4th Semester Courses offered by AE&AM Dept.

VISCOUS FLOW (AE 401)

(only for AE)

Contact Period: 3L + 1T per week Full Marks: 100 [Credit – 4]

Prerequisites: Fluid Dynamics

Sl No.	Article	No. of Classes
1	**Fundamental Equations of Viscous Flow**: Stress tensor, Stokes' law of viscosity, Derivation of Navier-Stokes equation in different co-ordinate systems; Energy equation, Boundary conditions for viscous flow, Basic equations in dimensionless form, Dimensionless parameters in viscous flow	07
2	**Exact Solutions of Equation of motion**: Couette flow between parallel plates; Steady pressure driven flow through parallel-plate channel and ducts (circular and non-circular), Hydraulic diameter; Flow between concentric cylinders; Similarity solution for plane stagnation-point flow; Creeping flow, Stokes' solution for an immersed sphere; Theory of hydrodynamic lubrication	12
3	**Boundary Layer Theory**: Boundary-Layer approximations, The laminar-boundary-layer equations; Integral analysis of boundary layer over a flat plate; Similarity solution (by Blasius) for laminar-boundary-layer flow past a flat plate; Boundary-Layer transition, Turbulent boundary layer; Boundary Layer separation	09
4	**Turbulent flow – an introduction**: Physical description of turbulence, Wall-bounded turbulent flow, Turbulent pipe flow - Karman-Prandtl equation for friction factor, Hydraulically smooth and rough wall	06
5	**Thermal boundary layer and elements of heat transfer:** Thermal boundary layer equations, Reynolds' analogy, Similarity solution for forced convection over a flat plate, Integral methods for heat transfer calculation, Boundary layer with viscous dissipation	07
6	**Flow over Immersed Bodies**: Flow past streamlined (e.g. aerofoil) and bluff bodies (e.g. sphere, cylinder), Drag and Lift	04
7	**Unsteady flow**: Flow due to steady and oscillating motion of a flat plate (Stokes' 1st and 2nd problem), Unsteady flow between parallel plates	03
	Total	**48**

Books recommended:

1. Viscous Fluid Flow, F.M. White, McGraw-Hill International.
2. Boundary Layer Theory, H. Schlichting, McGraw-Hill.
3. Foundations of Fluid Mechanics, S.W. Yuan, Prentice Hall of India.
4. An Introduction to Fluid Dynamics, G.K. Batchelor, Cambridge University Press.

Basic Aerospace Structure (AE402)

(Only for AE)

Contact Period: 3L + 1T per week Full Marks: 100 [Credit – 4]

Prerequisites:

Sl. No.	Article	No. of Classes
1	**Basic Elasticity** : Introduction to tensor – generalized coordinate transformation – stress tensor at a point – principal stress & stress invariant – analysis of strain – constitutive & compatibility equation in 3D Cartesian coordinate – introduction to plane stress – introduction to plane strain.	10
2	**Virtual Work:** Principle of VW for particle & rigid body – VW done by axial forces, shear forces, bending moment and torsion – application to beams and trusses	10
3	**Energy Methods** : Strain energy due to axial force, bending and torsion with applications – Complimentary energy – total potential energy; total complimentary energy and principles of stationary value – application to determinate & indeterminate problems (beams, frames, rings)	14
4	**Structural Instability** : Short and long columns, critical load, column with eccentric loading – transversely loaded column (beam-column) – energy method for buckling loads in column – effect of initial imperfection in column & Southwell plot – complete diagonal tension field beam – incomplete diagonal tension field beam – applications.	14
	Total	**48**

Books recommended :

1. Elasticity, Martin H. Sadd
2. Theory of Elasticity, Timoshenko & Goodier
3. Aircraft Structures, T.H.G. Megson
4. Applied Elasticity, Zhi Lun Xu
5. Foundations of Solid Mechanics, Y.C. Fung

Aircraft Dynamics (AE 403)

(Only for AE)

Contact Period : 3L + 1T per week Full Marks : 100 [Credit – 04]

Prerequisite : Engineering Mechanics, Rigid Body Dynamics

Sl No.	Article	No. of Classes
1	Aircraft Performance : Equations of Motion Airplane Performance – Steady Flight Airplane Performance – Unsteady Flight	20
2	Equations of Vehicle Motion: Aircraft Equations of Motion, Linearised Equations of Motion, Force and Moment Derivatives	20
	Total	**40**

Books:

Aircraft Performance and Design – J. D. Anderson, Jr

Mechanics of Flight – W. F. Philips

ENGINEERING THERMODYNAMICS (AE 404)

(Only for AE)

Contact Period: 3L + 1T per week Full Marks: 100 [Credit – 4]
Prerequisite : None

Sl No.	Article	No. of Classes
1	**Introduction to classical thermodynamics**: Energy conversion, Internal energy, Microscopic vs. Macroscopic viewpoint; Thermodynamic system and control volume, Properties and State of a substance, Processes and Cycles; Thermodynamic equilibrium, The Zeroth law of thermodynamics; Quasi-equilibrium process	03
2	**Properties of a pure substance**: Phase equilibrium in a pure substance, Thermodynamic surfaces, Equation of State, Thermodynamic tables	02
3	**Work and Heat interactions**: Work, Simple compressible system, Work done at a moving boundary; Other modes of work transfer; Heat, Comparison of heat and work	03
4	**First law of thermodynamics**: 1^{st} law for a Cycle, 1^{st} law for a control mass, Internal energy – a thermodynamic property, Enthalpy, Specific heats; 1^{st} law for a control volume – the steady-state steady-flow (SSSF) model, the transient flow model, and their applications	08
5	**Second law of thermodynamics**: Limitations of 1^{st} law, Statements of 2^{nd} law of thermodynamics, 1^{st} law (thermal) efficiency and C.O.P; Reversible and irreversible processes; The Carnot cycle; Thermodynamic temperature scale; Inequality of Clausius, Entropy – a thermodynamic property, 2^{nd} law equation for a control mass, Principle of the increase of entropy; Thermodynamic property relations, Reversible polytropic processes for an ideal gas; 2^{nd} law equation for a control volume - The steady-state steady-flow (SSSF) model, the transient flow model; Thermal efficiencies of nozzle, turbine and compressor	11
6	**Irreversibility and Availability**: Reversible work, Evaluating irreversibility in a general transport process, Availability or Exergy, Exergy balance for a closed system, Exergy balance for control volumes at steady state, 2^{nd} law efficiency	07
7	**Power cycles**: Rankine cycle; Brayton cycle, regenerator, Air standard cycle for jet propulsion; Working principle of Spark-ignition and Compression-ignition engines, Otto cycle, Diesel cycle	06
8	**Thermodynamic relations**: The Maxwell relations; Behaviour of real gases	03
9	**Combustion thermodynamics**: Mixture of ideal gases, fugacity; Fuels, Combustion process, Enthalpy of formation, First-law analysis of reacting systems, Adiabatic flame temperature, Higher and lower heating value; Third law of thermodynamics	05
	Total	**48**

Books recommended :

1. Fundamentals of classical thermodynamics – G.J. Van Wylen & R.R. Sonntag, Wiley
2. Engineering Thermodynamics – P. K. Nag, Tata-McGraw Hill
3. Internal Combustion Engines – V. Ganesan, McGraw Hill India Pvt. Ltd.

INTRODUCTION TO AEROSPACE ENGINEERING (AE 406)

(Only for AE)

Contact Period : 3L + 1T per week Full Marks : 100 [Credit – 04]

Prerequisite : None

Sl No.	Article	No. of Classes
1	**Airfoils, Wings and Other Aerodynamic Shapes:** Airfoil Nomenclature; Finite Wings; Swept Wings; Delta Wings; Mechanisms for High Lift.	05
2	**Aerodynamic Interactions:** Force, Moment and Pressure Coefficients; Lift and Drag, Drag Polar	07
3	**Elements of Propulsion:** Introduction; Propeller; Reciprocating Engine; Jet Propulsion; Turbojet Engines; Turbofan Engines	07
4	**Elements of Compressible Flow:** One Dimensional Flow Equations of Conservation Principles; Some Conveniently Defined Flow Parameters; Alternative Forms of Energy Equations; Normal and Oblique Shock Relations;	04
5	**Static Stability and Control:** Basic Concepts of Airplane Stability and Control; Static Stability and Dynamic Stability; Controllability.	02
6	**Longitudinal Stick–Fixed Static Stability and Control:** Criterion of Longitudinal Static Stability, Contribution of Aircraft Components, Wing Contribution, Horizontal Tail Contribution, Fuselage Contribution, Power Plan Contribution, Stick-Fixed Neutral Point, Static Margin.	04
7	**Longitudinal Control** Elevator, Elevator Power, Elevator Effectiveness, Elevator Angle to Trim.	04
8	**Longitudinal Stick-Free Static Stability** Hinge Moments and Effect of Freeing the Stick, Trim Tab, Stick Forces and Stick Force Gradients, Analysis of Stick-Free Static Stability, Floating Angle of Elevator, Static Stability in Stick-Free Condition, Stick-Free Neutral Point, Effect of Acceleration, Stick-Fixed Manoeuvre Point; Stick Force Gradient in Pull-Up; Stick-Free Manoeuvre Point.	04
9	**Directional Static Stability and Control** Criteria of Directional Static Stability, Side Slip and Yaw, Contribution of Wing, Fuselage, Power and Vertical Tail to Directional Stability, Pedal Fixed and Pedal-Free Directional Stability, Directional Control, Adverse Yaw and Cross Wind Take-off and Landing	04
10	**Lateral Static Stability and Control** Criteria of Lateral Static Stability, Rolling Moment, Dihedral Effect and Contributions of Wing, Fuselage, Vertical Tail, Propeller and Flaps, Roll Control, Aileron, Rolling Moment due to Aileron, Damping Moment, Rate of Roll, Aileron Power, Aerodynamic Balancing, Tabs, Elevons.	04
	Total	**45**

MMS Lab (AE 451)

(Only for AE)

Contact Period : 3S Full Marks : 50 [Credit – 2]

Prerequisite:

Sl No.	Name of the experiments	No. of Classes
1.	Concept of Modelling and Simulation	04
2.	Introduction to C Graphics	04
3.	Introduction to MatLab software	04
4.	Introduction to LabVIEW software	04
5.	Modeling of basic mechanical system (spring-mass-damper system)	04
6.	Motion simulation of a four bar linkage and crank-connecting rod mechanism	04
7.	Simulating of motion of a pendulum	04
8.	Modeling and simulation of a process plant	04
9.	Modeling and simulation of an aero model - lift and drag force estimation	04
10.	Modeling and simulation of deflection of different types of loading member	04
	Total	40

CAD LABORATORY (AE 452)

(Only for AE)

Contact Period : 3 S Full Marks : 50 [Credit – 02]

Prerequisite:

Sl No.	Name of experiments	No. of Classes
1	Intro to CAD	02
2	Precision Drawing & Drawing Aids	02
3	Geometric Shapes	02
4	Editing Tools	02
5	Architectural Views & Drafting Views	02
6	3D modeling (Surfaces, Solids)	02
7	Dimensioning	02
8	3D Modeling with SketchUp	02
9	Annotating with Text & Hatching	02
10	Layers	02
11	Templates & Design Center	02
12	Advanced plotting (Layouts, Viewports), Office Standards	02
13	Internet and collaboration	02
14	Blocks, Drafting symbols, Attributes, Extracting data	02
Viva voce		03
Total		**31**

4th Semester CIVIL ENGINEERING

ENGINEERING GEOLOGY (for Civil Engineering) (GE 401)

Weekly contact: 3 - 0– 0 (L – T – S) Prerequisite: NIL Full Marks: 100 Credit: 3

Physical Geology- Weathering, Erosion, Transportation, Deposition ,Geological Agents. Overall ideas about the work done by Geological Agents. The Earth- Origin, age, internal constitution. Geological timescale- a brief introduction.

Mineralogy -Definition of Minerals, /.on-crystalline, crystalline matter and -Crystals. Physical Properties of Minerals in general. An Introduction to physical properties of Common Rock Forming Minerals and Economic Minerals.

Petrology- definition of Rocks. Brief idea on different types of Rocks. Igneous Rocks- ,...forms, structures and textures. Sedimentary Rocks- Genesis, Texture, Classification. Metamorphic Rocks - Factors controlling Metamorphism, Textures and Structures of Metamorphic Rocks. Petrography of: Granite, Basalt, -Diorite, Granodiorite, --Gabbro, Rhyolite, Pegmatite, Anorthosite, Sandstone, Shale, Conglomerate, Limestone, B.I.F, Micaschist, Gneiss, Quartzite.

Structural Geology - Brief idea about fold, fault, unconformity, lineation, foliation.

Geohydrology - Sources of Ground water, Hydrological Zones below the surface, porosity, permeability, aquifer-confined and unconfined, engineering importance of ground water study.

Engineering Geology – Importance of geological investigation in engineering projects, site selection for dam, bridge, tunnel & reservoir, stability of hill slopes along road and railway cuttings.

