BIJU PATNAIK UNIVERSITY OF TECHNOLOGY, ODISHA
ROURKELA

Tentative Curriculum and Syllabus

of

B.Tech (*Mechanical Engineering)* from the Batch 2018-19

Semester (4th)

Fourth Semester							
Theory							
Sl No	**Category**	**Course Code**	**Course Title**	**L-T-P**	**Credit**	**University Marks**	**Internal Evaluation**
1	PC	RME4C001	Kinematics & Dynamics of Machines	3-0-0	3	100	50
2	PC	RME4C002	Engineering Thermodynamics	3-0-0	3	100	50
3	HS	REN4E001 / ROB4E002	Engineering Economics / Organisational Behaviour	3-0-0	3	100	50
4	PC	RME4C003	Introduction to Physical Metallurgy and Engineering Materials	3-0-0	3	100	50
5	PE	RME4D001	Internal Combustion Engines and Gas Turbines	3-0-0	3	100	50
		RME4D002	Mechanical Measurement, Metrology & Reliability				
		RME4D003	Advanced Mechanics of Solids				
6	OE	RME4G001	Digital Systems Design	3-0-0	3	100	50
		RME4G002	Microprocessor and Microcontroller				
		RME4G003	Data Structure				
6	MC*	RCN4F001	Constitution of India	3-0-0	0	—	100 (Pass mark is 37)
Total Credit (Theory)					**18**		
Total Marks						**600**	**300**
Practical							
1	PC	RME4C201	Kinematics & Dynamics of Machines Laboratory	0-0-3	2		100
2	PC	RME4C202	Engineering Thermodynamics Laboratory	0-0-3	2		100
3	PC	RME4C203	Introduction to Physical Metallurgy and Engineering Materials Laboratory	0-0-3	2		100
Total Credit (Practical)					**6**		
Total Semester Credit					**24**		
Total Marks							**300**

***Mandatory Non-Credit Courses (MC) result will be reflected with Pass (P) / Fail (F) grade. Thus the grade obtained will not be affecting the grade point average. However it shall appear on the grade sheet as per AICTE rule.**

4th Semester	RME4C001	Kinematics & Dynamics of Machines	L-T-P 3-0-0	3 CREDITS

Module – I : (12 hrs)

Kinematic fundamental: Basic Kinematic concepts and definitions, Degrees of freedom, Elementary Mechanism : Link, joint, Kinematic Pair, Classification of kinematic pairs, Kinematic chain and mechanism, Gru ebler's criterion, Inversion of mechanism, Grashof criteria, Four bar linkage and their inversions, Single slider crank mechanism, Double slider crank mechanism and their inversion. Transmission angle and toggle position, Mechanical advantage.

Kinematic Analysis : Graphical analysis of position, velocity and acceleration of four bar and Slider crank mechanisms. Instantaneous centre method, Aronhold-Kennedy Theorem, Rubbing velocity at a Pin-joint.Coriolis component of acceleration.

Module – II : (10 hrs)

Gear and Gear Trains: Gear Terminology and definitions, Theory of shape and action of tooth properties and methods of generation of standard tooth profiles, Standard proportions, Force analysis, Interference and Undercutting, Methods for eliminating Interference, Minimum number of teeth to avoid interference. Analysis of mechanism Trains: Simple Train, Compound train, Reverted train, Epicyclic train and their applications.

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Module – III : (8 *hrs*)

Combined Static and Inertia Force Analysis: Inertia forces analysis**,** velocity and acceleration of slider crank mechanism by analytical method, engine force analysis - piston effort, force acting along the connecting rod, crank effort. dynamically equivalent system, compound pendulum, correction couple.

Module – IV : (8 *hrs*)

Friction Effects: Screw jack, friction between pivot and collars, single, multi-plate and cone clutches, anti friction bearing, film friction, friction circle, friction axis.

Flexible Mechanical Elements: Belt, rope and chain drives, initial tension, effect of centrifugal tension on power transmission, maximum power transmission capacity, belt creep and slip.

Module – V : (7 *hrs*)

Brakes & Dynamometers : Classification of brakes, Analysis of simple block, Band and internal expanding shoe brake, Braking of a vehicle. Absorption and transmission dynamometers, Prony brake, Rope brake dynamometer, belt transmission, epicyclic train, torsion dynamometer.

