First Year First Semester

Prod/T/111   ENGINEERING MECHANICS

Parts I : Statics

C. Free-body Diagram and Equations of Equilibrium: Some important special cases of equilibrium, Concurrent and Parallel forces in a plane and in space.
D. Friction.
E. Centre of Gravity, Centroid, First and Second Moments of Area, Moments of Inertia.
F. Trusses : Method of joints, Method of Sections.
G. Principle of Virtual Work.

Parts II : Dynamics

A. Kinematics: Kinematics of rectilinear and curvilinear motion of a particle, Motion of rigid bodies, Instantaneous center of rotation.
B. Principle of Kinetics: Motion of a particle, Motion of a system of particles, Force, Mass & Acceleration, D Alember’t’s principle
C. Work, Power and Energy: Kinetic energy of a particle, Work-energy in plane motion, Energy equation and conservation of energy, Acceleration from work-energy
D. Impulse and Momentum: Linear Impulse & momentum, Angular Impulse & momentum, Conservation of momentum
E. Friction
F. Periodic Motion: Free vibrations

Prod/T/112   PROJECTION AND SPATIAL GRAPHICS

Objects, conditions and methods of projection; Classification of projections; Scales, scale distortion and conditions of conformability and equivalence; Orthographic projection, Axonometric projections; Isometric, diametric and oblique projections; Introduction to conical equivalence and equivalent cylindrical projections. Basic principles of multi view drawing and Monge's projection; Sectional view; Points in quadrants and octants; Projection of lines and traces of a line; True relative positions of two planes, and of a straight line and a plane; Method of revolution; Projections of polyhedrons; Curved lines and surfaces; Contour mapping of curved surfaces; Plane sections of polyhedrons and curved surfaces; Intersection of planes and surfaces, and lines and surfaces; Development of curved surfaces.

ETech/EE/T/A   ELECTRICAL TECHNOLOGY-A

3-Phase Induction Machine: Types of induction machines. Rotating magnetic field, slip, torque equation, torque-speed curve. DOL starting and reduced voltage starting.
3-Phase Synchronous Machines: Alternator, constructional features, EMF equation, synchronous reactance, power-angle characteristics. Concept of synchronous motor.

Books:
1. Electrical Science by Prof. S. Chowdhury, Prof. R. Chakraborty & Prof. P. K. Chatterjee.
2. Electrical Machines by Prof. P.K. Mukherjee & Prof. S. Chakravorti.

**Prod/Math/T/114  MATHEMATICS-IS**

Function of a single variable, Review of limit, continuity and differentiability, Successive differentiation, Rolle’s theorem, Mean value theorem, Taylor’s theorem, Indeterminate forms, Maxima and minima.
Function of several variables: Limit and continuity, Partial derivatives, Differentials, Euler’s theorem on homogeneous function, Partial derivatives of composite function, Implicit function, Taylor’s theorem, Maxima and minima, Lagrange’s method, Riemann Integration.

**Prod/Math/T/115  MATHEMATICS-IIS**

Complex numbers, DeMoivre’s Theorem, Exponential values of sines and cosines, Hyperbolic functions.
Determinants (upto order 4): Definition and properties, Solution of a system of linear equations by Cramer’s rule.
Matrices: Definition, Addition and multiplication of matrices, Transpose and inverse of a matrix, Solution of a system of linear equations by matrix method.
Solid Geometry: Cartesian coordinates in three dimension, Direction cosines, Equations of planes and straight lines, Shortest distance between two skew lines, Equations of spheres Cylinders and cones
Application of calculus: Tangent and normal, Curvature, convexity and concavity.

Ph/T/1B       PHYSICS-IB

1. Use of vectors in particle mechanics, Unit vectors in spherical and cylindrical polar coordinates, Conservative vector fields and their potential functions - gravitational and electrostatic examples, Gradient of a scalar field, Equipotentials, States of equilibrium, Work and Energy, Conservation of energy, Motion in a central field and conservation of angular momentum.
2. Angular momentum of a system of particles, Torque, Moment of inertia, Parallel and Perpendicular axes theorem, Calculation of moment of inertia for (i) thin rod, (ii) disc, (iii) cylinder and (iv) sphere. Rotational dynamics of rigid body (simple cases).
3. Motion of fluids, Bernoulli's equation and its applications, motion of viscous fluids - Poiseuille's equation.
4. Simple harmonic motion, Composition of simple harmonic motion, Forced vibration and resonance, Wave equation in one dimension and travelling wave solution, Standing waves, Wave velocity and group velocity.
5. Assumption for the kinetic theory of gases, Expression for pressure, Significance of temperature, Deduction of gas laws, Qualitative idea of (i) Maxwell's velocity distribution. (ii) degrees of freedom and equipartition of energy, Specific heat of gases at constant volume and constant pressure.
6. Macroscopic and microscopic description, Thermal equilibrium, Zeroth law of thermodynamics, Concept of international practical temperature scale, Heat and Work, First law of thermodynamics and some applications, Reversible and irreversible processes, Carnot cycle, Second law of thermodynamics, Concept of entropy, Thermodynamic relations.
7. Statistical description of a system of particles, Phase space, Microstates and macrostates, Boltzmann's formula for the entropy, Canonical partition function, Free energy and other thermodynamic quantities in terms of the partition function, Classical ideal gas, Equipartition theorem and its applications.