Suggested Readings:

- A Textbook of Geology by P. K. Mukherjee
- An Introduction to Physical Geology by Arthur Holmes
- Structural Geology by M P Dillings

STRUCTURAL ANALYSIS I (CE 401)

Prerequisite: Engineering Mechanics AM 1201 Strength of Materials AM 304

Weekly contact: 3-1-0 **Full Marks: 100 (Credit 4)**

Sl. No.	Topic	No. of hours / lectures
1	Introduction: Structure and its various forms;	2
2	Deflection of simple beam and truss	8
3	Concept of Determinate and Indeterminate Structures; Determinacy and stability, Introduction to analysis of statically indeterminate structures	8
4	Continuous beam analysis by Three Moment Theorem;	4
5	Moment Distribution and Slope Deflection Methods for indeterminate beam and frame structures	12
6	Applications of energy methods to indeterminate structures	8
7	Analysis of Three hinged and two hinged arches	6
	Total	**48**

Suggested Readings:

- Hibbler R C, Structural Analysis, PHI
- Sack R L, Structural Analysis, McGrawhill
- Aslam Kassimali, Structural Analysis, CENGAGE LEARNING
- C S Reddy, Basic Structural Analysis, Tata McGrawhill
- Roy S K, Chakraborty S, Fundamentals of Structural Analysis, S Chand
- Thandavamoorthy, T.S., Structural Analysis, Oxford University Press.

GEOTECHNICAL ENGINEERING – I (CE 402)

Pre-requisite: Mechanics (AM-1201) Hydraulics (AM-303/1)

Weekly contact: 3-1-0 **Full Marks: 100 (Credit 4)**

Sl. No.	Module Name and Topics	No. of Lectures
1.	**Formation of soil.**	2
2.	**Phase relation:** Soil phases, Definitions, Specific gravity of soils, Weight volume relationships	2
3.	**Index properties:** Shape and size of particles, Stoke's Law, Determination of grain size distribution of soils, Limits and indices, Plasticity chart, Identification of soils, Relative density	4
4.	**Classification of soils:** Indian Standard Classification System, Unified soil classification system	3
5.	**Soil water:** Structural water, adsorbed water, capillary water, free water, concept of effective and pore water pressure	2
6.	**Permeability and Seepage:** Head , Gradient and potential, Darcy's Law, Factor affecting permeability, permeability of stratified deposits, laboratory and field determination of permeability, Laplace equation, seepage, quick sand condition, flow net	7
7.	**Stresses in soils:** Boussinesq and Westergaard equations, concept of pressure bulb. Vertical stresses in soils under concentrated load, line load, strip load and uniformly distributed loads over limited areas of different shapes, Newmark's chart.	6
8.	**Compressibility and consolidation:** Compressibility parameters, consolidation, Terzaghi's one dimensional consolidation, determination of coefficient of consolidation, normally consolidated and over consolidated soils, computation of consolidation settlement.	8
9.	**Shear strength of soil:** Concept of shear strength, Mohr-Coulomb failure criteria, Mohr circle, Determination of shear strength parameters – laboratory and field methods, pore pressure parameters, sensitivity and thixotropy	7
10.	**Earth pressure:** Concept of earth pressure. Rankine and Coulomb's earth pressure theories, Different types of backfill, Analytical and graphical methods for determination of earth pressure against retaining walls	7
	Total =	48

Suggested Readings:

1. *Tayler, D.W. (1948), "Fundamentals of Soil Mechanics", Asia Publishing Hall.*
2. *Sing, A. (1967), "Soil engineering in theory and practices", Asia Publishing Hall.*
3. *Murthy, V.N.S. (2010), "Geotechnical engineering", CRC Press.*
4. *Craig, R.F. (2004), "Craig's Soil Mechanics", Taylor & Francis.*
5. *Lambe, T.W., and Whiteman, R.V. (1969), "Soil Mechanics", John Wiley & Sons.*

CIVIL ENGINEERING MATERIALS (CE-403)

Weekly Contact: 3-1-0 **Full Marks: 100 (Credits: 4)**

Module No.	Module Name and Topics	No. of Hours / Semester
A. Concrete (Materials and Technology):		
1.	***Preparation of Conventional Concrete****:* 1) *Properties of Ingredients* (cement, aggregate, water and admixture), Procedures for Mixing, Placing, Curing etc. 2) *Properties of fresh concrete*: Workability, Segregation, Bleeding, Air content, setting time etc. 3) *Properties of Hardened Concrete*: Compressive Strength, Tensile and Flexural Strength, Elasticity, Maturity, Shrinkage, Creep, Durability (permeability, chloride & sulphate attack, carbonation etc).	15
2.	***Concrete Mix Design****:* Factors and Requirement of Mix Design; Type of Mixes; Factors Affecting the Choice of Mix Proportions; Mix Proportion Designation; Detailed Procedure and Standard Guidelines.	6
3.	***Special type of Concrete***: Ferrocement, Light weight concrete, Polymer concrete, Fiber reinforced concrete, Ready mixed concrete, High performance concrete, Ultra high strength concrete, Sulphur-impregnated concrete, Bacterial concrete etc.	9
B. **Other Civil Engineering Materials:**		
1.	***Conventional Civil Engineering Materials****:* 1) *Building Materials*: Timber, brick, lime, steels, tiles, paints and varnishes, asbestos, polymeric materials etc. 2) *Foundation Materials*: Geotextiles, Geomembrane, Grouting etc. 3) *Pavement Materials*: Asphalt, Bitumen, Tar, Polymer modified bitumen, granular materials, paver blocks etc. 4) *Materials for Environmental Protection*: Geopolymer, Pervious block etc.	12
2.	***Innovative and Alternative Civil Engineering Materials*****:** Industrial waste materials, Nano materials, Fiber reinforced plastics etc.	6
	TOTAL	**48**

Suggested Readings:

1. A.M.Neville,J.J. Broks “Concrete Technology”, Pearson Education India.
2. S.K. Duggal, “Building Materials”, New Age International Publishers
3. P.C. Varghese, “Building Materials”, PHI Learning Pvt. Ltd.
4. M.S. Shetty, “Concrete Technology (Theory and Practice)”, S. Chand Publishers .
5. M.L. Gambhir, “Concrete Technology”, Tata McGraw-Hill Education.

Water Resources Engineering I (CE 404)

Weekly Contact: 3-1-0 **Full Marks: 100 (Credits: 4)**

Sl. No.	Module Name and Topics	No. of Lectures
1.	**Introduction:** Catchment and its physical characteristics, Hydrologic Cycle, Hydrologic Budget, use of DEM data for Catchment Delineation.	**04**
2.	**Precipitation:** Types and Forms, Southwest Monsoon, Measurement: Rain Gauges, Data Processing: Rainfall Mass Curve, Hyetograph, Average Rainfall, Frequency Analysis, Intensity Duration Curve, DAD curve, Computer Applications with Gridded Data	**06**
3.	**Losses from Precipitation:** Evaporation, Evapotranspiration and Infiltration: Processes, Measurement and Estimation, Computer applications.	**04**
4.	**Runoff:** Factors affecting Runoff, Estimation of Runoff, SCS method, Watershed Models, Flow-duration curve, Surface Water Resources of India, Water Scarcity, Drought Analysis, Computer Applications with HEC-HMS.	**07**
5.	**Streamflow Measurement:** Different Direct and Indirect Methods, Stage-Discharge Curve; Unsteady Flow and Backwater Effects, Bathymetry, Use of ADCP, Computer Applications.	**07**
6.	**Hydrographs:** Definition and Characteristics, Baseflow Separation**,** Unit Hydrographs, S-Curve, Synthetic Unit Hydrograph, Distribution Graph, Computer Applications.	**06**
7.	**Statistical Preliminaries:** Statistical Terminology, Probability of Discrete and Continuous Random variables, Method of Moments, Distribution Functions, Reliability of Estimates of Distribution Characteristics, Frequency Distributions, Statistical Programming.	**07**
8.	**Open Channel Flow:** Channel Characteristics and parameters, Uniform flow, Critical flow, Specific Energy concepts, Gradually Varied Flows, Computer Applications with HEC-RAS.	**07**
	TOTAL:	**48**

Suggested Books:

1. *Subramanya, K,"Engineering Hydrology", Tata McGraw-Hill.*
2. *Reddy,P.J., "A Textbook of Hydrology", University Science Press.*
3. *Singh,V.P., "Engineering Hydrology", Prentice Hall of India.*
4. *Subramanya, K,"Flow in Open Channels", Tata McGraw-Hill.*

SURVEYING LAB (CE 451)

Prerequisite: Surveying (CE-301) Weekly contact: 0-0-3 Credit: 2

Introduction to surveying equipment and basic measurement; Introducing to use of Chain and Compass; Levelling; Theodolite traversing; curve setting; Total station; Viva and Evaluation

ESTIMATION AND VALUATION PRACTICE (CE 452)

Weekly contact: 0-0-3 Full Marks 50 (Credit: 2)

Sl. No.	Task	No. of Periods
1	Purpose of Estimating; Quantity Survey; Types of Estimating -- Detailed Estimate, Preliminary Estimate, Approximate Estimate; Revised Estimate, Supplementary Estimate, Maintenance Estimate.	6
2	Introduction to Rate Analysis of different items of works of a standard residential building, factors affecting rate of an item, Use of standard schedules such as PWD schedules of rates, Analysis of rates of important item of works	9
3	Detailed estimate of a simple residential building including sanitary works;	9
4	Purpose of valuation of land and building, Concept of price, value and cost, free hold and lease hold properties; market value, present value; sinking fund; year's purchase, Different methods of land valuation, Different methods of valuation of real properties, depreciation- different methods, Fixation of rents.	9
5	Viva	3
		36

Books

1. Estimating, Costing, Specification & Valuation in Civil Engineering by M. Chakraborty
2. Text Book of Estimating and Costing by G S Bindra

CIVIL ENGINEERING MATERIALS LAB (CE 453)

Prerequisite: CE Materials (CE-403)

Weekly contact: 0-0-3 **Full Marks (Credit: 2)**

Sieve Analysis of Coarse and Fine Aggregates, Determination of Fineness Modulus. (I.S.: 2386 Part-I, I.S. : 383);Determination of Specific Gravity & Water Absorption of Coarse and fie Aggregates.(I.S.: 2386 Part-III); Determination of Crushing Strength of Coarse Aggregates. (I.S. : 2386 Part-IV); Determination of Bulking Factor and Silt Factor of Fine Aggregates. (I.S. : 2386 Part-III)

Determination of Standard Consistency of Cement and Fineness of Cement by Sieving. (I.S.: 4031 Part-IV); Determination of Initial and Final Setting Time of Cement (I.S.: 4031 Part-V, I.S. : 269,8112, 12269); Determination of Specific Gravity of Cement. (I.S. : 4031 Part-II);

Determination of Compressive Strength of Sand-Cement Mortar. Casting and Testing (I.S. 4031 Part-VI , I.S. 269,8112, 1269) of mortar specimens.

Test on Bricks (as per code IS3495)

Design of Concrete Mix; Casting of Concrete Cubes , Cylinders, Flexure Beams; Testing of Concrete Cubes , Cylinders, Flexure Beams; Viva and Evaluation.

GENERAL CIVIL ENGG. PROBLEMS I (MINI I) (CE 471) Credit: 2

This will be individual/small group project on simple Civil Engineering problems, primarily to be acquainted with complete problem solving and report writing practice.