Books:

- Kinematics and Dynamics of Machinery by R L Norton, Tata MacGraw Hill
- Theory of Machines and Mechanisms by John J. Uicker Jr., Gordon R. Pennock and Joseph E. Shigley, Oxford University Press
- Theory of Machines by S.S.Rattan, Tata MacGraw Hill
- Theory of Machines by Thomas Bevan, CBS Publications
- Kinematics and Dynamics of Machinery by Charles E. Wilson and J.Peter Saddler,

Pearson Education

- 3. Mechanism and Machine Theory by J.S.Rao and R.V.Dukipatti, New Age International.
- Theory of Mechanisms and Machines by A. Ghosh & A. K. Mallick, East West Press.
- Kinematics and Dynamics of Machines by G.H. Martin, McGraw-Hill.
- Theory of Machines and Mechanisms by P.L.Ballaney, Khanna Publishers
- Theory of Mechanisms and Machines by C.S.Sharma and K.Purohit, PHI.

4th Semester	**RME4C201**	**Kinematics & Dynamics of Machines Laboratory**	**L-T-P 0-0-3**	**2 CREDITS**

Laboratory Experiments: (Minimum 8 experiments)

1. Design of any one working model related to Kinematics of Mechanisms i.e., Module I and II.
2. Design of any one working model related to Dynamics of Machinery i.e., Module III and IV.
3. Radius of gyration of compound pendulum
4. Radius of gyration of connecting rod
4. TRI –FILAR / BI-FILAR System
5. Experiment on Screw Jack
6. Experiment on Journal Bearing Apparatus
7. Experiment/Study on clutches
8. Experiment on Epicyclic Gear Train
9. Experiments on Simple/Compound/Reverted Gear trains
10. Experiment on Dynamometer
11. Experiment on Brake
12. Experiment on Coriolis component of acceleration

4th Semester	**RME4C002**	**Engineering Thermodynamics**	**L-T-P 3-0-0**	**3 CREDITS**

Module-I (08 hrs)

Review of First and Second laws, First law analysis of steady and unsteady flow control volumes, Entropy generation ,Entropy balance for closed systems and steady flow systems.

Module- II (12 hrs)

Available energy, Quality of energy, Availability for non flow and flow process, Irreversibility, Exergy balance, Second law efficiency.

General Thermodynamic property relations: The Maxwell relations, The Clapeyron equation, The TdS relations, Isothermal compressibility and volume expansivity, The Joule-Thomson coefficient.

Module- III (10 hrs)

Vapour Power Cycles: The Carnot vapor cycle and its limitations, The Rankine cycle, Means of increasing the Rankine cycle efficiency, The reheat cycle, The regenerative feed heating cycle, Cogeneration (Back pressure and Pass-out turbines), Combinedcycle power generation systems, Binary vapour cycles.

Module- IV (08 hrs)

Gas Power Cycles: Air standard cycles- Otto, Diesel, Dual Combustion and Brayton cycles, The Brayton cycle with non-isentropic flow in compressors and turbines, The Brayton cycle with regeneration, reheating and intercooling, Ideal jet propulsion cycles.

Refrigeration cycles: Reversed Carnot cycle, Reversed Brayton cycle (Gas refrigeration system), The vapor compression cycle, The vapor absorption cycle.

Module- V (07 hrs)

Reciprocating Air Compressors: Introduction (Uses of compressed air), The reciprocating cycle neglecting and considering clearance volume, Volumetric efficiency and its effect on compressor performance, Limitations of single stage compression, Multistage compression and intercooling, Optimum intercooler pressure, Performance and design calculations of reciprocating compressors, Air motors.

Books:

- Engineering Thermodynamics by P. K. Nag, Publisher:TMH
- Engineering Thermodynamics by P. Chattopadhyay, OXFORD
- Fundamentals of Thermodynamics by Sonntag, Borgnakke, Van Wylen, John Wiley & Sons
- Fundamentals of Engineering Thermodynamics by E. Rathakrishnan, PHI B.Tech (Mechanical Engineering) detail Syllabus for Admission Batch 2015-16 3rd Semester
- Thermodynamics An Engineering Approach by Yunus A.Cingel and Michale A.Boles ,TMH
- Engineering Thermodynamics by M.Achyuthan, PHI

- Engineering Thermodynamics by Y.V.C. Rao, University Press
- Thermodynamics and Thermal Engineering by Kothandaraman & Domkundwar, Dhanpat Rai
- Applied Thermodynamics by P.L.Ballaney, Khanna Publishers
- Steam Tables in SI Units by Ramalingam, Scitech
- Steam Tables by C.P.Kothandaraman, New Age International
- Fundamentals of Engineering Thermodynamics by Michale J.Moran and Howard N.Shaprio John Wiley & Sons