Ph/S/1        PHYSICS LABORATORY - I
(Selected Experiments from the following)

1. Determination of Galvanometer resistance by half - deflection method.
3. To find high resistance by Galvanometer deflection method.
4. To measure mechanical equivalent of heat, J by electrical method (Joule's) using copper calorimeter (radiation correction to be done).
5. To compare to low resistance by drop of potential method.
6. To determine resistance per unit length of wire by using Carey Foster bridge.
7. To estimate strength of a current by using copper voltmeter.
8. a) To compare the EMF's of two cells by using a potentiometer  
b) To measure current by using a potentiometer  
9. To measure the horizontal components of earth's magnetic field intensity using  
deflection and vibrating magnetometers. 
10. Determination of coefficient of linear expansion by optical lever method.  
12. To determine coefficient of viscosity by Capillary flow method.  
14. To draw mutual and anode characteristics of triode and hence too fine Rp, μ, and gm  
15. To draw the transistor characteristics (NPN/PNP) in the given configuration and  
hence to find hi, hf  
16. Determination of refractive index of the material of the glass prism by prism  
spectrometer (for at least two ?s)  
17. Study of collisions in one dimension using a linear air track  
18. Use of an air track for obtaining potential energy curves for magnetic interactions.  
19. Study of oscillations under potential wells of various shapes using an air track.  
20. Experiments on diffraction in single slit, double slit and plane grating using He- Ne  
laser 
   a) To find the wavelength of a monochromatic light by single slit.  
   b) To find slit separation of a double slit.  
   c) To find number of rulings per cm of a plane grating  
21. To find the wavelength of a monochromatic light by Newton rings.  
22. Fabry-Perot interferometry: To find out separation of wavelength of sodium D1 & D2  
   lines.

**Prod/S/112  GRAPHICS LABORATORY - I**

Manipulation and use of drafting equipment and instruments; Exercises in instrumental  
drawing; Learning drafting codes as per ISO and IS; Preparation and use of scales;  
Technical lettering; Engineering geometry with examples from product stereometry;  
Geometric configurations and evolving solids; Single plane projections of product  
features; Orthographic and axonometric projections of sample objects; Sectional and  
avuxiliary views; Selected problems on Descriptive Geometry.

**Prod/S/113  TECHNICAL ARTS**

Introduction to different materials in engineering practices with respect to their  
workability, formability and machinability with hand-tools and power tools:  
Specification, identification and use of hand-tools and sensitive machines: Datum  
selection, location layout and marking problems for wood, plastics and metals: Cutting  
shearing, chipping, sizing and finishing of woods, plastics and metals: Making temporary  
and permanent joints between materials by processes of mechanical fasteners chemical  
boning & reveting. All exercise will be woven around a group of carefully designed  
product features involving material selection, technology decisions, choice of tooling and  
fixtures, layout marking and measurements. Processing of plastic products, Injection  
moulding and Blow moulding.
ELECTRICAL TECHNOLOGY LABORATORY

To supplement the course on "Electrical Technology-A".

First Year Second Semester

Hum/T/B HUMANITIES-B

English - 2 Pds/week - 50 Marks
Sociology - 2 Pds/week - 50 Marks

HUMANITIES

1. Basic writing skills
2. Report, Covering Letter & Curriculum-Vitae writing
3. Reading and Comprehension
4. Selected Short Stories

Text Book: ENGLISH FOR ALL

SOCIOLOGY

1. Sociology: Nature and scope of Sociology - Sociology and other Social Sciences - Sociological Perspectives and explanation of Social issues
2. Society and Technology: Impact of Technology on the Society - A case study
3. Social Stratification: Systems of Social Stratification - determinants of Social Stratification - Functionalist, Conflict and Elitist perspectives on Social Stratification
5. Development - Conceptions of and approaches to development - The Roles of State and the Market in the Development
7. Industrial Policy and Technological change in India - The nature and Role of the State in India
8. Technology Transfer: The Concept and Types of Technology Transfer-Dynamics of Technology Transfer
9. Technology Assessment: The Concept - Steps involved in Technology Assessment
10. Environment: Sociological Perspectives on Environment - Environmental Tradition and values in ancient India
12. Technological Problems and the Modern Society: Selected Case Studies - Electric Power Crisis, Industrial and/or Environmental Disaster, or Nuclear Accident.

CHEMICAL SCIENCE
Basic properties of chemical bonding; chemical thermodynamics and kinetics; Electrochemistry - electrolytic dissociation and conduction, ionic equilibrium, electrochemical cells, pH and indicators.
Phase rule and its applications, principles of surface chemistry, Chromatography, ion exchange Chemisorptions and structure of solids.
Structure of organics molecules, nomenclature of organics compounds, sterio-chemistry, optical activity; reaction mechanisms; study of organics compounds, polymers and lubricants- synthesis of polymers.
Chemical fuels-fossil fuels (coals and petroleum), produces gas, water gas - blue water gas; Nuclear fuels- binding energy, fission and fusion, controlled fission, power reactor, sources of nuclear fuels, explosives and rocket fuels; water and waste water chemistry.

Prod/Math/T/123    MATHEMATICS-IIIS

Sequence and Infinite Series: Concept of a sequence and its limit, Sum of an infinite series as the limit (if exists) of the partial sum upto n terms. Comparison test, D’Alembert’s ratio test and Cauchy root test.
Ordinary Differential Equations: Differential equation of first order exact equation, linear as well as non-linear, Linear differential equation of second and higher orders with constant coefficients. Euler Cauchy equation, Method of variation of parameters.
Integral Transforms: Laplace transforms: Definition and properties, Inverse Laplace transform, Convolutions, Application to ordinary differential equations.
Fourier Transforms: Definition and properties, Inverse Fourier transform, Convolutions, Application to partial differential equation, Z-transforms, Definition and properties, Applications.

Prod/Math/T/124    MATHEMATICS-IVS

Vector Algebra: Addition of vectors, Multiplication of a vector by a scalar, Components of a vector, Scalar and Vector product of two vectors, Products of three vectors, Applications to Mechanics
Vector Calculus: Vector functions, of a scalar variable, Derivative of vector function, Applications to mechanics, Gradient, divergence and curl, Vector integration, Line, Surface and Volume integrals, Green, Gauss and Stokes theorem, Applications.
Fourier series: Periodic function, Trigonometric series with sines and cosines. Euler formula, Fourier series, Dirichlet’s conditions, Even and odd functions, Half range sine and cosine series.
Partial differential equation: Solution of one dimensional wave and diffusion equations and two dimensional Laplace equation by the method of separation of variables, Applications to physical problems.