4th SEMESTER COMPUTER SCIENCE AND TECHNOLOGY

Design and Analysis of Algorithm (CS 401)

Weekly Contact: 3-0-0 **Full Marks: 100 (Credit: 3)**

Module	Module name and topics	No. Of Lectures
1	**Mathematical Foundations and Basic of Complexities:** Time and space complexitity, Asymptotic growth of functions, Recurrences and methods of solving recurrences (substitution, iteration, recursion tree, Master method). Worst, Average and Amortized complexities.	5
2	**Sorting and Order Statistics:** Quicksort, Insertion sort, Mergesort, Lower bound for comparison based sorting, Sorting in linear time (Counting, Radix and Bucket sort), Medians and order statistics.	5
3	**Advanced Data Structures:** Heap and Heapsort, Hash tables, Data structures for disjoint sets	8
4	**Design and Analysis techniques:** Divide and Conquer, Dynamic programming, Greedy algorithms, Backtracking	6
5	**Graph Algorithms:** Elementary graph algorithms, Minimum Spanning Trees, Single source and all-pair shortest paths	6
6	**NP-Completeness and Approximation Algorithms** Polynomial-time verification, NP-hard and NP-completeness, Notion of approximation Algorithms for NP-complete problems, etc.	6
	Total	36

Computer Architecture and Organization – I (CS 402)

Weekly Contact: 3-0-0 **Full Marks: 100 (Credit: 3)**

Sl. No.	Module name and topics	No. of Lectures
1	**Introduction:** History of computing, von Neumann machine, Instruction and data, fixed- point and floating-point numbers, errors, IEEE standards.	3
2	**Processor design:** Instruction Set Architecture - Instruction format, opcode optimization; operand addressing; Instruction implementation - data movement, branch control, logical, Input/output and debugging instructions; arithmetic instruction implementation – addition and subtraction, multiplication-division, 2's complement multiplication; Booth's algorithm – theory and examples; bit-pair algorithm; high performance arithmetic.	7
3	**Control unit design:** Hardwired control, micro-programmed control design – micro-instruction formats, control optimization.	6
4	**Memory subsystem:** Memory technology, memory interfacing, Memory hierarchy – introduction to virtual memory system; cache memory – performance, address mapping, content addressable memory (CAM)	8
5	**Peripherals:** Basic properties, bus architectures, interfacing of I/O devices, data transfer schemes – programmed I/O, DMA, mass storage, RAID	6
8	**Pipelining:** Pipelining datapath and instructions, speed up, CPI, latency; linear/non-linear pipeline – reservation table, MAL; super-pipelined and super-scalar processors	6
	Total	36

Programming Paradigms (CS 403)

Weekly Contact: 3-0-0 **Full Marks: 100 (Credit: 3)**

Module	Module name and topics	Hours
1	**Programming Languages and Programming Paradigms:** Concepts of functional, imperative, Object oriented and logic programming.	3
2	**Functional Programming:** Introduction to computation models like u Recursive Functions and Lambda Calculus, Lisp as a functional programming language, abstraction with procedures and data, multiple representations of same data, higher order procedures.	10
3	**Imperative Programming:** Cost of introducing assignment, idea of local state (variables), data driven programming,	3
4	**Object Oriented Programming:** Review of OOP. Importance of OOP over procedural languages and software crisis. Classes and methods – encapsulation, message passing, base and derived classes, virtual base class, constructor, multiple inheritance. Operator and function overloading. Runtime Polymorphism. C++ and Java for object oriented programming.	16
5	**Unified Modeling Language (UML):** Introduction to UML for designing object oriented programs.	4
	TOTAL:	36

Theory of Computation (CS 404)

Weekly Contact: 3-0-0 **Full Marks: 100 (Credit: 3)**

Module	Module Name and topics	Hours
1	**Introduction:** Computations, Different models of computation, Language recognizer and generator	2
2	**Regular Languages:** Finite Automata – Deterministic and non determininstic, Regular expression, regular grammar, Equivalence of regular languages, Pumping lemma, Myhill-Nerode Theorem, Minimization of FSM, Properties of the class of Regular languages, Decision algorithm for regular sets.	12
3	**Context Free Language:** Context free grammers (CFG) and languages (CFL), Parse trees, Ambiguous, unambiguous and inherently ambiguous grammars, Normal Forms (Chomsky and Greibach), simplification of CFG, Pushdown automata (deterministic and non determininstic), Acceptance of language by empty stack, final state and their equivalence, Properties of the class of CFLs, Proving a language to be CFL or not, Pumping lemma for CFG, Decision algorithm for CFG	12
4	**Recursive and Recursively enumerable Language:** Unrestricted grammar, Computable function, Turing Machines (deterministic and non determininstic), Equivalence of deterministic and non deterministic TM, Extensions og TM and their simulations, Universal TM, Halting problem of TM, Decidability, Non-computability, Complexity classes, notion of reductions	10

Algorithm -II Laboratory (CS 451)

Weekly Contact: 0-0-3 **Full Marks: 100 (Credit: 2)**

Module	Module name and topics	Hours
1	Implementation of Various comparison sort algorithms (Bubble sort, insertion sort, selection sort, merge sort, randomized quick sort) and comparing their efficiencies, Determining k-th smallest element from an array in linear worst case running time	6
2	Implementation of Linear time sorting algorithms (Counting sort, Radix sort and Bucket sort)	3
3	Implementation of Hashing	6
4	Solving problems using Dynamic Programming	3
5	Solving problems using Greedy algorithms	6
6	Solving problems using backtracking	3
7	Implementation of graph algorithms (single source and all-pair shortest path problem)	6
8	Implementation of Approximation algorithms for NP-complete problems	3
	Total	36

Computer Architecture and Organization Laboratory (CS 452)

Weekly Contact: 0-0-3 **Full Marks: 100 (Credit: 2)**

Module	Module name and topics	Hours
1	Design of adders	6
2	Memory module design	9
3	Implementation of simple memory test logic (such as March test)	6
4	Realization of data transfer among CPU registers, Main memory and External sources	3
5	Swapping of registers'contents	3
6	Control design	9
	Total	30

Programming Paradigms Laboratory (CS 453)

Weekly Contact: 0-0-3 **Full Marks: 100 (Credit: 2)**

Module	Module name and topics	Hours
1	Recursive Functions	3
2	Functional Programming using LISP	12
3	Object Oriented Programming using C++, Java, PHP	21
	TOTAL	36

4th SEMESTER ELECTRICAL ENGINEERING
Electrical Machines-II (EE-401)

Weekly Contact: 3-1-0 (L-T-S)

Full Marks: 100 **Credits: 4**

Prerequisites: (i) Basic Electrical Engg. (EE-1201) at the first year level and (ii) Electrical Machines-I(EE 301)at the second year level.

Sl. No.	Module Name and Topics	No. of Lectures
Electrical Machines-II		
1.	Pitch factor and distribution factor.	02
2.	Armature excitation in electrical machines: - Concept of uniform and sinusoidal current sheet. MMF wave forms and their amplitude for dc, ac single phase and polyphase winding.	06
3.	General torque equation for dc and ac machines	03
4.	Construction, Principle of operation [as motor, generator and brake], concept of slip, rotor frequency, rotor emf during motion	03
5.	Flux-mmf relationship and phasor diagram .Derivation of per-phase equivalent circuit, measurement of parameters and performance calculation .Operating characteristics of 3-phase induction motor. Effects of varying V and f on motor performance	06
6.	Torque–slip characteristics and its analysis	03
7.	Circle diagram and its limitations. Prediction of performance from circle diagram	03
8.	High torque cage motors–Deep bar and double cage	03
9.	NEMA classification. Induction Generator and its application.	03
10.	Methods of starting for squirrel cage and slip ring motors	02
11.	Different methods of speed control of IM and slip power control: Resistance and reactance variation, V/f control, variation of no. of poles, pole amplitude modulation, Kramer and Scherbius drives	11
12	Effect of space harmonics	05
	Total:	**50**

Suggested Readings:

1. M.G. Say –The Performance and design of Alternating Current Machines
2. P.S. Bimbhra – Electrical Machines
3. A.S.Langsdorf – Theory of AC Machinery
4. S.K. Sen – Electric Machines
5. Chester L. Dawes–A Course in Electrical Engineering, Vol-II.
6. Kostenko and Piotrovsky – Design and analysis of Electric Machines

Analog and Digital Electronics (EE-402)

Weekly Contact: **3 – 1 – 0** (L – T – P) Pre-requisite: **Basic Electronics** Full Marks: **100**

Credit: **4**

Sl. No.	Module Name and Topics	No. of Lectures
1.	**Transistor circuits and applications:** FET low frequency small signal model, High frequency model, biasing of FET, Hybrid π-equivalent circuit of BJT and high frequency effects, cut off frequency, Current mirror, Para-phase amplifier, Classification of amplifiers, Distortion in amplifiers, frequency response, fidelity consideration,	**08**
2.	**Multi-stage and Feedback Amplifiers:** Multistage amplifiers, Coupling methods, Bootstrapping, Darlington combination, Feedback Amplifiers: Different feedback configurations. Use of negative feedback, Analysis of amplifier circuit using feedback concept	**06**
3.	**Transistorized Oscillators:** Theory of sinusoidal oscillator –The Barkhausen criteria. Transistor Colpitts and Hartley oscillator, astable, mono-stable, bi-stable multi-vibrators with BJT	**04**
4.	**Transistorized Differential Amplifiers:** Differential amplifiers, common mode and differential mode gains, CMRR. Realization of DIFF amplifier using BJT and FET and their difference mode and common mode gain.	**02**
5.	**Internal Circuit of an OPAMP:** Internal circuit of a typical OPAMP (analysis); drift, offset;	**02**
6.	**Realization of logic gates**: TTL , CMOS and ECL logic gates	**02**
7.	**Special Applications of OPAMPs:** Wien Bridge, Phase-Shift, Colpitts, and Hartley Oscillator; Quadrature Oscillator; Triangle & Saw-tooth waveform generator – Schematics and Principles; Bi-stable, mono-stable and astable multivibrators; VCO and PLL; 555 IC and its applications; F to V and V to F converters; Comparators – Window, ZCD, Hysteresis	**10**
8.	**Combinational Logic Circuits:** Karnaugh Mapping; SOP, POS; realization; Code Converter, Arithmetic Operations; MUX and DMUX, Encoder/Decoder - PLA	**06**
9.	**Sequential Logic Circuits:** R-S, D, T, J-K Flip-Flops, state-tables; flip-flops as units of memory and application as contact de-bouncer; Registers and buffers using flip-flops; Shift-registers and Ring-counters using flip-flops; Tri-state Buffer, Serial to Parallel and Parallel to Serial data conversion: Principle and Block diagram; Counters: Up and Down; synchronous and ripple counters; Modulo-N counter – a few examples	**08**
	TOTAL:	**48**

N. B.: *The above syllabus is based on the assumption that the Basic Electronics course will be common to all departments, and the course content will be the same as in the* ***Basic Electronics course for non-Electrical Science students (subject code: ET-1201NE) presently****.*

Suggested Reading:

1. "OPAMPs and Linear Integrated Circuits," – Ramakant A. Gayakwad, Prentice Hall.
2. "Digital Design," – M. Morris Mano and Michael D. Ciletti, Pearson Education.
3. "Integrated Electronics," – Jacob Millman and Christos C. Halkias, McGraw-Hill.
4. "Microelectronic Circuits," – Adel S. Sedra and Kenneth C. Smith, Oxford University Press.

SIGNALS AND SYSTEMS (EE-403)

Weekly Contact: 3-1-0 (L-T-S) **Pre-requisite:** Basic circuit theory, Laplace Transform, matrix handling

Full Marks: 100 **Credits: 4**

Sl. No./ Module	Module Name and Topics	No. of Lectures
1.	**Complex Frequency and The Laplace Transform:** Definitions, Transform of common forcing functions. Derivatives and integrals, shifted functions, Initial and Final Value theorems, Inverse Laplace Transform, Convolution integral, Heaviside Theorem.	**6**
2.	**Transient responses of Passive circuits:** (Differential equation approach) – RL, RC, RLC circuits with dc and sinusoidal excitation. Application to transient solution for simple network, time domain analysis by formation of state equations.	**6**
3.	**Response of Network to Special Signal Waveforms:** Gate functions, steady state response due to periodic excitations, switching transients and impulses in networks.	**2**
4.	**Fourier Analysis:** Fourier series, Evaluation of Fourier co-efficients, waveform symmetry as related to Fourier co-efficients, Frequency spectrum, convergence in truncated series, Properties of Fourier analysis, shifting function, Exponential form and Trigonometric form of Fourier series, Line spectrum, steady state responses to periodic signals, aperiodic functions, Fourier Integral and continuous spectra: Spectrum envelope for a recurring Pulse, Fourier Integral and Fourier Transform.	**10**
5.	**Network Functions:** Driving point and Transfer functions and their properties, computing various driving point and transfer functions of standard networks, concept of poles and zeros, time-domain responses for pole locations in complex s-plane.	**4**
6.	**Elements of Network Topology:** Graph of network, concept of branch, node, mesh, tree, co-tree, Planar and non-planar graphs, incidence, tie-set and cut-set matrices, inter-relation between various matrices, KCL and KVL in topological form, network solution by node basis and loop basis, principle of duality, related problems.	**8**
7.	**Attenuators and Passive Filters:** Image and characteristic impedances of a two-port network, propagation constants , classification of filters, prototype T-section and π-section filters, Low-Pass, High-Pass, Band-Pass, Band-Reject filters, Design of Constant-K filters, (low pass and high pass) , m-derived filters (low pass and high pass); Composite filters.	**7**
8.	**Elements of Passive Network Synthesis:** Routh-Hurwitz stability criteria, Hurwitz polynomial, its properties , positive real function (p.r.f), properties and testing of p.r.f , synthesis of driving point and transfer functions of passive networks in Foster and Cauer forms.	**5**
	Total	**48**

Suggested Readings:

1) D. Roy Choudhury – Networks and Systems
2) F.F.Kuo – Network Analysis and Synthesis
3) A. Chakrabarti – Circuit Theory: Analysis and Synthesis
4) C.L.Wadhwa – Network Analysis and Synthesis
5) K.M.Soni – Circuits and Systems

CONTROL SYSTEMS (EE 404)

Weekly Contact: 3-1-0 (L-T-S) **Pre-requisite: Mathematics III (MA 301)**
Full Marks: 100 **Credits: 4**