4th Semester	**RME4C202**	**Engineering Thermodynamics Laboratory**	**L-T-P 0-0-3**	**2 CREDITS**

Laboratory Experiments: (Minimum 8 experiments)

1. Study of Cut-Sections of 2 stroke and 4 stroke Diesel Engine/Petrol engine.
2. Study of steam power plant.
3. Study of refrigeration system.
4. Study of gas turbine power plant.
5. Performance analysis of reciprocating air-compressor.
6. Performance analysis of Centrifugal / Axial Flow compressor.
7. Determination of performance characteristics of gear pump.
8. Measurement of steam quality using calorimeter
9. Verification of Joule-Thomson coefficient
10. Load test on 4-stroke single cylinder C.I. engine.
11. Load test on 4-stroke single cylinder S.I. engine.
12. Morse Test on multi-cylinder S.I. or C.I. engine

4th Semester	REN4E001	ENGINEERING ECONOMICS	L-T-P 3-0-0	3 CREDITS

Module - I (10 hours)

Engineering Economics- Nature, Scope, Basic problems of an economy, Micro Economics and Macro Economics.
Demand - Meaning of demand, Demand function, Law of Demand and its exceptions, Determinants of demand, Elasticity of demand & its measurement (Simple numerical problems to be solved), Demand Forecasting – Meaning
Supply-Meaning of supply, Law of supply and its exception, Determinants of supply, Elasticity of supply, Determination of market equilibrium (Simple numerical problems to be solved).

Module - II (08 hours)

Production - Production function, Laws of returns: Law of variable proportion, Law of returns to scale
Cost and Revenue Concepts - Total Costs, Fixed cost, Variable cost, Total revenue, Average revenue and Marginal revenue, Cost-Output Relationships in the Short Run, and Cost-Output Relationships in the Long Run, Analysis of cost minimization.

Module III (08 hours)

Market - Basic understanding of different market structures, Determination of equilibrium price under perfect competition (Simple numerical problems to be solved), Break Even Analysis-linear approach (Simple numerical problems to be solved).

Module - IV (12 hours)

Time Value of Money- Interest - Simple and compound, nominal and effective rate of interest, Cash flow diagrams, Principles of economic equivalence.
Evaluation of Engineering Projects-Present worth method, Future worth method, Annual worth method, Internal rate of return method, Cost benefit analysis for public projects.
Depreciation- Depreciation of capital assert, Causes of depreciation, Methods of calculating depreciation - Straight line method, Declining balance method, SOYD method, After tax comparison of project.

Module –V (07 Hours)

Inflation-Meaning of inflation, types, causes, measures to control inflation.
National Income-Definition, Concepts of national income, Method of measuring national income.
Banking -Commercial bank, Functions of commercial bank, Central bank, Functions of Central Bank.

Books:

1. Principles of Economics by Deviga Vengedasalam and Karaunagaran Madhavan, Oxford
2. Riggs, Bedworth and Randhwa, “Engineering Economics”, McGraw Hill Education India
3. C. S. Park, Contemporary Engineering Economics, 6th Edition, Pearson Education, 2015.
4. Engineering Economy by William G.Sullivan, Elin M.Wicks, C. Patric Koelling, Pearson
5. R.Paneer Seelvan, “ Engineering Economics”, PHI
6. Ahuja,H.L., “Principles of Micro Economics” , S.Chand & Company Ltd
7. Jhingan,M.L., “Macro Economic Theory”
8. Macro Economics by S.P.Gupta, TMH

Course Outcomes of Engineering Economics

At the end of the course the engineering graduates will be able to

1. **Remembering** : Define the basic concept of micro and macro economics, engineering economics and their application in engineering economy.

2. **Understanding** : Evaluate numerically the effects of changes in demand and supply on price determination of products and services.

3. **Analyze :** the macroeconomic environment and financial systems of the country and its impact on business, society and enterprise.

4. **Develop :** the ability to account for time value of money using engineering economy factors and formulas.

5. **Apply:** knowledge of mathematics, economics and engineering principles to solve engineering problems and to analyze decision alternatives in engineering projects considering upon depreciation, taxes and inflation.

4th Semester	ROB4E002	ORGANISATIONAL BEHAVIOUR	L-T-P 3-0-0	3 CREDITS

Objectives:

1. To develop an understanding of the behavior of individuals and groups inside organizations
2. To enhance skills in understanding and appreciating individuals, interpersonal, and group process for increased effectiveness both within and outside of organizations.
3. To develop theoretical and practical insights and problem-solving capabilities for effectively managing the organizational processes.