Prod/ET/T/125     BASIC ELECTRONICS ENGINEERING

half-wave and full-wave rectifiers, filters, voltage amplifier, selection of operating point bias, gain of amplifier, equivalent circuits, frequency response, power amplifier, push-pull amplifier; Oscillators: multivibrators, saw tooth generators.

**Ph/T/2A  PHYSICS-IIA**

1. Electric potential and intensity, Flux of electric field, Gauss's law and its application to problems with spherical and cylindrical symmetry, Capacitance- parallel plate and spherical condensers, Energy of a capacitor, Energy density of an electric field, Potential and field due to a dipole, Dielectric polarisation, Electric displacement vector, dielectric susceptibility.
2. Biot-Savart law and Ampere's law in magnetostatics, Calculation of magnetic field in simple situations like (i) straight wire (ii) circular wire (at a point on the symmetry axis) and (iii) Solenoid.

**Ph/S/2  PHYSICS LABORATORY-II**

(Selected Experiments from the following)

1. Determination of Galvanometer resistance by half - deflection method.
3. To find high resistance by Galvanometer deflection method.
4. To measure mechanical equivalent of heat, J by electrical method (Joule's) using copper calorimeter (radiation correction to be done).
5. To compare to low resistance by drop of potential method.
6. To determine resistance per unit length of wire by using Carey Foster bridge.
7. To estimate strength of a current by using copper voltmeter.
8. a) To compare the EMF's of two cells by using a potentiometer
   b) To measure current by using a potentiometer
9. To measure the horizontal components of earth's magnetic field intensity using deflection and vibrating magnetometers.
10. Determination of co efficient of linear expansion by optical lever method.
12. To determine co-efficient of viscosity by Capillary flow method.
14. To draw mutual and anode characteristics of triode and hence too fine Rp, µ, and gm
15. To draw the transistor characteristics (NPN/PNP) in the given configuration and hence to find hi, hf
16. Determination of refractive index of the material of the glass prism by prism spectrometer (for at least two ?s)
17. Study of collisions in one dimension using a linear air track
18. Use of an air track for obtaining potential energy curves for magnetic interactions.
19. Study of oscillations under potential wells of various shapes using an air track.
20. Experiments on diffraction in single slit, double slit and plane grating using He-Ne laser
   a) To find the wavelength of a monochromatic light by single slit.
   b) To find slit separation of a double slit.
   c) To find number of rulings per cm of a plane grating
21. To find the wavelength of a monochromatic light by Newton rings.
22. Fabry-Perot interferometry: To find out separation of wavelength of sodium D1 & D2 lines.

Prod/S/122 MANUFACTURING SYSTEMS LABORATORY-I

Introduction to primary technology/technological processes involving forging, bending, blanking, punching and drawing; Preparation of foundry sand and moulds: experiments of properties of foundry sands; post casting fettling, cleaning deburring, polishing and painting operations. Laboratory Experiments in Production Processes on Electric Arc Welding, Electric Resistance Welding MIG, TIG, Thermit and submerged arc welding; Testing of Joints. Heat treatment, surface preparation, etching and metallographic studies of different materials.

Prod/S/123 BASIC ENGINEERING LABORATORY

Experiments involving calibration of and measurements by direct signal receivers and analogue transducers for major physical quantities; Characterization of materials - solids and fluids: Characterization of resilient systems; investigations of thermal, transporting and radiation properties of materials and fluids; Kinematic synthesis; Laws of Machines.

Prod/ET/S/124 BASIC ELECTRONICS LABORATORY

Experiments pertaining to the theoretical subject "Basic Electronics Engineering" and commensurate with the same.

Second Year First Semester

Prod/Math/T/211 MATHEMATICS-VS

Complex Analysis: Functions of a complex variable, Limit, Continuity and differentiability, Cauchy-Riemann Equations, Complex integration, Cauchy’s
fundamental theorem, Cauchy’s integral formula, Taylor’s theorem, Laurent’s theorem, Singularity Pole Residue theorem, Contour integration.
Series solution of differential equations: Ordinary point and regular singularity of second order linear differential equations, Generating functions and recurrence relation, Orthogonal property of Legendre polynomials.

Prod/CSE/T/212  COMPUTER PROGRAMMING & NUMERICAL ANALYSIS

1. Introduction to Computer System: Computer Organization - CPU, Memory (ROM, RAM), input-output units: Different levels of languages - High level, assembly and machine languages, Assemblers, Compilers, interpreters; Operation system, bits, bytes, words, serial and parallel communication.
2. Programming Logic Algorithms and flow-charts, Programming in a high level language (C/C++ & VB) - Data types, constants and variables; Expressions - numeric & non-numeric, library function, input-output and control statements, loops, arrays, functions, subroutines, file handling; Miscellaneous other features.

Prod/T/213  DEFORMATION OF SOLIDS

Definitions of stress and strain: Stress tensor; Differential equations for equilibrium; Linear stress-strain laws and strain energy; Problems of strength and stiffness of circular and non-circular sections subjected to axial load, torsion and bending; Analysis of composites; Transformation of stresses and strains; Mohr's circle; Yield and fracture criteria and theories of failure; Statically indeterminate systems; Virtual work equations; Stability of columns.

Prod/T/214  PRIMARY PRODUCTION PROCESSES

(A) Types of production and production processes; Product configuration and manufacturing requirements; Casting of ferrous and non-ferrous metals including die casting. Loam moulding, investment casting, centrifugal casting, transfer moulding, etc. (B) Designing moulds, risers, sprues and gating system, casting defects, (C) Joining methods: welding brazing and soldering: Welding processes like fusion welding, electric arc welding, resistance welding, TIG, MIG submerged arc welding processes, friction welding: welding defect. (D) Hot and cold working of metals, Bending, Wire/Tube Drawing, Deep drawing, spinning flow turning, stretch forming, forging defects etc.