Sl. No.	Module Name and Topics	No. of Lectures
1.	**Applications of Laplace Transform**: Definition, Theorems, Transform of common forcing functions, Inverse Laplace Transform, Convolution integral.	**07**
2.	**Systems:** Continuous/Discrete, Time-invariant/Time-varying, Linear/Nonlinear, Open loop/Closed loop, Effects of negative feedback.	**04**
3.	**Transfer Function:** Definition, Order and type of transfer functions, Example: R-L-C series circuit or equivalent.	**05**
4.	**Representation of Systems:** Block diagram algebra, Signal Flow graph (Problems as well as Matlab assignments)	**05**
5.	**Time domain analysis:** Transient analysis of standard first and second order systems with unity feedback, Transient and steady state errors – definitions, Error constants. (Problems as well as Matlab assignments)	**03**
6.	**Frequency domain analysis:** Bode plot, Minimum/Non-minimum phase systems, Transportation lag, Pade approximation. (Problems as well as Matlab assignments)	**05**
7.	**Stability:** Definition, Routh Hurwitz's criterion and Nyquist stability criterion, Relative stability. (Problems as well as Matlab assignments)	**06**
8.	**Introduction to Design**: Construction of Root locus, P, PI, PD and PID control, Lead and lag compensation, Elementary design.	**10**
9.	**Control system components:** Synchros, Tachogenerators, A.C. and D.C. Servomotors.	**03**
	TOTAL:	**48**

Suggested Readings:

1. Control Systems Engineering – N. Nise
2. Modern Control Engineering – K. Ogata
3. Control Systems Engineering – Nagrath and Gopal
4. Automatic Control Systems – B. C. Kuo and F. Golnaraghi
5. Feedback Control of Dynamic Systems – Franklin, Powell and Naeimi

ELECTRICAL MACHINE LABORATORY (EE-451)

Class load/week: 3 periods
Full Marks: 100 **Credits: 2**

Item			Lab Classes
Introductory Class			**3**
Experiments	Sl No.	**Title of the Experiments**	
	1.	Starting and Reversing of D.C . Shunt Motor	**3**
	2.	Transformer Connections	**3**
	3.	Retardation Test, Swinburne Test And Separation of Losses on a D.C. Machine	**3**
	4.	Ward Leonard Method of Speed Control of D.C. Motor	**3**
	5.	No Load Characteristics of D.C. Generator	**3**
	6.	Load Characteristics of D.C. Generator	**3**
	7.	Characteristics of D.C Series Motor	**3**
	8.	Hopkinson's Test	**3**
	9A. **9B.**	Familiarization With Different Parts of a D.C. Motor Familiarization With Different Parts of a 3 - Phase Squirrel cage Induction Machine	**3**
Arrear and Practice Class			**3**
Lab Test and Viva Voce Examination			**3**
Total			**36**

CONTROL SYSTEMS, ANALOG AND DIGITAL ELECTRONICS LABORATORY (EE452)

Full Marks: 50+50 **Credits: 2**

Class load/week: 3 periods

Item			Lab Classes
Introductory Class			**3**
Control Systems Laboratory (Based on EE 404)			
Experiments	Sl No.	**Title of the Experiments**	
	1.	Transient and Frequency Response of a series R-L-C Circuit	**3**
	2.	Linear System Simulator.	**3**
	3.	Design of a PID Controller	**3**
	4.	Introduction to MATLAB (Control Systems Toolbox)	**3**
Analog and Digital Electronics Laboratory (Based on EE 402)			
Experiments	Sl No.	**Title of the Experiments**	
	1.	Study on characteristics of Diodes	**3**
	2.	Study on characteristics of Bipolar Junction Transistors	
	3.	Familiarisation with OP-AMP Circuits	**3**
	4.	Application of Operational Amplifiers	
	5.	Studies on Logic Families	**3**
	6.	Study on Combinational Logic Circuits	
	7.	Study of Flip-Flops and Latches	**3**
	8.	Study on Sequential Logic Circuits	
Arrear and Practice Classes			**3**
Lab Test and Viva Voce Examination			**6**
Total			**36**

NUMERICAL SIMULATION AND APPLICATION TOOLS LABORATORY
(EE-453)

Class load/week : 3 periods
Full Marks : 100
Credits: 2

Item			Lab Classes
Introductory Class			**3**
Experiments	Sl No.	**Title of the Experiments**	
	1.	Complex and Rational Number: C/C++ programming and coding	**3**
	2.	GSL / BLAS: Numerical Simulation using external libraries	**3**
	3.	Numerical Computation in MATHEMATICA (www.wolfram.com/mathematica/)	**3**
	4.	Programming and Simulation in MATLAB / SCILAB/OCTAVE & GNUPLOT	**3**
	5.	High Performance Computing (HPC) and Parallel Programming using Open MPI	**3**
Arrear and Practice Class			**6**
Lab Test and Viva Voce Examination			**12**
Total			**36**

4th Semester ELECTRONICS ENGINEERING

PRINCIPLES OF ANALOG AND DIGITAL COMMUNICATIONS (ET401)

L-T-P: 4-0-0 Credit: 4 Full Marks: 100

Sl. No	Module Name and topics	Class hours
1.	Introduction: elements of an electronic communication system, Modulation: necessity and types	2
2.	Amplitude modulation and demodulation schemes: DSB/ SSB/ VSB spectral analysis	2
3	Angle modulation and demodulation systems: narrowband, wideband, spectral analysis	6
4	Channel noise: types, modelling, SNR analysis of amplitude scheme and angle modulation in presence of channel noise	4
5	Elements of digital communication systems, advantages; Sampling theorem	2
6	PCM, DPCM, DM	4
7	Base band transmission and reception: line codes, matched filter, ISI and its control	4
8	Digital modulation demodulation techniques – ASK, FSK, PSK, DPSK	2
9	Spectral analysis and probability of error calculation of digital modulation schemes : ASK, PSK, FSK	4
10	Basics of Multiple access schemes: FDMA, TDMA, CDMA	3
11	.Elements of information theory: Measure of information, entropy,	3
12	Source-coding and channel-coding theorems	4
13	Introduction to Error Correcting Codes: importance, classification	2
14	Linear block codes	4
	Total	46

Text Books/References:

1. Modern digital and analog communication systems- Lathi
2. Principles of communication system-Taub, Schilling
3. Electronic communication system- Kennedy
4. Communication Systems- Simon Haykin,
5. Digital Communications-John G. Proakis,

Digital Electronics (ET402)

L-T-P: 4-0-0 Credit: 4 Full Marks: 100

Sl. No	Module Name and topics	Class hours
1	Review of Binary Number systems, Logic Gates, Boolean Algebra. Gray Reflected Binary Code. Logic expressions: Standard Sum of products and Standard Product of sums, Logic minimization by Karnaugh map, Quine-McClusky method	6
2	Combinatorial Logic circuits: Half adder, Full adder, Half subtractor, Full subtractor, Parallel addition and subtraction for n-bit binary numbers. Realization of Multiplexers, Decoders, De-multiplexers using logic gates. Encoder: Binary to BCD encoder circuit. Cascadable magnitude comparator.	6
3	Sequential logic circuits: Flip-flops: NOR based and NAND based S-R flip-flops, Master-Slave flip-flop, Capacitive storage flip-flop. J-K flip-flop, D flip-flop. Shift Registers	6
4	Diode Transistor Logic (DTL): NAND gate realization, Integrated circuit DTL gate, Fan-out of DTL gate. Transistor Transistor Logic (TTL) and its advantage over DTL. Emitter Coupled Logic (ECL).	4
5	Implementation of digital circuits using CMOS : Complementary CMOS logic. Pseudo NMOS logic, Dynamic CMOS logic, Domino CMOS, Pass transistor logic, NP Domino logic.CVSL.	4
6	Counters: Asynchronous ripple counter, synchronous counter, up, down and controlled up-down counter, loadable up-down counter. Non-binary counters: modulo and arbitrary type. Ring Counter and Johnson counter. Sequence Generator	8
7	Signed binary number system. Controlled adder/subtractor in 1's com and 2's com systems, overflow detection. Carry look-ahead adder.	4
8	Serial processing, parallel processing and pipelining in digital circuits. Serial addition. Binary multiplication: unsigned and signed array multiplier, serial multiplier. Combinatorial shifter. Constant multiplier.	6
9	Binary division: serial divider, parallel divider. Concepts of state machines: Mealy and Moore machine, state transition table & diagram	4
	Total	**48**

Prerequisites: (i) Basic Electronics and (ii) Analog Electronics

Text Books/References:

1. Digital Integrated Electronics-Taub, Schilling
2. Computer Arithmetic-Kai Hwang
3. Digital Design, Principles and Practices-John F.Wakerly
4. Switching and Finite Automata Theory-Zvi Kohavi
5. Digital Design-M. Morris Mano
6. CMOS VLSI Design-Weste, Harris, Banerjee

Microelectronics (ET-403)

L-T-P: 3-0-0 Credit: 3 Full Marks: 100

Sl. No.	Module Name and Topics	No. of classes
1.	IC technology: introduction, common semiconductor materials, semiconductor measurements.	3
2.	Preparation of single crystal silicon: Czochralsky and float zone technique, wafer cleaning	4
3.	Diffusion: predeposition, drive in diffusion	4
4.	Oxidation: dry and wet oxidation, properties and characterization	4
5.	Photolithography: clean room concepts, mask fabrication, proximity and contact printing, repeat and step method, photoresists, yield	4
6.	Etching: wet and dry, isotropic and anisotropic	3
7.	Metallization: evaporation, sputtering, multilevel metallization, electromigration	3
8.	Epitaxy: liquid phase, vapor phase, chemical vapor deposition, plasma deposition.	3
9.	Ion implantation: equipment description, principle of operation, electronics and nuclear collision, implant damage and annealing	4
10.	Bipolar and CMOS processes: fabrication process flow, isolation techniques, resistor, capacitor and inductor fabriaction	4
11.	MEMS technology: Bulk and surface micromachining, applications in sensors and RF circuits packaging	4
	Total	**40**

References:

1. Fundamentals of Semiconductor Fabrication, G.S.May and S.M.Sze, John Wiley
2. Microchip Manufacturing, Peter Van Zant, Mc Graw Hill
3. Semiconductor Manufacturing Technology, M.Quirk, J.Serda

Electromagnetic Theory and Transmission Lines (ET404)

L-T-P: 3-0-0 Credit: 3 Full Marks: 100

Prerequisite: Vector Algebra, Vector Calculus, Network Theory

Sl. No.	Module Name and Topics	No. of classes
1.	**Introduction:** Necessity of EM theory	1
2.	**Electrostatics:** Coulomb's & Gauss's Laws and their Applications, Potential, Continuity Equation, Poisson's & Laplace Equations, Uniqueness Theorem, Boundary Value Problems.	5
3.	**Magnetostatics:** Magnetic Forces, Biot-Savart Law & Ampere's Law and their Applications, Hall Effect.	4
4.	**Electromagnetic Induction:** Faraday's law and applications.	2
5.	**Maxwell's Equations:** Time Varying Electric and Magnetic Fields, Displacement Current, Maxwell's Equations, Time-harmonic Fields.	3
6.	**Boundary Conditions:** Electric & Magnetic.	2
	Electromagnetic Wave: Wave Equations, Plane Waves, Skin Depth, Pointing Theorem.	5
7.	**Transmission Line Introduction:** Brief Construction and Characteristics of Various Lines.	2
8.	**Transmission Lines:** Transmission Line Equations and their Solutions. Line Parameters, Characteristic Impedance, Input Impedance, SWR, Power, Distortion Less Line, Lossy Line, Radio Frequency Line, Line Terminated by Arbitrary Load, Reflection and Standing Wave Pattern, Slotted Line Measurements at Radio Frequency, RF Lines as Circuit Elements, Resonant and Anti Resonant Line, Q of Resonant Line, Impedance Matching.	12
9	**Smith chart:** Smith Chart Theory and Applications.	4
	Total	**40**

Prerequisite: Vector Algebra, Vector Calculus, Network Theory

Text Books/References:

1. Elements of Electromagnetics- Sadiku
2. Electromagnetic Waves and Radiating Systems- Jordan & Balmain
3. Electromagnetics- Kraus
4. Engineering Electromagnetics- Hayt
5. Field and Wave Electromagnetics- Cheng
6. Foundation for microwave engineering- R.E. Collin

Analog and Digital Communications Lab (ET451)

L-T-P: 0-0-3 Credit: 2 Full Marks: 50

Sl. No.	**Name of Experiment**	class hours
1.	Study of Amplitude Modulation & Demodulation Technique	3
2.	Study of Frequency Modulation & Demodulation Technique	3
3.	Study of Pulse Amplitude Modulation (PAM) & Demodulation	3
4.	Study of Frequency Division Multiplexing (FDM) & Demultiplexing	3
5.	Study of the Time Division Multiplexing(TDM) and Pulse Code Modulation(PCM)	3
6	Study of BFSK(Binary Frequency Shift Keying)	3
7	Study of Delta Modulation	3
8	Study of Pulse Shaping Filter in Digital Modulation Schemes	3
	TOTAL	**24**

Experiment lists may be updated based on the subject **Principles of Analog and Digital Communications (ET401).**

Digital Electronics Lab (ET452)

L-T-P: 0-0-3 Credit: 2 Full Marks: 50

Sl. No.	**Name of Experiment**	Class hours
1.	To design and test a) 4-bit controlled binary complementer b) 4-bit binary to gray encoder c) half adder d) full adder using logic gates.	3
2.	To design and test a) full subtractor b) 2 to 4 line decoder c) Magnitude Comparator using logic gates.	3
3	To design and test a) 4-bit binary up-down ripple counter b) 4-bit Johnson counter using J-K flip-flops and logic gates.	3
4	To design and test a) 4-bit binary synchronous up counter b) 4-bit binary synchronous down counter using J-K flip-flops and logic gates.	3
5	To design and test 4-bit Binary to BCD encoder using logic gates	3
6	To design and test arbitrary counter using D flip-flops and logic gates.	3
7	To design and test binary multiplier for multiplication of two 3-bit unsigned binary number using logic gates.	3
8	To design and test pseudo random binary sequence generator using D flip-flops and logic gates.	3
	TOTAL	**24**

Experiment lists may be updated based on the subject **Digital Electronics (ET402)**.

