	2
PHA F344	Natural Drugs	2	1	3

*** To be offered to B.Pharm. students admitted in 2014 onwards in place of PHA F243**

DISCIPLINE ELECTIVE COURSES		L	P	U
MATH F212	Optimization	3	0	3
PHA F413	Pharmaceutical Management and Quality Control	3	0	3
PHA F414	Biopharmaceutics	3	0	3
PHA F415	Pathophysiology	3	0	3
PHA F416	Chemistry of Synthetic Drugs	3	0	3
PHA F417	Pharmacoeconomics	3	0	3
PHA F422	Cosmetic Science	2	1	3
PHA F432	Hospital Pharmacy	3	0	3
PHA F441	Biochemical Engineering	3	0	3
PHA F442	Applied Pharmaceutical Chemistry	3	0	3
PHA F461	Phytochemistry	2	1	3

BIOLOGICAL SCIENCES

CORE COURSES		L	P	U
BIO F211	Biological Chemistry	3	0	3
BIO F212	Microbiology	3	1	4
BIO F213	Cell Biology	3	0	3
BIO F214	Integrated Biology	3	0	3
BIO F215	Biophysics	3	0	3
BIO F241	Ecology & Environmental Science	3	0	3
BIO F242	Introduction to Bioinformatics	3	0	3
BIO F243	Genetics	3	0	3
BIO F244	Instrumental Methods of Analysis	1	3	4
BIO F311	Recombinant DNA Technology	3	0	3
BIO F312	Plant Physiology	3	0	3
BIO F313	Animal Physiology	3	0	3
BIO F341	Developmental Biology	3	0	3
BIO F342	Immunology	3	0	3

DISCIPLINE ELECTIVE COURSES		L	P	U
BIO F314	Conservation Biology	2	1	3
BIO F352	Cell and Tissue Culture Technology	3	1	4
BIO F411	Laboratory	0	3	3
BIO F413	Molecular Biology of Cell	3	0	3
BIO F417	Biomolecular Modelling	3	0	3