Prod/T/215  ANALYSIS AND SYNTHESIS OF MECHANISMS

1. Mechanisms and machines, Kinematic elements and chain, condition of movability and Grubbler criteria, Higher order linkages, Kinematic inversion. Velocity and acceleration
analysis of link systems. Various Mechanisms: Slider Crank, Differential, Pentograph quick returns Automatic Steering gear etc.
2. Synthesis of linkages; Kinematic analysis of machine elements Frudenstein's equation, path generation, Cam Synthesis.
3. Belt Drive; Chain Drives, Gear & Gear elements Gear Drive, Gear Train, Cam follower Motion analysis etc.

**Prod/T/216 PRODUCT & SYSTEM GRAPHICS**

Introduction to various product features: Identification of functional and non functional surfaces, Representation of products and its features through graphics, Selection of datum for manufacturing and assembly requirements, auxiliary views, Cumulative and non-cumulative assembly; Dimension of assembled elements; Use of standard parts; Detailing of assembled systems; Representation of assembled systems through graphs; Line diagrams and symbolic representation of engineering systems and construction of exploded diagram from basic schemes for: a) Mechanical Systems b) Welding Systems c) Priping Systems Product representation through computers: 2D and 3D representation, Solid model creation, 3D surface generation, viewing transformation Exchange of graphics data: DXF, IGES, STEP format Specification, Extraction of graphic entities from these data file.

**Prod/CSE/S/211 COMPUTER PROGRAMMING & NUMERICAL**

ANALYSIS LABORATORY Use of digital computers for solving matrix problems of various dimensions: Use of algorithm for matrix inversion, generation of random numbers for simulation studies, Programming for numerical differentiations and integration Programming Applications to be carried out in high level languages (C/C++ & VB).

**Prod/S/212 ENGINEERING EXPERIMENTATION LABORATORY**

Experiments leading to: (a) Energy Balance, (Boiler & Refrigeration system); (b) Performance evaluation of Pumps, Engines, Heat exchanger; (c) Equilibrium of trusses and structures; (d) Deformation characteristics of solids; (e) Kinematic synthesis; (f) Fluid laws and equations, study of hydraulic system; (g) Tribology; (h) Balancing & Stability; (i) Vibrations & noise; (j) Experimental stress analysis; (k) Thermal properties of material.

**Prod/S/213 MANUFACTURING SYSTEMS LABORATORY-II**

(A) Simple machining operations involving Lathe, Drilling, Shaping, Milling etc. (B) Simple machining operations with production of flat surfaces, surface of revolution, conicoids; Internal holes; Slots and threads. (C) Simple measurements and inspection of product features, like, shafts, slots, holes, tapers etc.

**Prod/S/214 GRAPHICS LABORATORY-II**
Selected problems on Nomography; Path generation. Selected drafting problems involving consideration of steroimetric features and technological processing parameters: Dimension and geometrical tolerancing; Partial views and sectioning problems, auxiliary sections; Schematic product symbols for standard parts of electrical, mechanical and electronics systems; welding symbols and pipe joints.

Second Year Second Semester

Prod/T/221 THERMODYNAMICS AND HEAT TRANSFER

1. Basic concept and the first law of thermodynamics and its applications Non-flow and flow processes; Second law; Concept of Entropy; Equation of states for gases; Properties of steam and mixture of gas; Thermodynamic relations.
2. Thermodynamics Systems; Steam boilers; Thermal power plant Cycle; Air standard Cycles; Reversed Cycle principles: Heat pump and refrigerator.
3. Heat flux and Fourier's law of conduction; convection and radiation heat transfer; Performance of Heat exchangers and Fins; Use of dimensionless Parameters in solving heat transfer problems.

Prod/T/222 MATERIALS SCIENCE AND TECHNOLOGY

1. Nature and properties of materials, packing and crystal structure, crystal imperfections; Phase equilibrium and phase transformation; Mechanical properties, Non-destructive testing (NDT)
2. Metallography; Binary phase equilibrium; Iron carbon equilibrium diagram and characteristics of alloy microstructure; Ternary phase diagram.

Prod/T/223 MICROPROCESSOR CONTROL AND MECHATRONICS


Prod/T/224 FLUID SYSTEMS

(A) Review of fluid properties; Hydrostatic; Fluid Kinematics, Fluid Dynamics, Basic principles of flow of fluids through closed conduits, open channel and weirs. (B) Fluid Machinery: Pumps and turbines. (C) Hydraulic and pneumatic circuits, power nits,
accumulators and intensifiers: Valves for pressure, flow and direction controls and compensations; (D) Fluid logic systems.

**Prod/T/225  MACHINE DYNAMICS**

1. Static and dynamic force analysis of constrained kinematic systems: Dynamics of rotary and reciprocating machines; Critical speeds, Precessional motions and gyroscopic stability. Balancing of rotating and reciprocating masses, flywheel, governor mechanism.
2. Simple Harmonic Motion vibration of single degree freedom system: Force & undamped, damped & forced vibration systems, Two degrees of freedom systems, Mode coupling, Vibration Damper.

**Prod/T/226  INDUSTRIAL STATISTICS**

(A) Basic laws of probability, conditional probability; Random variable, sample distribution, statistical hypothesis; Statistical tests of significance, correlation, regression analysis; Auto-correlation, analysis of variance. (B) Analysis of basic experiment designs; Randomized block design; Latin and orthogonal squares; Factorial designs. (C) Markov chains: Poisson's process; Diffusion process. (D) Introduction to stochastic problems in engineering.