Microelectronics Lab (ET453)

L-T-P: 0-0-3 Credit: 2 Full Marks: 50

Sl. No.	Name of Experiment	Class hours
1.	Metal contact fabrication on silicon by vaccum evaporation method and measurement of IV characteristics.	6
2.	Estimation of oxidation and diffusion profiles from SUPREM II.	6
3.	Coventorware Simulation.	6
4.	Cleaning of Silicon Wafer.	3
	TOTAL	**21**

Experiment lists may be updated based on the subject **Microelectronics (ET403)**.

Modelling and Simulation Lab (ET454)

L-T-P: 0-0-3 Credit: 2 Full Marks: 50

Sl. No.	Name of Experiment	Class hours
1.	Simulation of gain-frequency response of cascaded and cascoded RC coupled BJT amplifiers using SPICE	3
2.	Study of MOS single stage amplifiers – CS, CD and CG using SPICE.	3
3	Study of double ended and single ended output MOS differential amplifiers using SPICE	3
4	To simulate using MATLAB first order function , y[n] = a0x[n] + a1x[n-1] for the input signal x[n] = unit sample function and step function	3
5	To simulate using MATLAB the following difference equation y[n] = b1 y [n-1] + a1x [n-1] + a0x[n], considering initial conditions are zero and the input discrete sinusoidal signal.	3
6	Studying probability density function of speech signals through digital computer and verifying existing speech signal characterization statistics.	3
7	Design and performance evaluation of envelop detector circuits for demodulation of AM modulated voice signal.	3
8	Simulation of BER performance of BPSK modem in additive white Gaussian noise channel.	3
	TOTAL	**24**

Experiments of this laboratory are based on modelling and simulation of electronic circuits and communication systems and may be updated accordingly

4th SEMESTER INFORMATION TECHNOLOGY

Computer Organization and Architecture (IT 401)

Weekly contact: 3 – 1 – 0 (L – T – S) **Prerequisite: IT 302 (Digital Logic and Circuit Design) or any equivalent course**

Full Marks: 100

Sl. No.	Module Name and Topics	No. of Classes
1.	**Computer function and Interconnection:** Computer Components, Computer function, Interconnection structures, Bus interconnection, PCI	2
2.	**Central Processing Unit:** **Computer Arithmetic:** ALU, Integer representation, Integer arithmetic, Floating point representation, Floating point arithmetic.	2
3.	**Instruction Sets:** Machine instruction characteristics, types of operands, Types of operations, Assembly language, Addressing, Instruction formats.	4
4.	**Processor Design and Datapath:** Processor role, processor design goals, processor design process, datapath organization, main memory interface, local storage/register file, datapath for simple instructions, floating point unit datapath, advanced processors and datapaths.	6
5.	**Processor design and control unit:** Role of control unit, reset sequence, interrupt recognition and servicing, abnormal situation handling, instruction cycle and decisions involved, hardwired control unit, microprogrammed control unit.	6
6.	**Memory:** Overview of computer memory system, memory parameters, classification of memory, main memory allocation, static RAM IC, Dynamic RAM, ROM logic, multiple memory decoding.	4
7.	**Cache:** Cache memory principles, elements of cache design, Cache organization.	2
8.	**Internal memory:** Semiconductor main memory, error correction, advanced DRAM organization.	2
9.	**External memory:** Magnetic disk, RAID, optical memory, magnetic tape.	2
10.	**Input/Output:** External devices, I/O modules, Programmed I/O, Interrupt driven I/O, DMA, I/O channels and processors, External interface: Firewire, Infiniband, and USB.	4
11.	**Concurrency in Pipelining and Vector processing:** Performance enhancement strategies, classification of parallelism, multiple functional units, pipelining, vector computing, array processor.	**6**
	Total:	**40**

Suggested Reading:

1. Computer Architecture and Organization Design Principles and Applications: B. Govindarajalu: TMH
2. Computer Organization and Architecture Designing for Performance: William Stallings: Pearson
3. Computer Architecture A Quantitative Approach: John L. Hennessy and David A. Patterson: ELSEVIER
4. Computer Systems Architecture A Networking Approach: Rob Williams: 2nd Ed: PEARSON
5. Computer Organization and Design The Hardware Software Interface ARM Edition: David A. Patterson and John L. Hennessy: MK

Communication Systems (IT 402)

L-T-P: 3+1

Sl no.	Topic	Class hours
1.	Introduction to communication systems	2
2.	Basedand and carrier signal representation, concepts, PSD, Sampling theorem	4
3.	Analog modulation and demodulation techniques, AM, FM, PM, their comparisons	4
4.	SNR vs. Bandthwidth. Preemphasis, deemphasis.	2
5.	SNR vs. Bandthwidth. Preemphasis, deemphasis.	2
6.	SNR vs. Bandthwidth. Preemphasis, deemphasis.	6
7.	Base band shaping for data transmission, line coding, Calculation of power spectral density	4
8.	Nyquist criterion for zero ISI and eye pattern, Equalizer, repeaters	6
9.	Digital modulation techniques, coherent and non coherent detection. ASK, FSK, PSK. MPSK, BER performance study. M-ary signal representation, PSD and bit error rate calculation.	8
10.	Introduction to spread spectrum communication, jamming effect, DSSS, FHSS, THSS, process gain, demodulation techniques	4
Total		42

References:

1. Modern Digital and Analog Communication System; B.P. Lathi
2. Principles of Communication Systems; Taub. Schilling
3. Communication Systems; A.B. Carlson
4. Digital and Analog communication Systems; K. Sam Sanmugam
5. Digital Communications; J. G. Proakis

IT-403: COMPUTER GRAPHICS

Section Number with name	Topics with Lecture Number	No. of Classes
Section 1 Introduction to Computer Graphics:	**Lecture 1:** Overview of Computer Graphics Computer Graphics Applications and Software	1
	Lecture 2: Basic graphics I/O devices, overview of Raster and vector graphics display working principle of CRT based display device,	2
	Lecture 3: LCD display device. Introduction to frame buffer, Colour Look Up Table etc..	2
Section 2 Scan conversion – lines, circles and Ellipses; Filling polygons and clipping algorithms	Lecture 4: Scan Converting Lines: DDA, Bresenham, Mid-point algorithms and Problems of Aliasing Scan Converting Circles and Ellipse	5
	Filling Polygons: Lecture 5: Flood fill, boundary fill, scan line fill,	2
	Lecture 6: Line clipping algorithms: Cyrus-Beck, Cohen-Sutherland Liang-Barsky	3
	Lecture 7: Polygon Clipping algorithms: Sutherland Hodgman and WeilerArtherton algorithm	2
Section 3 Graphics Programming using OPENGL:	**Lecture 8** Why OpenGL, Features in OpenGL, OpenGL operations, Abstractions in OpenGL – GL, GLU & GLUT 3D viewing pipeline, viewing matrix specifications Few examples and demos of OpenGL programs	4
Section 4 Two-Dimensional Transformations:	**Lecture 9:** Transformations and Matrices Transformation Conventions Basic 2D Transformations	2
	Lecture 10: Homogeneous Coordinates and Matrix Representation of 2D Transformations	1

	Lecture 11: Combined Transformations,	2
	Lecture 12: Window-to-Viewport Transformations.	2
Section 5 **Three-Dimensional Transformations and Projections:**	**Lecture 13:** Introduction, Basic transformation matrices in Three-Dimensional Space	2
	Lecture 14: Rotation about an Arbitrary Axis in Space, Reflection through an Arbitrary Plane	2
	Lecture 15: Projections: Orthogonal, axonometric, and oblique.	3
Section 6 **Visible-Surface Determination:**	**Lecture 16:** Techniques for efficient Visible-Surface Algorithms, Categories of algorithms	1
	Lecture 17: Back face removal, The z-Buffer Algorithm, Scan-line method,	2
	Lecture 18: Painter's algorithms (depth sorting), Area sub-division methods:BSP trees, Visible-Surface Ray Tracing.	2
Section 7 **Plane Curves and Surfaces:**	**Lecture 19:** Curve Representation, Representation of Space Curves:Cubic Splines, Bezier Curves, B-spline Curves.	3
Total		43

Suggested Text Books:

1. Computer Graphics Principles & Practice by James D. Foley, Andries van Dam, Steven K. Feiner and John F. Hughes, 2nd Edition in C.
2. Computer Graphics with OpenGL (3/e), D. D. Hearn and M. P. Baker
3. Mathematical Elements for Computer Graphics by Rogers and Adams, McGraw Hill.
4. Computer Graphics (First Indian Edition), Peter Shirley and Steve Marschner, Cengage Learning Reprint of A. K. Peters, 2011

Reference Books / Manuals

1. Computer Graphics Using OpenGL. F.S. Hill and S. M. Kelley, Pearson Education, 2009 (Indian print).
2. Interactive Computer Graphics: A Top-Down Approach with OpenGL. Edward Angel, Addison-Wesley, 1997 (Reprinted with corrections, January 2000).
3. OpenGL Programming Guide. Jackie Neider et al., Addison-Wesley, 1993.
4. OpenGL Reference Manual. Addison-Wesley, 1992.

Formal language and Automata Theory: IT 404

Sl. No.	Module Name and Topics	No. of Classes
1.	**Language and Grammar:** definition, Alphabet, languages and grammars, productions and derivation, Chomsky hierarchy of languages	4
2.	**Finite State Machines:** Definition, concept of sequential circuits, state table and state assignments, capability and limitations of FSM, state equivalence & minimization.	6
3.	**Finite automata:** Definition, Characteristics, Transitional system, deterministic finite automata (DFA), Nondeterministic finite automata (NFA) , equivalence of DFA and NFA, Dead state, Finite Automata with output, Mealy machine and Moore machine, Conversion of one machine to another, Minimization of finite automata. Mihill-Nerode theorem, Two way finite automata, Application and limitation.	8
3.	**Regular Expression**: regular sets and regular expressions, regular grammars and equivalence with finite automata, NFA from regular expressions, regular expressions from DFA, ε-closure and conversion of NFA with ε move to equivalent DFA, pumping lemma for Regular expression, closure properties of regular expression, Application of RE.	8
4.	**Context-free languages and pushdown automata:** Left and right linear grammars. Context-free grammars (CFG) and languages (CFL), Chomsky and Greibach normal forms, parse trees, ambiguity in CFG, inherent ambiguity, closure properties of CFL, pumping lemma for CFL, CFG and RE, Application Pushdown Automata(PDA), language recognized by PDA, deterministic PDA, equivalence of PDA and CFL.	12
6.	**Context-sensitive languages:** Context-sensitive grammars (CSG) and languages, linear bounded automata and equivalence with CSG.	2
7	**Turing machines:** The basic model for Turing machines (TM), Turing-recognizable (recursively enumerable) and Turing-decidable (recursive) languages and their closure properties, variants of Turing machines, nondeterministic TMs and equivalence with deterministic TMs, concept of undecidability.Variation of Turing machine-Multi tape, multi head, two way infinite tape. Turing machine as an integer function.	8
	Total:	**48**

Suggested Reading:

1. "Introduction to Automata Theory, Languages & Computation", Hopcroft JE. and Ullman JD., Narosa.
2. "Elements of the theory of Computation", Lewis H. R. and Papadimitrou C. H., P.H.I.
3. "Introduction to Languages and Theory of Computation", Martin, McGraw Hill.
4. J. E. Hopcroft, J. D. Ullman and R. Motwani: Introduction to Automata Theory, Languages and Computation, Addison-Wesley, California, 2001.
5. "An Introduction to Formal Languages and Automata", Linz Peter, Narosa.
6. "Switching & Finite Automata", Kohavi ZVI, Tata McGraw Hill.
7. "Theory of Computer Science", K.L.P. Mishra & N. Chandrasekharan,PHI

Computer Organization and Architecture (IT 451)

1. Know your Computer and its Organization

a. Hands on demonstration of assembling and disassembling of PC.
b. Hands on experience with different components of computers of different generations.
c. Basic troubleshooting with everyday usage of computer.

2. Introduction to VHDL and Xilinx ISE

a. Tutorial on VHDL as Hardware Description Language.
b. Tutorial with hands on demonstration in Xilinx ISE Design Tool (Programming Language: VHDL).

3. Build your own Computing Units

a. Experiments on different combinational design blocks and simulation using VHDL under ISE environment.
b. Experiments on different sequential design blocks and simulation using VHDL under ISE environment.
c. Experiments on designing different computing units for processing, memory, and IO interfacing.

4. Mini project (Group activity)

A small project related to Computing Unit design and Simulation.

5. Verify and Test your design

Verification and test of simulated and synthesized design using FPGA Prototype Boards.