Module-I: **(06 Hrs.)**

Fundamentals of OB: Definition, scope and importance of OB, Relationship between OB and the individual, Evolution of OB, Theoretical framework (cognitive), behavioristic and social cognitive), Limitations of OB.

Module-II: **(12 Hrs.)**

Attitude: Importance of attitude in an organization, Right Attitude, Components of attitude, Relationship between behavior and attitude, Developing Emotional intelligence at the workplace, Job attitude, Barriers to changing attitudes.
Personality and values: Definition and importance of Personality for performance, The Myers-Briggs Type Indicator and The Big Five personality model, Significant personality traits suitable to the workplace (personality and job – fit theory), Personality Tests and their practical applications.
Perception: Meaning and concept of perception, Factors influencing perception, Selective perception, Attribution theory, Perceptual process, Social perception (stereotyping and halo effect).
Motivation: Definition & Concept of Motive & Motivation, The Content Theories of Motivation (Maslow's Need Hierarchy & Herzberg's Two Factor model Theory), The Process Theories (Vroom's expectancy Theory & Porter Lawler model), Contemporary Theories – Equity Theory of Work Motivation.

Module-III: **(10 Hrs.)**

Foundations of Group Behavior: The Meaning of Group & Group behavior & Group Dynamics, Types of Groups, The Five – Stage Model of Group Development.
Managing Teams: Why Work Teams, Work Teams in Organization, Developing Work Teams, Team Effectiveness & Team Building.
Leadership: Concept of Leadership, Styles of Leadership, Trait Approach Contingency Leadership Approach, Contemporary leadership, Meaning and significance of contemporary leadership, Concept of transformations leadership, Contemporary theories of leadership, Success stories of today's Global and Indian leaders.

Module-IV: **(08 Hrs.)**

Organizational Culture : Meaning & Definition of Organizational Culture, creating & Sustaining Organizational Culture, Types of Culture (Strong vs. Weak Culture, Soft Vs. Hard Culture & Formal vs. Informal Culture), Creating Positive Organizational Culture, Concept of Workplace Spirituality.

Module-V: **(09 Hrs.)**

Organizational Change: Meaning, Definition & Nature of Organizational Change, Types of Organizational Change, Forces that acts as stimulants to change.
Implementing Organizational Change : How to overcome the Resistance to Change, Approaches to managing Organizational Change, Kurt Lewin's-Three step model, Seven Stage model of Change & Kotter's Eight-Step plan for Implementing Change, Leading the Change Process, Facilitating Change, Dealing with Individual & Group Resistance, Intervention Strategies for Facilitating Organizational Change, Methods of Implementing Organizational Change, Developing a Learning Organization.

Books:

1. Understanding Organizational Behaviour, Parek, Oxford
2. Organizational Behaviour, Robbins, Judge, Sanghi, Pearson.
3. Organizational Behaviour, K. Awathappa,HPH.
4. Organizational Behaviour, VSP Rao, Excel
5. Introduction to Organizational Behaviour, Moorhead, Griffin, Cengage.
6. Organizational Behaviour, Hitt, Miller, Colella, Wiley

4th Semester	RME4C003	Introduction to Physical Metallurgy and Engineering Materials	L-T-P 3-0-0	3 CREDITS

MODULE-I (10 hrs)

Classification of Engineering Materials, Engineering properties of materials. Characteristic property of metals, bonding in solids, primary bonds like ionic, covalent and metallic bond, crystal systems, common crystal structure of metals, representations of planes and directions in crystals, atomic packing in crystals, calculation of packing density, voids in common crystal structures and imperfections crystals.

MODULE-II (10 hrs)

Concept of plastic deformation of metals, critical resolve shear stress, dislocation theory, deformation by slip and twin, plastic deformation in polycrystalline metals, yield point phenomenon and related effects, concept of cold working preferred orientation. Annealing ; recovery; recrystalization and grain growth; hot working.
Concept of alloy formation, types of alloys, solid solutions, factors governing solids solubility viz. size factor, valency factor, crystal structure factor and chemical affinity factor; orderdisorder transformation.