**Prod/S/221  MICROPROCESSOR CONTROL & MECHATRONICS LABORATORY**

Laboratory experiments involving the following are to be done. Use of logic gates & circuits, Microprocessor Programming - for simple control operations. Measurements of Position, Displacement, Velocity, Force, Temperature, Proximity and range. Open loop position control; Closed loop position control using position and velocity feedback; Use of analog and digital servo systems. Experiments on actuators and drives; PLC

**Prod/S/222  GRAPHICS LABORATORY-III**

Drafting exercise involving: (A) Preparation of product assembly details. (B) Aggregation for assembly. (C) Exploded machine kinematics, (D) Computer drafting

**Prod/S/223  MANUFACTURING SYSTEMS LABORATORY - III**

Laboratory exercises involving: (A) Machining of complex product configurations, (B) Machining of spur and helical gears, (C) Advanced Welding Processes

**Prod/S/224  VACATIONAL PRACTICAL TRAINING AND VIVA-VOCE I - 200 hrs**

In-Plant training involving various production processes like: (A) Foundry, forging, welding and fabrication (B) Organisational hierarchy (C) Product handling features (D)
Specialized toolings and set-ups. Students will be required to submit a report on the in-plant training and appear for a Viva-Voce on the said training and report.

Third Year First Semester

Prod/T/311 TECHNOLOGY OF MACHINING SYSTEMS

(A) Manufacturing system as an input-output model; Survey of products; Machining accuracy and algebra of dimensions, surface finish and sub-surface properties of products. (B) Selection processes, tooling and machines for producing: i) External surface of revolution; ii) Internal surface of revolution; iii) Regular and irregular profiles; iv) Threads and gears. (C) Selection of cutting variables compatible to machines and processes. (D) Finishing processes, viz. grinding, honing lapping etc. (E) Estimation of machining time. (F) Stereometry of cutting tools, Mechanics of metal cutting action (G) Computations of cutting forces (H) Failure of cutting tools materials (I) Economics of machinings

Prod/T/312 INSPECTION AND PRODUCT CONTROL

(A) Standards of measurements; Concepts of interchangeability, Taylor's principles; Design of limit gauge; Selective assembly. (B) Mechanical, pneumatic, electrical, electronic and optical measuring systems for in-processes and post-processes features inspection of products; Principles of light wave interferrometry and interferometers; Ultrasonic gauging. (C) Co-ordinate measurement principles, Co-ordinate measuring machines (CMM); Product feature recognition and image processing. (D) Surface finish measurement and analysis; Metrology of screw threads, gear metrology, machine tool metrology; Quality and reliability; Basic principles of statistical quality control; General theory of control charts for variable and attributes; Concept of acceptance sampling; Computer applications in inspection and quality control, ISO 9000 requirements.

Prod/T/313 ENERGY PRODUCTION SYSTEMS

(A) Energy Management; (B) Elementary study of combustion; Power developing and power absorbing reciprocating engine; Internal Combustion Engine; Reciprocating compressor; (C) Principles of turbo-machines: Steam and Gas turbine; Gas Turbine power plant Cycle; (D) Utilization of Nuclear energy and nuclear power plants; Principles of Direct Energy Conversion: Fuel cells, MHD generators; Solar energy Conversion Systems; Bio-energy conversion Systems; Wind, Tidal , Geothermal and Ocean Thermal energy Conversion systems.

Prod/T/314 PLANT LAYOUT & PRODUCT HANDLING

Objective of Facility Design: Types of layout problems, the layout function, organization of layout. Analysis and Design of Material Flow: Systems approach to flow cycle, flow possibilities, facility layout, process charts, string diagram, flow process charts, Quantitative analysis of material flow; optimal material flow configuration. Space and
Area Allocation for Production and Physical Plant Services; Computerized handling of layout algorithms; Algorithms for computerized Layout Planning, Construction and Development type of computerized Layout Planning Techniques i.e. CRAFT, ALDEP, CORELAP etc.; Product handling; Design of system configurations conforming to various kinds of product features and layout characteristics; Design concepts of common handling and transfer equipment; Different types of conveyors, crane, elevator, fork lifters; Design concept of warehouse facilities commensurate with adopted kind of handling and transfer devices; Automated packaging devices. Application of pneumatic and hydraulic system in transportation and handling of products. Design of integrated plant layout for product handling systems.

**Prod/T/315      DESIGN OF ENGINEERING SYSTEMS - I**

Interrelatedness of product design and production processes. Introduction of engineering design processes; Conceptual design, configurational design, detail design; Design Methods; Design to Standards. Design of Simple Systems involving fastners, pins, cotters, welds, rivets, pressure vessels, etc. Use of general design rules, rational sections for strength, rigidity, weight reduction, choice of materials. Modelling, simulation and optimization in design; Economic considerations; Systems Engineering using the concepts of concurrent engineering/DFM/DFA/QFD/robust design (Taguchi methods)

**Prod/T/316       PRODUCTION MANAGEMENT**

Management approaches to planning, analysis and control, Functions involved in a production system; Production cycles, Planning functions; Types of industry: Job, batch, continuous, mass and flow productions; Organization and policies in respect of production planning and control; Forecasting techniques; Resources economics and scheduling, Sequencing and plant loading for optimal utilization; Queueing models and line balancing; Materials planning and control; Inventory management: MRP, MRP-II,JIT, Value analysis; Productivity analysis; Mechanics of production control.

**Prod/S/311       METROLOGY AND PRODUCT CONTROL LABORATORY**

(A) Laboratory experiments for the measurement and inspection of various product features using:- i) Mechanical, pneumatic, optical, electrical and electronic instruments, ii) Co-ordinate measuring machine (CMM) iii) Interferometer; iv) Colour image processing system for product feature recognition, edge detection, etc; v) Ultrasonic ecograph; vi) Surface roughness measuring system, and vii) Gear inspection modules. (B) Laboratory experiments and exercises involving hardware and software modular based off-line product gauging and inspection analysis, inspection information recording and processing - signal channel and multi-channel; on-line and off-line computer aided quality control analyses.

**Prod/S/312       MANUFACTURING SYSTEMS LABORATORY - IV**
(A) Experiments to demonstrate: i) Layout of die and die making practices, ii) Wire drawing, iii) Extrusion processes, v) Friction and lubrication in forming processes. vi) Use of computer for die design/die layout, etc. (B) Machining operations related to: i) Relieving, and profiling ii) Contouring, iii) Finishing processes and iv) Grinding of tools and cutters

**Prod/S/313 \** PRODUCTION MANAGEMENT LABORATORY

Experiments and computational work involving: i) Production planning and scheduling ii) Processes planning iii) Resources allocation, machine loading and optimization, iv) Plant facility layout models; v) Mechanical, electro-analogue and computer aided analogue space models for optimal plant facility location analysis; vi) Time study & Motion study.