Signal system and communication Lab (IT 452)

1. Experiments on various types of signals, time domain, frequency domain analysis
2. Continuous and discrete time domain signal analysis
3. Experiments on modulation techniques
4. Ideas on basic communication systems building blocks
5. Experiments based on Communication Systems theory.

Computer Graphics Lab (IT 453)

1. Study of Graphics Card and related hardware;
2. Overview of OpenGL;
3. Programming for generating lines, curves and rendered surfaces;
4. Geometric transformations and clipping;
5. Modeling of objects
6. Computer animation

Modelling and Simulation Lab (IT 455)

Prerequisite:

Basic Mathematics, Basic Statistics, Programming.

Detailed Syllabus:

Module Number	Topics	Class Load
1	Introduction to R, Octave, MATLAB,	4
2	Basic Mathematical Modeling; Vector and Matrix Analysis; Complex Analysis	4
3	Random Number Generation;	4
4	Solving Differential Equations; Simulating probabilistic Events; Bernoulli Trials	4
5	Curve and Surface Fitting; Optimization	4
6	Statistical Tests and Significance Analysis, Linear programming	4
7	Stochastic Models; Markov Models; Monte-Carlo Simulation; Growth Processes; Queuing Models	6
Total		30

Suggested Books:

1. Edward A. Bender. An Introduction to Mathematical Modeling. Dover Publications.
2. A. C. Fowler. Mathematical Models in Applied Sciences. Cambridge University Press.
3. Mark M. Meerschaert. Mathematical Modeling. Academic Press.
4. S.M. Ross.Simulation, Academic Press.
5. A.M.Law and W.D. Kelton. Simulation Modeling and Analysis, Tata McGraw-Hill.

4th SEMESTER MECHANICAL ENGINEERING

Fluid Mechanics (AM 403)
(Only for ME)

Contact Period: 4 (3L + 1T) Full Marks: 100 [Credit – 4]
Prerequisite: Mechanics, Mathematics

Sl No.	Article	No. of Classes
1	**Introduction:** Continuum; Eulerian and Lagrangian description of motion; Fluid properties (acceleration of a fluid particle, pressure, viscosity and surface tension); Classification of fluid flow; Flow visualization (streamline, streakline and pathline)	5
2	**Fluid Statics:** Equation for hydrostatic pressure variation, manometers, Fluids in rigid body motion	3
3	**Control Volume Analysis**: Reynolds transport theorem, conservation equations in integral form	4
4	**Elementary fluid dynamics (incompressible flow):** Euler's equation for inviscid flow along a streamline, Bernoulli's equation; Laminar and turbulent flow, critical Reynolds number, major and minor head losses; kinetic energy correction factor and momentum correction factor, Hagen-Poiseuille equation, Darcy-Weisbach equation, Moody chart, Pipes in series and parallel	11
	Flow Measurements: Pitot tube, orificemeter, flow nozzle, venturimeter, etc.	2
	Differential analysis of fluid motion – Kinematics and Viscous flow: 3D continuity equation in cartesian and cylindrical reference frame, Stream function; Kinematics - translation, rotation and deformation of a fluid element (in 2D), Vorticity; Ideal flow - velocity potential, elementary potential flows - source, sink, vortex, etc; Navier-Stokes equation in Cartesian reference frame and some exact solutions, Theory of hydrodynamic lubrication, Energy equation	12
	Dimensional Analysis and similarity: Buckingham's Pi theorem; Geometric, Kinematic and Dynamic similarity, Dimensionless parameters	3
	Boundary layer theory and wall bounded turbulent flow: Prandtl's boundary layer equations over a flat plate, Displacement & momentum thickness, Integral methods for boundary layer, Blasius solution, Turbulent boundary layer, Reynolds time-averaging technique, Karman-Prandtl equation for friction factor, Hydraulically smooth and rough wall, Boundary layer separation, Drag and lift	8
	Total	48

Books:

1. R W Fox and A T McDonald, *Introduction to Fluid Mechanics*, Wiley India
2. F M White, *Fluid Mechanics*, McGraw-Hill International
3. Bernard Massey, *Mechanics of Fluids*, Taylor & Francis

Basics of Machine Design (ME - 401)
(Only for ME Department)

Weekly Contact Period: 3 L + 0 T **Full Marks: 100 (Credit – 3)**

Sl No.	Topics	No. of lecture periods
1	Introduction to mechanical design - basic steps.	02
2	Standardization (BIS) and preferred numbers.	01
3	Limits, fits and tolerances.	04
4	Stress concentration and factor of safety.	03
5	Design of Cotter & Knuckle Joints.	04
6	State of stress, strain at a point in 3-dimensions and Cauchy's equation.	03
7	Stress invariants, principal stresses in 3-dimensions and their directions, hydrostatic and deviatoric states of stress.	05
8	Theories of failure in terms of 3-dimensional state of stress for ductile and brittle materials.	05
9	Concepts of variable loading and fatigue failure, endurance limit - Gerber, Goodman and Soderberg criteria, Application on bolted joints for pressure vessel.	05
10	Design of springs - helical compression & leaf springs.	10
	Total	**42**

Text Book:

1. Mechanical Engineering Design - Joseph Edward Shigley - McGraw Hill Book Company - First metric edition, 2nd printing 1987

Reference Books:

1. Design of Machine Elements - V. B. Bhandari - Tata McGraw Hill - Third Edition, 2010
2. Advanced Mechanics of Solids - L. S. Srinath - Tata McGraw Hill - Eleventh Reprint, 1995
3. Machine design - An Integrated Approach - Robert L. Norton, Prentice Hall, Third Edition
4. Machine Design - P. C. Sharma & D. K. Aggarwal - S. K. Kataria & Sons - Edition 2001-02
5. Mechanical Metallurgy - George E. Dieter - McGraw Hill Education (India) Pvt. Ltd. - Third Edition
6. Shigley's Mechanical Engineering Design - Richard G. Budynas & J. Keith Nisbett - McGraw Hill Education (India) Pvt. Ltd. - Ninth Edition, 2013
7. Machine Design Data Book - V. B. Bhandari - McGraw Hill Education (India) Pvt. Ltd. - First Edition,

Applied Thermodynamics (ME - 402)
(Only for ME Department)

Weekly Contact Period: 3 L + 1 T **Full Marks: 100**
(Credit: 4)

Sl. No.	Topics	No. of Periods
1.	**Analysis of gas power cycles**: Carnot, Otto, Diesel, Dual, Stirling, Ericsson and Brayton cycles, Comparison of Otto, Diesel and Dual cycles.	08
2.	**Analysis of vapour power cycles**: Carnot and Rankine cycles, Practical difficulties with Carnot cycle as a vapour power cycle, Effect of steam parameters on performance, Reheat and Regenerative steam power cycles.	08
3.	**Refrigeration cycle**: Definition of refrigeration plant capacity, Different methods of refrigeration, Refrigerants. Analysis of different refrigeration cycles: Reversed Carnot cycle, Air refrigeration (Bell-Coleman), Vapour compression refrigeration cycle.	08
4.	**Boiler:** Classification of boilers. Fire tube and water tube boilers, High pressure and low pressure boiler, Once -through boiler. Description and working of Cochran, Babcock-Wilcox, Stirling, Lamont and Benson boilers. Boiler mounting and accessories: Location, function and working. Performance analysis of boiler: Equivalent evaporation, factor of evaporation, boiler efficiency, Losses in boiler and boiler heat balance, Boiler specifications.	10
5.	**Reciprocating compressor:** Working principle, FAD, Single stage and multi-stage compression with intercooler, optimum inter-stage pressure, power without and with clearance volume, volumetric efficiency and isothermal efficiency of compressor.	08
6.	**Introduction to rotary compressors**: Roots blower, vane type compressors, screw type compressors, centrifugal and axial compressors.	03
7	**Introduction to nuclear power generation**: Fundamentals of nuclear reactions, nuclear reactor, estimation of nuclear fuel quantity for power generation.	05
	Total	**50**

Text Books:

1. Engineering Thermodynamics by P. K. Nag
2. Applied Thermodynamics for Engineering Technologists by T. D. Eastop and A. McConkey

Reference Books:

1. Principles of Energy Conversion by A. W. Culp
2. Thermodynamics for Engineers by Michel A. Saad

Engineering Materials and Processes (ME-403)

(Only for ME Department)

Weekly Contact Period: 3 L + 1 T **Full Marks: 100**

(Credit: 4)

Sl. No.	Topics	No. of Periods
1.	**Mechanical properties and their testing**: Engineering and true stress-strain diagram, ductile and brittle fracture, hardness, toughness, endurance limit and fatigue testing, creep, strain hardening.	05
2.	**Phase diagrams:** Solid solutions, binary alloy system, lever rule, iron-carbon equilibrium diagram, TTT diagrams.	06
3.	**Heat treatment:** Annealing, normalizing, hardening and tempering, surface hardening.	08
4.	**Engineering materials:** A brief overview on ferrous and non-ferrous metals, alloyed steel, stainless steel, tool and die materials, cast iron, nonferrous alloy, ceramics, polymers and composite materials.	06
5.	**Casting:** Types of patterns and allowances; mould materials and their properties; mechanized moulding; solidification; gating and risering; cupola and charge calculations; special casting processes: investment casting, die casting, centrifugal casting, continuous casting; casting defects.	09
6.	**Joining process:** Terminology and types; DC and AC welding; arc length and power calculation; edge preparation; oxy-fuel gas welding, shielded metal arc welding and resistance welding; welding defects and detection methods.	08
7.	**Metal forming processes:** Terminology and classification; Introduction to Rolling, Forging, and Extrusion; Metal forming defects.	08
	TOTAL	**50**

Text books:

1. Engineering Materials & Processes by E.P. DeGarmo, J.T. Black and A. Kohser, Prentice-Hall India Publication

Reference books:

1. Manufacturing Science by A. Ghosh & A.K. Mullick, East-West Publication
2. Manufacturing Technology by P.N.Rao, Tata McGraw-Hill Publication
3. Welding Technology by JF Little, Tata McGraw-Hill Publication

Mechanical Measurement and Control Engineering (ME-404)
(Only for ME Department)

Weekly Contact Period: 4 L + 0T **Full Marks: 100 (Credit: 4)**

Sl. No.	Topics	No. of periods
1.	**Measurements:** Basic concepts, standard, transducers, components of measuring system, dynamic characteristics, accuracy and errors in measurements.	03
2.	**Stress and Strain:** Measurement and analysis; strain gauge, ballast and bridge circuits, temperature compensation, calibration of strain gauge.	04
3.	**Measurement of Force and Torque:** Methods, mechanical systems, elastic transducers, hydraulic and pneumatic systems. Mechanical and hydraulic dynamometers.	05
4.	**Measurements of fluid pressure and fluid velocity:** Pressure measuring systems, pressure measuring transducers, elastic type pressure measuring transducers, measurement of high and low pressures, calibrations of instruments. Pitot tube, anemometer and flow meter.	04
5.	**Measurement of temperature:** Standard of temperature, liquid in glass thermometer, pressure thermometer, resistance thermometer, thermocouple and pyrometry.	04
6.	**Metrology:** Different types of standards, measurement of surface roughness, angle, diameters of screw thread.	05
7.	**Introduction to control systems:** System modeling, transfer function, block diagram, closed-loop and open-loop systems, actuators and sensors for controlled mechanical systems.	06
8.	**Time and frequency of systems:** Impulse, step and ramp response, time constant, overshoot in second-order systems, bode plot.	07
9.	**Characteristics of closed-loop control systems:** Sensitivity to modeling errors, disturbance rejection, steady-state errors.	04
10.	**Stability of systems:** Asymptotic stability bonded input bonded output stability, Routh-Hurwitz stability criterion, Nyguist stability criterion.	05
11.	**Examples of control systems:** Position servo, velocity control motors, temperature control, automatic trajectory control.	03
Total		**50**

Text Books:

1. Mechanical Measurements by Beckwith, Marangoni and Lienhard, Pearson Education, Asia.
2. Mechanical Measurements by S.P. Venkateshan, Ane Books Pvt. Ltd.
3. Control System Engineering by I.J.Nagrath and M.Gopal, New Age International (P) Limited.