**Prod/S/314 \** PROJECT AND TERM PAPER

An individualized project will be assigned either for analysis or for manufacture or both to be completed within the semester and submitted for evaluation along with the Report. Alternatively, students will be required to submit a term paper for evaluation based on an assignment of the thematic area of development in Engineering and Technology.

**Third Year Second Semester**

**Prod/T/321 \** MACHINE TOOL SYSTEMS

Basic concepts and general requirements of machine tools; Conformable kinematic synthesis for tracing, forming, enveloping and generation; Pseudo-Boolean approach for kinematic order; Fuzzy-cluster grouping for size range evaluation; Determination of power for optimal utilization; Designing discrete step drives for machine tools speeds and feeds; Stepless drives; Hydraulic drives and control; Functional analysis of machine tool spindles, guides and slideways; Compliance of machine tools; Automation and control features; Selection and acceptance testing of machine tools.

**Prod/T/322 \** ERGONOMICS AND WORK DESIGN

Human factors in a production system: characteristics features of man-machine system: quantitative and qualitative visual displays; Human factors associated with speech communication; Introduction to kinesiology; Biomechanics and bioengineering aspects of human motor activity; performance analysis of body members in making specific types of movements; and conceptual relationships of stimuli and responses; Design of control function. Tools and related control devices and control systems. Design of work place and work-components; Applied anthropometry, activity analysis: concepts of productivity and its improvement strategies; Design of individual work place; Human performance under heat, cold, illumination, vibration, noise, pollution. Static and dynamic conditions. Application of results from human factors data and analysis in work
study; work design; Method study and work measurement techniques; performance rating and time standards.

**Prod/T/323   MATERIAL FORMING**


**Prod/T/324   MASS PRODUCTION TECHNOLOGY AND AUTOMATION**

Types of production systems; Role of interchangeability and standardization; Economics of mass production; Factors of production; Planning for optimal production. Comparative Study of various production processes for making (a) Flat surfaces, (b) Housing, (c) Shafts and spindles, (d) Screw threads, (e) Gears, (f) Assembled products. Holding devices for tools and workpieces; Collets and chucks; jigs and fixtures; Locating and clamping and clamping elements; Locating rules. Alternative processes for polymer products; Moulding, extrusion and machining of thermoplastics and thermosetting plastics; Mass production processes by precision castings; Investment casting, loam moulding, die casting, etc. Press tools and punch-die working shears, drawing and forming dies and punches. Economics of tooling. Basic principles of automation; Extending the capabilities of conventional machines through improved devices; Automatic machines; Hydro copying lathe; copy milling; single spindle Auto screw machine; Swiss type Automats.

**Prod/T/325   INFORMATION TECHNOLOGY**


**Prod/T/326   DESIGN OF ENGINEERING SYSTEMS-II**

**Prod/S/321**  
**ERGONOMICS LABORATORY**

Experiments involving: A) Anthropometry B) Kinesiology C) Comfort analysis D) Fatigue, and E) bio-engineering, etc. are to be done.

**Prod/S/322**  
**COMPUTER GRAPHICS AND MODELLING**

Laboratory exposure on: Use of graphics package for (A) Interactive graphics for Generation of polyhedron, cylinder, sphere, cone etc. (B) 3D viewing and transformation, hidden surface removal. (C) Generation of curves and surfaces; Geometric modelling;

**Prod/S/323**  
**DESIGN SESSIONAL**

Design problems related to simple engineering systems, involving fastners, pins, cotters, welds, rivets, pressure vessels, etc. Problems related to static and dynamic analysis of engineering systems involving shafts, linkages, couplers, transmission devices, toothed elements etc. Tribological analysis of support systems Computer solutions of design problems.

**Prod/S/324**  
**VACATIONAL PRACTICAL TRAINING AND VIVA-VOCE II - 200 hrs.**

In-plant training involving study of: a) Complex machining operation b) Plant layout c) Organizational hierarchy d) Degree of automation e) Product handling features. f) Specialized tooling, set-ups Students will be required to submit a report on the in-plant training and appear for a viva-voce test of the said training.

**Fourth Year First Semester**

**Prod/T/411**  
**NON-TRADITIONAL MACHINING**

Introduction to new methods of production; Need and capability analysis of various processes; Classification and selection of non-traditional machining technologies. Abrasive processes of machining including Abrasive Jet machining (AJM), Water Jet Machining (WJM) and ultrasonic machining (USM). Chemical machining (CHM), Hot chlorine machining, Electrochemical machining (ECM): Electrochemical deburring and honing: Electrochemical Grinding (ECG); Electrochemical Discharge Machining (ECDM); Electrochemical Arc Machining (ECAM). Electrical discharge machining (EDM); wire EDM, Electron beam machining (EBM); Plasma arc machining (PAM); Laser beam machining (LBM); Ion beam machining (IBM), Netural particle etching. Cryogenic machining; Hot machining, stretched turning; Dynamic cutting; Magnetic
cutting; Oscillating turning; Ballistic machining. Selecting the most suitable process for a product; Economic analysis of non-traditional machining processes.

**Prod/T/412  PRODUCTION ECONOMICS AND FINANCIAL MANAGEMENT**


**Prod/T/413  CNC MACHINES AND ROBOTICS**

Basic principles of numerical control; Methods of coding Computer Numerical Control (CNC) System, Machine Structure, drive system, motion elements, Incremental and Absolute position encoders, velocity sensors CNC programming G and M code, Turning centre, Machining centre canned cycle, Subprogram, loops, CNC Tooling. Economics of numerical control and DNC. Introduction to Robotics: Robot anatomy; Hydraulic, pneumatic and electrical manipulators; Controllers with microprocessors of fluidics; Sensors; End effectors and their design; Performance analysis of industrial robots; Economics of robotics.

**Prod/T/414  PLANT AND MAINTENANCE ENGINEERING**

Introduction: Emphasising the functional similarity as a conversion medium of different types of plants; Common features in terms of infrastructural input requirements; some typical plant, and their system configurations. Climatological, economic, social legal, political, industrial determinants of site selection; Establishing various kinds of weighing coefficients of these factors in relation to the nature of the plant. Techno-economic viability study, Depreciation, LCC, Replacement analysis Concept of reliability, availability and maintainability (RAM); System reliability; Reliability improvement; FTA,FMEA,FMECA, Maintenance Planning and Control, Design of maintenance systems; Spare parts managements, Kaizen, Terotechnology, SWOT analysis; Multipractice of safety engineering. An executive overview of six sigma, gearing up and adapting six sigma to plants, implementing six sigma; Introduction to benchmarking, the strategic application of benchmarking for best practice, the process of benchmarking in practice. Performance evaluation of plants

**Prod/T/415  OPERATIONS RESEARCH**
Linear Programming, Simplex method, Duality and Sensitivity analysis, Transportation model and its variants, network models, Revised simplex methods, Integer programming: Game Theory, Queuing systems, simulation Modeling, Markovian Decision Process, Non linear models

Prod/S/411 AUTOMATION, CNC MACHINES AND ROBOTICS LABORATORY


Prod/S/412 MACHINE TOOLS AND METAL CUTTING LABORATORY

(A) Experiments will be performed to illustrate: a) Kinematic structures of machine tool drives, b) Compliance characteristics c) Tribological behaviours of machine tool slideways d) Hydraulic and pneumatic control systems e) Use of mass production machine tools, f) Acceptance tests. (B) Experiments to illustrate: a) Chip formation characteristics b) Dynamometry and force measurement during machining c) Wear and tool life d) Grinding and lapping

Prod/S/413 MANUFACTURING PROJECT

Assignment of individual/ Group project involving manufacturing/Production of an engineering product

Prod/S/414 SEMINAR

Each student will be required to give a seminar talk along with a report on any current topic with audiovisual aids, graphs, charts and models as assigned to them on individual basis.

Fourth Year Second Semester

Prod/T/421 COMPUTER INTEGRATED MANUFACTURING

Concept of computer integrated manufacturing (CIM); Basic components of CIM; Distributed data base system; Distributed communication system, Computer networks for manufacturing; Future automated factory; Social and economic factors. Computer Aided Design (CAD); CAD hardware and software; Product modelling; Automatic drafting; Engineering analysis; FEM design review and evaluation; Group technology centre. Computer Aided Manufacturing (CAM): Computer assisted NC-part programming; Computer assisted robot programming; Computer aided process planning (CAPP); Computer-aided material requirements planning (MRP); Computer aided production scheduling; Computer aided inspection planning; Computer aided inventory planning.
Flexible manufacturing system (FMS); Concept of flexible manufacturing; Integrating NC machines, robots, AGVs, and other NC equipment; Computer aided quality control; Business functions; Computer-aided forecasting; Office automation.

**Prod/T/422 ECOLOGY AND ENVIRONMENT**

Development dynamics in environment perspective; Macro principles of eco-development; Continuing, renewable, non-renewable and extrinsic sources in eco-systems; Bio-sphere cycle, o2 - co2 cycles and other natural eco-systems. Demographic structure; Population growth and other human factors in development processes; The economics of eco-development; Cost-benefit analysis of pollution abatement. Problems of technological choice and technological transfer; Extent, ideals, exogenies and policies of alternative development systems; Eco-development desideration; Devising strategies and operational tactics for planning of projects compatible to eco-systems. Systems approach to modelling of eco-systems in general. UNO and ISO directives on protection of environment. Design for Environment. Environmental pollution and its control strategies.

**Prod/T/423 PLANNING AND EVALUATION OF PROJECTS**

Project Definition: Project study techniques: Project management features; Management information and control systems for projects; Project organization design: Plant location analysis models; Project scheduling; Gantt charts, PERT, CPM, RAMPS, multi-project control; Project cost optimization time cost Trade off: Crashing; decompression, Resources and resource allocation; Decision making theories in management under certainty, risk, uncertainty and competitive situations; Application of the methodologies and formation in project decision making problem solutions; Project capital, cost estimation: Breakeven analysis, Cost-benefit analysis: Profitability analysis, commercial and notional profitability; Management and human factor analysis, Project Risk Management.

**Prod/T/424 ELECTIVE-I (TECHNOLOGY ELECTIVES)**

1. TRIBOLOGY
2. TEROTECHNOLOGY
3. ROBOTIC TECHNOLOGY
4. PRODUCT DESIGN
5. FINITE ELEMENT METHOD AND APPLICATIONS
6. CONCURRENT ENGINEERING AND AGILE MANUFACTURING
7. PRECISION ENGINEERING

**Prod/T/424A TRIBOLOGY**

Introduction to Tribological Systems and their Characteristic Features: Physico-mechanical interactions at interfacial contact surfaces: Analysis and assessment of topography; Deterministic and stochastic tribo-models for asperity contact, frictional
resistance and wear; Frictional instability and stick-slip phenomenon; Models of adhesion-diffusion wear process; kinetics of solid state interfacial interactions. Principles of Lubrication: Hydro-dynamic, hydro-static, elasto-hydrodynamic cases; Boundary film lubrication; Solid lubricants; Tribological design of machine elements and systems; Principles of life-cycle analysis and their application.