Reference Books:

1. Measurement Systems: Application and Design by Ernst O. Doeblin, Tata McGraw-Hill.
2. Control System Engineering by Norman S. Nise, Wiley International Publication

FLUID MECHANICS LABORATORY (AM 453)

(Only for ME)

Contact Period : 3 S Full Marks : 50 [Credit – 02]

Sl No.	Name of experiments	No. of Classes
1	Friction losses in commercial pipes	03
2	Friction losses in pipe and pipe fittings	03
3	Forces of impact of jet on vanes	03
4	Verification of Bernoulli's theorem	03
5	Reynolds experiment	03
6	Calibration of an orifice meter	03
7	Calibration of speed indicator of Wind Tunnel	03
8	Measurement of surface pressure distribution around a circular cylinder in two-dimensional laminar and turbulent flow	03
9	Performance study of a centrifugal pump	03
Viva voce		03
Total		**33**

Applied Thermodynamics Laboratory (ME 451)

(Only for ME)

Weekly Contact Period: 3 P **Full Marks: 50 (Credit – 02)**

Sl No.	Name of experiments	No. of Classes
1	Calibration and use of Planimeter.	03
2	Study of Double-acting steam engine model.	03
3	Measurement of airflow by standard orifice meter and study of variation of coefficient of discharge of different orifices with Reynolds's Number.	03
4	Experimental determination of the values of polytropic index (n) for compression & expansion processes.	03
5	Verification of relationship between pressure & volume for Isothermal processes.	03
6	Determination of heat capacity ratio by Clement & Desormes method.	03
7	Determination of dryness fraction of steam by throttling calorimeter.	03
8	Flue gas analysis by Orsat apparatus.	03
	Viva Voce	03
	Total	**27**

Mechanical Measurement Laboratory (ME 454)

(Only for ME)

Weekly Contact Period: 3 P **Full Marks: 50 (Credit – 02)**

Sl No.	Name of experiments	No. of Classes
1	Measurement of diameter of a cylindrical hole by two- ball and four-ball method.	03
2	Measurement of internal taper angle of a tapered hole.	03
3	Measurement of external taper angle of a tapered plug.	03
4	Measurement of radii of curvatures of external and internal radius gauges.	03
5	Measurement of angles by Sine devices.	03
6	Measurement of outside, inside and pitch diameters of screw threads by Floating Carriage Micrometer.	03
7	Measurement of pitch error of screw threads by pitch error measuring apparatus.	03
8	Measurement of angles by Angle Dekkor.	03
9	Study and use of Tool Makers Microscope.	03
	Viva Voce	03
	Total	**30**

4TH SEMESTER METALLURGY

Subject: Phase Transformation (MT- 401)

Weekly contact 3-1-0 **Full Marks: 100** **Credit – 4**

Sl. No.	Module Name and Topics	No. of Lectures
1.	Introduction and classification of phase transformations; thermodynamics and kinetics of phase change;	04
2.	Theory of nucleation and growth in liquid to solid and solid to solid transformations, Homogeneous and Heterogeneous nucleation; evolution of microstructure, Recrystallization phenomena.	08
3.	Diffusional and non-diffusional transformation in iron-carbon alloy system-Construction and interpretation of ITT and CFT diagrams; formation and decomposition of austenite in steels; characteristics, mechanism and kinetics of pearlitic, bainitic and martensitic transformation in steels.	20
4.	Massive transformation and order-disorder transformation	04
5.	Precipitation phenomena; continuous and discontinuous precipitation, spinodal decomposition and age hardening in alloys.	06
6.	Recovery, recrystallisation and grain growth. Particle coarsening.	04
	Total	46

Suggested Reading:

1. Solid State Phase Transformation - V. Raghavan
2. Phase Transformations of Metals and Alloys - Porter and Easterling
3. Phase Transformation - R.W. Cahn
4. Modern Physical Metallurgy – R. E. Smallman
5. Principals of Physical Metallurgy – R. E. Reedhill

Subject: Principles of Extractive Metallurgy (MT- 402)

Weekly contact 3-1-0 **Full Marks: 100** **Credit – 4**

Sl. No.	Module Name and Topics	No. of Lectures
1.	Introduction - Important ores and minerals and their occurrence in India; importance of mineral dressing.	02
2.	Mineral dressing - Various Comminution processes – theories involved, brief description and applications, various Concentration techniques and their applications, mineral dressing circuits and flowsheets.	06
3.	Refractories: Types, classification, properties and testing; selection and applications.	02
4.	Unit Processes in pyrometallurgy: Introduction, calcinations, roasting, agglomeration, reduction smelting, matte smelting, flash smelting, converting, distillation, refining etc-suitable examples.	08
5.	Unit processes in hydrometallurgy: Introduction, leaching, purification of leach liquor, solvent extraction and ion exchange process, techniques of metal recovery from aqueous phase – suitable applications	05
6.	Unit processes in Electrometallurgy: Introduction; Faraday's laws of electrolysis, concept of overvoltage, limiting current density, Electro-winning and Electro-refining with reference to Cu, Zn, Al etc.	05
7.	Flowsheets and numerical calculations – Flow charts, material balance and heat balance.	05
8.	Elements of fluid flow – Newtonian and non-Newtonian fluids, equations of fluid flow. Principles of Heat and Mass Transfer.	05
	Total	38

Suggested Reading:

1. Principles of Extractive metallurgy – A. Ghosh and H. S. Ray
2. Non-ferrous Extractive Metallurgy – H. S. Ray, R. Sridhar and K.C. Abraham
3. Extractive Metallurgy principles- T. Rosenqvist
4. Extractive Metallurgy – J. Gilchrist

Subject: Deformation Behaviour of Materials (MT- 403)

Weekly contact 3-1-0 **Full Marks: 100** **Credit – 4**

Sl. No.	Module Name and Topics	No. of Lectures
1.	*Concept of stress and strain*: Stress and Strain - Engineering and True; Stress-strain relationships; Different types of stress-strain diagrams	03
2.	*Elastic Behavior of Materials*: Constitutive equations in elasticity; strain energy; Mohr's circle; effect of crystal structure on elastic constants	04
3.	*Plastic Behavior of Materials*: Classification of stress-strain curves; plastic stress-strain relations; yield criteria	03
4.	*Elements of dislocation theory*: Dislocation; Movement of dislocation; elastic properties of dislocation; dislocation reactions in different crystal structure; origin and multiplication of dislocations	06
5.	*Plastic Deformation in Single & Polycrystalline Materials*: Theoretical versus actual shear stress of materials; Deformation by slip and twinning; Critical resolved shear stress; Stacking fault; Strain hardening of single crystal; Dislocation barriers; Deformation and kink bands; Climb and cross slip; Jogs and kink formation; Role of grain boundaries in plastic deformation; Concept of geometrically necessary dislocations; Bauschinger effect	12
6.	*Strengthening Mechanisms in Materials*: Classifications of strengthening mechanisms; Strain hardening; Introduction to recovery, recrystallization and grain growth; Grain boundary strengthening; Solid solution strengthening; Yield point phenomenon; Strain ageing; Precipitation strengthening; Dislocation cutting and by-pass mechanisms; Dispersion and fiber strengthening, Rule of mixture, Concept of load transfer, Stress-strain diagrams, Derivation critical and minimum volume fraction of reinforcement; Martensitic strengthening	14
7.	Introduction to deformation behavior of materials at low and elevated temperatures.	02
	Total	44

Suggested Reading:

1. Mechanical Metallurgy – G. E. Dieter
2. Mechanical Behavior of Materials – T. H. Courtney
3. Mechanical Behavior of Materials – N. E. Dowling
4. Mechanical Behavior of Materials – M. A. Meyers & K. K. Chawla

Subject: Introduction to Materials Manufacturing (MT- 404)

Weekly contact 2-1-0 **Full Marks: 50** **Credit – 3**

Sl. No.	Module Name and Topics	No. of Lectures
1.	Materials for engineering: Basic classification, structure and application; Future materials.	05
2.	Properties of engineering materials: Physical, mechanical and manufacturing properties.	03
3.	Importance of manufacturing technology: Selection of materials and manufacturing processes; Planning of manufacturing; Quality control; Economy and environmental considerations; Health and safety aspects.	03
4.	Casting, Bulk forming of metallic materials, processing of ceramic materials, Joining, Machining.	08
5.	Nano-fabrication, IC device manufacturing, Clean room design.	08
6.	Advanced manufacturing processes.	03
	Total	30

Suggested Reading:

1. Principle of Electronic Materials and Devices - S. O. Kasap; McGraw-Hill Education (India) Pvt. Ltd.
2. Semiconductor Devices: Physics and Technology - S. M. Sze; Wiley.
3. Materials Science of Thin Film - Milton Ohring; Academic Press.
4. Manufacturing Processes for Engineering Materials, 5th Ed., - S Kalpakjian and S R. Schmid, 2008, Pearson Education.
5. Manufacturing Technology: Materials, Processes and Equipment- H A Youssef, H A El-Hofy, and M H Ahmed, 2011, CRC Press.
6. Materials and Processes in Manufacturing, 9th Ed., E P DeGarmo, J T Black and R A Kohser, 2003, John Wiley & Sons.

Subject: Instrumentation & Control (MT- 405)

Weekly contact 2-1-0 **Full Marks: 50** **Credit – 3**

Sl. No.	Module Name and Topics	No. of Lectures
1.	Introduction: Introduction to measurement and control systems in metallurgical processes.	06
2.	Sensing and measurement: Methods and instrumentation for sensing and measurement of physical variables e.g., temperature pressure, vacuum, flow level, strain, thickness and measurement	08
3.	Different types of control: P, PI, PD, PID controllers, programmable logic controller.	08
	Total	22

Suggested Reading:

1. Control system Engineering by Nagrath and Gopal: New age international
2. Experimental methods in metallurgy by V. T. Cherepin and A. K. Mallick : Asia Publishing House

Subject: Phase Transformation Lab (MT- 451)

Weekly contact 0-0-3 **Full Marks: 100** **Credit – 2**

Sl. No.	Module Name and Topics	No. of Contact hours
1.	Study and comparison of the microstructures of low carbon steel, Medium carbon steel and high carbon steel (hypo-eutectoid and hyper-eutectoid) in different heat treated conditions, like Annealing, Normalizing, Oil Quenched and Water Quenched conditions	24
2.	Study and comparison of the microstructures of Copper in as rolled and heat treated conditions like recovery, recrystallization and grain growth	03
3.	Study and comparison of the microstructures of Al and its alloys	03
	Total	30

Subject: Extractive Metallurgy Lab (MT- 452)

Weekly contact 0-0-2 **Full Marks: 100** **Credit – 1**

Sl. No.	Module Name and Topics	No. of Contact hours
1.	Assignment on comminution of ore-crushing and grinding circuit, major equipment used, open circuit and close circuit	04
2.	Study of design and operation of primary crushing equipment I) JAW crusher II) GYRATORY crusher	06
3.	Study of design and operation of secondary crushing equipment: I) Roll crusher II) Cone crusher	06
4.	Study of design and operation of grinding equipment – Ball Mill	04
5.	Study of design and operation of Wilflay table	04
6.	Sieve analysis of particles : plotting of Cumulative curve	06
7.	Study of kinetics of oxidation of various metals samples at different temperatures	06
8.	Study of kinetics of Cementation of copper from aqueous solutions by Zn, Iron	04
9.	Study of kinetics of leaching of oxide minerals in dilute acidic solutions	04
	Total	44

Subject: Modelling and Simulation Lab (MT- 453)

Weekly contact 3-0-0 **Full Marks: 100** **Credit – 3**

Sl. No.	Module Name and Topics	No. of Contact hours
1.	Gnuplot-the plotting freeware, GNU Octave for computation and plotting, Introduction to different freeware like Scilab	06
2.	Plotting, Fitting, Interpolation, Numerical integration and differentiation	06
3.	Molecular dynamic simulation	06
4.	Mote Carlo simulation, Optimization	06
5.	Density function theory	06
6.	Finite element method	06
7.	Some applications in Materials Engineering	06
	Total	42

Suggested Reading:

1. Introduction to Computational Materials Science - Richard LeSar; Cambridge University Press.
2. Computational Materials Science: An Introduction - June Gunn Lee; CRC press
3. Solidmechanics.org
4. http://www.gnuplot.info/docs_5.0/gnuplot.pdf
5. https://www.vasp.at/index.php/documentation

4th SEMESTER MINING ENGINEERING

ENGINEERING GEOLOGY (for Civil Engineering) (GE 401)

Weekly contact: 3 - 0– 0 (L – T – S) Prerequisite: NIL Full Marks: 100 Credit: 3

Physical Geology- Weathering, Erosion, Transportation, Deposition ,Geological Agents. Overall ideas about the work done by Geological Agents. The Earth- Origin, age, internal constitution. Geological timescale- a brief introduction.

Mineralogy -Definition of Minerals, /.on-crystalline, crystalline matter and -Crystals. Physical Properties of Minerals in general. An Introduction to physical properties of Common Rock Forming Minerals and Economic Minerals.

Petrology- definition of Rocks. Brief idea on different types of Rocks. Igneous Rocks- ,...forms, structures and textures. Sedimentary Rocks- Genesis, Texture, Classification. Metamorphic Rocks - Factors controlling Metamorphism, Textures and Structures of Metamorphic Rocks. Petrography of: Granite, Basalt, -Diorite, Granodiorite, --Gabbro, Rhyolite, Pegmatite, Anorthosite, Sandstone, Shale, Conglomerate, Limestone, B.I.F, Micaschist, Gneiss, Quartzite.

Structural Geology - Brief idea about fold, fault, unconformity, lineation, foliation.

Geohydrology - Sources of Ground water, Hydrological Zones below the surface, porosity, permeability, aquifer-confined and unconfined, engineering importance of ground water study.

Engineering Geology – Importance of geological investigation in engineering projects, site selection for dam, bridge, tunnel & reservoir, stability of hill slopes along road and railway cuttings.