Prod/T/424B  TEROTECHNOLOGY

Life cycle cost analysis of plants and concept of tero-technology; Various maintenance management strategies; Production maintenance interface and Terotechnology based planning and control; Maintenance policy determination; Fixed time replacement of repair prior to failure; Concept of health and usage monitoring of plants (HUM); Condition based maintenance; Opportunity maintenance; Design-out maintenance; Preventive maintenance programme; Corrective maintenance guide-lines; Maintenance organization; Analysis of reliability, maintainability and availability of plants and equipment; Replacement strategies; Trade force mix, trade force location and trade force size for maintenance resource structure; Quantitative techniques, such as, queueing theory, simulation, etc, for determining optimum disposition and size of maintenance resources; Network analysis like CPM, PERT etc. for planning and control of Terotechnology; Condition monitoring methods in terotechnology, LEO approach for formalised assessment of monitoring techniques; Management techniques in terotechnology; Logical fault finding; Behavioural science and terotechnology, Maintenance indices, Computer application in terotechnology based critical analyses.

Prod/T/424C  ROBOTIC TECHNOLOGY

A. INTRODUCTION TO ROBOTICS: Basic concepts, Major components, Work-envelope, Pay load, Degree of freedom, Classification of Robot Systems. B. DRIVE AND CONTROL SYSTEMS: Types of drive system - hydraulic, pneumatic and electric, Open loop and closed loop control systems for robot drive. C. ROBOT END-EFFECTORS: Grippers and Tools, Types of robot grippers - mechanical, magnetic, vacuum, adhesive. D. ROBOT KINEMATIC: Homogeneous coordinates and homogeneous transformations, Direct and indirect kinematics in robotics. E. SENSOR SYSTEMS IN ROBOTICS: Internal external sensors, Contact and non-contact sensors; Position and velocity sensors; Touch and slip sensors, Force and torque sensors, Tactile sensors, Proximity and range sensors. F. ROBOT VISION SYSTEM: Imaging devices and image acquisition, Image processing and analysis - preprocessing, segmentation, feature extraction and object recognition, Robot vision applications. G. ROBOT PROGRAMMING: Robot programming methods - lead-through programming methods and textual robot languages, Elements and functions of a robot language. H. ROBOT APPLICATIONS: General applications of robots in material handling, machine loading and unloading, welding, spray painting and assembly.

Prod/T/424D  PRODUCT DESIGN

**Prod/T/424E  FINITE ELEMENT METHOD AND APPLICATIONS**


**Prod/T/424F  CONCURRENT ENGINEERING AND AGILE MANUFACTURING**


**Prod/T/424G  PRECISION ENGINEERING**

**Prod/T/425**  ELECTIVE-II (MANAGEMENT ELECTIVES)

1. LOGISTICS AND SUPPLY CHAIN MANAGEMENT
2. BEHAVIOURAL SCIENCE AND HUMAN RESOURCE MANAGEMENT
3. RELIABILITY ENGINEERING
4. DECISION SUPPORT SYSTEMS
5. PRODUCTIVITY ENGINEERING
6. TOTAL QUALITY MANAGEMENT
7. ENTREPRENEURSHIP DEVELOPMENT

**Prod/T/425A**  LOGISTICS AND SUPPLY CHAIN MANAGEMENT


**Prod/T/425B**  BEHAVIOURAL SCIENCE AND HUMAN RESOURCE MANAGEMENT


**Prod/T/425C**  RELIABILITY ENGINEERING

Reliability concept; Reliability and probability; Maintainability availability; The tasks of reliability. Decision making and failure statistics; Failure probability, survival probability and age-specific failure rate; Weibull pdf; Application of failure statistics to reliability prediction for complex plants; FTA, FMEA, FMECA Plant availability assessment;
Stand-by systems, multi-unit stand-by systems; Derating and maintenance; Reliability testing: Accelerated testing; Sequential testing. Project management. Human reliability; Software reliability, Super-reliability; Safety factor and reliability. Reliability allocation; Effects of environment in reliability assessment; Solutions of reliability to a variety of real engineering problems.

**Prod/T/425D \hspace{1cm} DECISION SUPPORT SYSTEMS**


**Prod/T/425E \hspace{1cm} PRODUCTIVITY ENGINEERING**

Productivity basic Measurement and evaluation of productivity, Development and implementation of a Productivity management Programme, Quality circle, SPC, total Quality control, CAPP, CIM/ factory automation, robotics, Concurrent engineering, Motivational theory, Participative management competitor analysis, value engineering, BPR Case studies.

**Prod/T/425F \hspace{1cm} TOTAL QUALITY MANAGEMENT**

Introduction, Definition, the stage for normalcy for Management, concept of quality, the evaluation of quality approaches, SQC, Taguchi's OA, organizational culture, concepts of customer value, measuring customer value, organizing to improve systems; strategic linkage of operations through employees involvement; management role responsibilities. SPC, various quality standards. Kaizen, various quality tools i.e. Pareto chart etc. Quality Audits, Quality certification. Enhancing the quality of Environment: Green & Clean Manufacturing. Quality Design: product, System: QED, etc.

**Prod/T/425G \hspace{1cm} ENTREPRENEURSHIP DEVELOPMENT**


**Prod/T/426 \hspace{1cm} GENERAL VIVA-VOCE**

General Viva-Voce examination based on the laboratory experiments and exercises performed during pre-final and final year semesters.
**Prod/S/421**  **NON-TRADITIONAL MACHINING LABORATORY**

Modular experiments to illustrate and study various non-traditional production processes such as: (i) Abrasive jet machining (AJM) and Ultrasonic machining (USM) (ii) Electrochemical machining (ECM), (iii) Electro-discharge machining (EDM) and Electrochemical arc machining (ECAM) (iv) Electron beam machining (EBM) and welding, (v) Laser beam machining (LBM) (vi) Plasma arc machining (PAM) (vii) Wire-Electro-discharge machining (WEDM) (viii) Electrochemical Discharge Machining (ECDM) and other non-traditional production processes.

**Prod/S/422**  **PROJECT & THESIS**

The project should be done on a subject related to technology/management topics. A presentation is to be given at the end of the project on the topic covered/study done/experiments conducted.

**Prod/S/423**  **TECHNOLOGICAL ELECTIVE LABORATORIES/PROJECT**

Commensurate with PROD/T/424 course.