Suggested Readings:

- A Textbook of Geology by P. K. Mukherjee
- An Introduction to Physical Geology by Arthur Holmes
- Structural Geology by M P Dillings

Basic Mechanical Engineering (ME-405)
(Only for MINING ENGINEERING Department)

Weekly Contact Period: 3L + 0T **Full Marks: 100 (Credit: 3)**

Sl. No.	Topics	No. of periods
1.	Fundamental concepts: Thermodynamic Systems, surroundings, properties, process, cycle, internal energy, enthalpy, flow work, zeroth law of thermodynamics, heat, work, entropy.	03
2.	First law of thermodynamics: statement, application to open and closed systems.	03
3.	Second law of thermodynamics: Difference with the First law and the two statements.	01
4.	Power Cycles: Carnot, Otto, Diesel, Dual, Joule and Rankine cycles.	06
5.	I.C.Engines: Classifications, two and four-stroke engines, fuels, carburetor, injector, power and efficiency; engine systems-cooling, lubrication, governing, starting.	05
6.	Reciprocating Compressor: Single and multi-staging, power and efficiency.	05
7.	Refrigeration cycles: Definition of Heat engine, Refrigerator, and Heat pump; C.O.P., reversed carnot cycle, air refrigeration and vapour compression refrigeration cycles.	04
8.	Keys and coupling: Types of keys. Types of couplings; muff coupling, clamp coupling, flange coupling and flexible coupling.	04
9.	Clutches: Types of clutches, friction clutches, single disc and multiple disc plate clutches, applications and design.	04
10.	Gears: Classification, terms used in gears, law of gearing, forms of teeth, gear materials, design procedure for spur gears; Helical, Bevel and Worm gears: Classification, terms used in helical, bevel and worm gears and their applications; Gear train.	05
Total		**40**

Text Books:

1. Applied Thermodynamics by Onkar Singh
2. Engineering Thermodynamics by P.K.Nag.
3. Thermal Engineering by P.L.Ballaney.
4. A Text book of Machine Design by Khurmi & Gupta.

Reference Book:

1. Applied Thermodynamics for Engineering Technologists by T. D. Eastop and A. McConkey

Fluid Mechanics and Fluid Machines (AM403/4)

(Only for Min)

Contact Period : 3L + 1T Full Marks : 100 [Credit – 04]

Prerequisite : None

Sl No.	Article	No. of Classes
1	Fluid properties, units and dimensions, pressure at a point, manometers and pressure gauges. Forces on immersed plane and curved surfaces, centre of pressure.	08
2	Types of flow**:** steady flow, uniform flow, laminar flow, turbulent flow, streamline, stream tube, streak line, path line, concept of one/two/three dimensional analysis of flow. Continuity equation for unidirectional flow, local & convective accelerations, Euler's equation of motion along a streamline, Bernoulli's energy equation, momentum equation	10
3	Fow through orifices, orifice coefficients, velocity measurement by Pitot tube, measurement of discharge by venturimeter, orificemeter, notches & weirs of different shapes and corresponding formulae.	04
4	Laminar and turbulent flow of liquids and gases through pipes, critical Reynolds number, Hagen-Poiseuille equation, pipe friction laws, minor losses, Derivation of Darcy-Weisbach equation for major head loss, friction factor & Moody diagram, hydraulic and energy grade lines, pipes in series and parallel, hydraulic transmission of power.	10
5	Centrifugal and other rotodynamic pumps, classification, application of principle of similarity of hydraulic machines, specific speed of pumps, performance characteristics for head, discharge and efficiency, selection of pumps, reversible pump turbines, hydraulic machines in parallel and series, cavitation and setting height of pumps.	10
	Total	42

1. Fluid Mechanics – Streeter & Wylie
2. Fluid Mechanics – Som & Biswas
3. Fluid Mechanics – Fox, McDonald and Pritchard
4. Fluid Mechanics – Cengel and Cimbala
5. Fluid Mechanics – F.M. White

Code	Subject	L	T	S
MN401:	UNDERGROUND COAL MINING	3	0	0

Full Marks: 100

After going through the course a student may be expected to:

1. Explain the unit operations in mining and choice of working methods.
2. Demonstrate the ability to elucidate both development and depillaring operations in bord and pillar method of coal mining.
3. Carry out simple design exercises in relation to above
4. Explain the method of longwallmining and its design aspects, process of development, face machineries, operations and salvaging process.
5. Ellucidate various types of stowing systems applied in underground coal mines.

Syllabus

Sl. No.	Modules and topics	No. of Classes
1.	Indian mining conditions and conditions suitable for Bord & Pillar mining, Mine unit operations In seam and horizon mining systems	01
2.	Concept on Panel, inter panel barriers, Pillar sizes, Size of the mine and related calculations, Relevant regulations	02
3.	Different layouts of Bord & Pillar mine, possible variations with change in production performance.	04
4.	Preparatory arrangements before depillaring operation, Flow diagram on steps of depillaring, types of mine plans required to be maintained during depillaring operation.	02
5.	Line of operation, different types of line of operation- merits and demerits, sequence of pillar extraction and conditions governing pillar extraction, concept on goaf line velocity and its importance, relevant coal mine regulations.	04
6.	Support requirement during depillaring- techniques of setting and withdrawal of supports, relevant regulations and circulars.	02
7.	Possible hazards during extraction of pillars- remedial measures	02
8.	Development of panel with SDL, LHD, Scraper- merits and demerits	03
9.	Coal face mechanization – advantages and disadvantages, various other measures to improve production performance.	02
	Longwall mining: applicable condition, types, layout, parameter, conventional & mechanized longwall; strata behaviour, types of fall, support resistance, mean load density, coal evacuation circuit; AFC, stage loader, lump breaker, gate-belt, coal preparing machine; shearer, coal plough, salvaging operation; salvaging chamber preparation, removal, loading & transportation of support, etc.	15
	Stowing systems: principles, hydraulic stowing, mechanical stowing, pneumatic stowing, etc	03
	Total	**40**

Suggested Reading:

Darling P. (ed). 2011.*SME Mining Engineering Handbook*, Third Edition. Society for Mining, Metallurgy, and Exploration, Liitleton. CO,1840 pages

Das S. K. 1994. *Modern Coal Mining Technology*, Second Edition. Lovely Prakashan, Dhanbad

Deshmukh D.J.2010. *Elements of Mining Technology* Vol. 1. 8th Edition.Denett & Company, Nagpur. 424 pages

Hartman H. L. and MutmanskyJ. M. 2002. *Introductory Mining Engineering*. John Wiley & Sons. 570 pages.

Peng S. S. 2006.*Longwall Mining*. Second edition. Published by Syd S. Peng. 636p.

Singh J. G. 2000. *Underground Coal Mining Methods*. Braj-Kalpa Publishers. Varanasi, India. 538 pages.

Singh R.D. 2005. *Principles and Practices of Modern Coal Mining*. New Age International. 696 pages

Code	Subject	L	T	S
MN402:	UNDERGROUND MINE ENVIRONMENT	3	0	0

Full Marks: 100

Expected Course Outcome:

After going through the course a student may be expected to:

1. Narrate and explain the composition and characteristics of mine atmosphere and the properties and physiological effects of its constituents.
2. Identify the sources of dust and explain the hazards associated with mine dust. Design campaign for dust measurement in mines and carry out the same. Design effective measures for dust suppression and control.
3. Identify possible sources of fires in underground coal-mine and take precautions and safety measures against occurrence of fire. They should also be able to take measures for dealing with underground mine.
4. Identify possible sources of inundation in a mine and take precautions measures for prevention of mine inundation.
5. Identify causes of mine explosion; design and execute effective action plans for rescue and recovery operations in mines.

Sl. No.	Modules and topics	No. of Classes
1	Composition of mine atmosphere amd Mine gases: composition of atmospheric air, impurities in mine air; noxious gases - properties, physiological effects, and analysis, dust, suspended liquid droplets, solid impurities, etc.	3
2	**Mine climate:** heat and humidity: air pressure, temperature, moisture, cooling power of mine air and its improvement, refrigeration, effective temperature, WBGT etc.	2
3	**Dust:** Sources of dust in mines, dust hazards, collagenous and non-collagenous dust properties, dust particle sizes responsible to respiratory diseases and possible measures to combat the problems.	2
4	**Measurement of dust and its prevention:** MAC of dust, measures to limit production of airborne dust and prevention of LAP of dust. Stone dust barriers – types, construction and erection. Related statutes from CMR 1957.	4
5	**Dust Abetment:** Various control measures of dust and scheme developed on dust monitoring, control and sampling in mines (pre and post dusting period).	2
6	**Fire:** Possible sources of fire in mines and their precautionary measures in surface and underground, Statutes on mine fire and spontaneous heating.	3
7	**Inundation:** Potential sources of mine inundation, concept on naturally wet and abnormal seepage in relation to mines, measures to restrict inundation related problems, relevant statutes on different conditions imposed on working susceptible to inundation.	3
8	**Mine explosions:** causes, prevention, and control: firedamp explosion &coal dust explosion, explosive limit, affecting factors, characteristics, etc.	4

9	**Rescue and Recovery operations:** human respiratory system, mine rescue apparatus, rescue organization, rescue stations & rescue rooms, recovery work , etc.	2
10	**Illumination:** standards and arrangements: concepts, statutory provisions, arrangements in opencast & in underground mines, etc.	3
11	**Class Tests**	2
	Total	**30**

Suggested Reading:

Banerjee S P (2003): *Mine Ventilation.* Lovely Prakashan, Dhanbad. 457p

Deshmukh D.J. (2010): *Elements of Mining Technology* Vol. 2. (8th Edition). Denett & Company, Nagpur. 424p

Hartman H L, Mutmansky J M, Ramani R V and Wang Y J (1997): *Mine Ventilation and Air Conditioning* (3rd edition). John Wiley and Sons. 730p

ILO (1986): *Safety and Health in Coal Mines: An ILO Code of Practice*. International labour Office Geneva. 176p

Kaku L C (2002): *Numerical Problems on Mine Ventilation – Coal and Metal.* 186

McPherson M J (1993): *Subsurface Ventilation Engineering* (web edition). Downloadable from http://www.mvsengineering.com

McPherson M J (2009): *Subsurface Ventilation and Environmental engineering* (2nd edition).Chapman and Hall, 824p

Misra G B (1986): *Mine Environment and Ventilation*. Oxford University Press. 619p

Misra G B (2001*)*: *Problems on Mine Ventilation*. Geeta Book Stores, Dhanbad. 213p

Ramlu M A (2007): *Mine Disasters and Mine Rescue*. (2nd Edition). Universities Press, Hyderabad. 448p

BASIC MECHANICAL ENGINEERING LABORATORY (ME 452)
(Only for MINING)

Contact Period: 2 P **Full Marks: 50 [Credit – 02]**

Sl No.	Name of experiments	No. of Classes
1	Study of Four stroke S.I. Engine	03
2	Study of Four stroke C.I. Engine	03
3	Study of vapour compression refrigeration system	03
4	Calibration and use of Planimeter.	03
5	Measurement of airflow by standard orifice meter.	03
6	Trial of a double acting reciprocating air compressor.	03
7	Diesel engine trial	03
8	Determination of Relative Humidity of moist air	03
	Viva Voce	03
	Total	27

FLUID MECHANICS LABORATORY (AM 453/ 4)
(Only for Min.)

Contact Period : 3 S Full Marks : 50 [Credit – 01]

Sl No.	Name of experiments	No. of Classes
1	Determination of orifice Coefficients	03
2	Verification of Bernoulli's theorem	03
3	Determination of orifice coefficients	03
4	Reynolds experiment	03
5	Friction losses in commercial pipe	03
6	Friction losses in pipe and pipe fittings	03
7	Calibration of an orifice meter	03
8	Forces of impact of jet on vanes	03
9	Performance study of a centrifugal pump	03
	Viva voce	03
	Total	**30**

Code	Subject	L T S
MN451	MINI PROJECT - II	0 0 0

Full Marks: 50

Expected Course Outcome:

After accomplishing the mini project a student may be expected to

- Demonstrate ability to comprehend technical problems and formulate methodology and work-plan to solve such problems
- Demonstrate ability to carry out literature search and review
- Demonstrate ability to carry out case exercises
- Demonstrate ability to cite and refer published documents
- Demonstrate ability to write technical report and express views in technical language.
- Demonstrate ability to draw conclusions from a technical study

Syllabus
Students will be required to undertake technical work on a technical topic and carry out independent study under the guidance of a Teacher. The result of the study will be submitted in the form of a mini project report.

ENGINEERING GEOLOGY LABORATORY (GE 451)

(Only for Mining Engineering)

Contact Period : 2S Full Marks : 50 [Credit – 01]

Sl No.	Name of experiments/Details	No. of Classes
1	Procedure of measuring 'Attitude of inclined plane 'With the help of Clinometer compass and plotting the Dip data.	02
2	Preliminary study of geological Maps	02
3	Study of Physical properties of Minerals and their identification (Quartz,Felspar,Mica,Tourmaline,Hematite,Magnetite,Bauxite,Chalcopyrite,Pyrite,Kyanite,Garnet,Gypsum,asbestos)	04
4	Study of rocks in hand specimen(Igneous--granite,Basalt Sedimentary---Conglomerate,sandstone,Shale Metamorphic---Phyllite ,Schist,Gneiss)	04
5	Arrear and Viva voce	04
	Total	**16**