MODULE-III (10 hrs)

Binary phase diagrams (a) Isomorphism system, (b) Eutectic system, (c) Peritectic system, (d)Eutectoid system and (e) Peritectoid system. Allotropic transformation. Lever rule and its application, Interpretation of solidification behaviors and microstructure of different alloys belonging to those systems, Effect of non-equilibrium cooling, coring and homogenization.
Iron-cementite and iron-graphite phase diagrams, microstructure and properties of different alloys (alloy steels; stainless steel, tool steel, HSS, high strength low alloy steel) types of cast iron, their microstructures and typical uses Specification of steel.

MODULE-IV (09 hrs)

T.T.T. diagram, concept of heat treatment of steels i.e. annealing, normalizing, hardening and tempering; microstructural effects brought about by these processes and their influences on mechanical properties; factor affecting hardenability.
Optical properties of Materials: Scattering, Refraction, Theory of Refraction and absorption, Atomic Theory of optical properties. Lasers, Optical fibres- Principle, structure, application of optical fibres.

MODULE-V (08 hrs)

Plastic-: Thermosetting and thermoplastics. Ceramics: Types, structure, Mechanical properties, application Composite Materials: Agglomerated Materials: Cermets .Reinforced Materials: Reinforced Concrete. Fibre reinforced plastics, Properties of composites, Metal matrix composites, manufacturing procedure for fiber reinforced composite.

Books:

- Introduction to Physical Metallurgy by Avner, Tata McGraw Hill
- Materials Science and Engineering by W.D.Callister, Wiley and Sons Inc.
- Physical Metallurgy: Principles and Practice by Ragahvan, PHI

- Engineering Physical Metallurgy and Heat Treatment by Y.Lakhtin, Mir Publisher, Moscow.
- Elements of Material Science and Engineering, L.H.Van Vlack, Addison Wesley
- Materials Science and Engineering by V.Raghavan, Prentice Hall of India Pvt.Ltd.
- Elements of Materials Science & Engineering by Van Vlack, Pearson
- Mechanical Metallurgy by Dieter, Tata MacGraw Hill
- Composite Material science and Engineering by K. K. Chawla, Springer
- Material Science and Metallurgy, by U. C. Jindal, Pearson

4th Semester	**RME4C203**	**Introduction to Physical Metallurgy and Engineering Materials Laboratory**	**L-T-P 0-0-3**	**2 CREDITS**

Laboratory Experiments(Minimum 8 experiments)

1. Study of Crystal Structures through Ball Models
2. Metallurgical Microscope: Principles and Operations
3. Specimen Preparation techniques for Metallographic Analysis
4. Microstructural Analysis of Carbon Steels
5. Microstructural Analysis of Cast Iron
6. Microstructural Analysis of Non-Ferrous Metals: Brass & Copper
7. Jominy end quench test
8. Heat treatment of Steels
9. Hardness testing of ferrous material.
10. Impact testing (Charpy/Izod)

4th Semester	RME4D001	Internal Combustion Engines and Gas Turbines	L-T-P 3-0-0	3 CREDITS

MODULE - I (10 hrs)

Introduction : Classification, Engine nomenclature, engine operating and performance parameters, Valve timing diagram of SI & CI Engines, Comparison of SI and CI engine.

Thermodynamic Analysis of cycles : Significance of Fuel-Air & Actual cycles of I.C. engines. Comparison with Air Standard Cycles. Analysis of Fuel-Air & Actual cycles (Effect of chemical equilibrium and variable specific heats. Effect of air fuel ratio and exhaust gas dilution. Time Loss Factor, Heat Loss Factor, Exhaust Blow down, Loss Due to Gas Exchange Processes, Volumetric Efficiency, Loss due to Rubbing Friction)

Fuels : Fuels of SI and CI engine, Fuel additives, Properties, potential and advantages of alternative liquid and gaseous fuels for SI and CI engines (biofuels, LPG and CNG) Fuel Induction Techniques in IC engines : Fuel induction techniques in SI and CI engines, Mixture Requirements at Different Loads and Speeds.

MODULE II (10 hrs)

Carburetion: Factors Affecting Carburetion, Principle of Carburetion, Simple Carburetor and its drawbacks, Calculation of the Air–Fuel Ratio, Modern Carburetors.

Fuel Injection: Functional Requirements of an Injection System, Classification of Injection Systems, Fuel Feed Pump, Injection Pump, Injection Pump Governor, Mechanical Governor,Pneumatic Governor, Fuel Injector, Nozzle, Injection in SI Engine, Electronic Injection Systems, Multi-Point Fuel Injection (MPFI) System, Functional Divisions of MPFI System, Injection Timing, Group Gasoline Injection System, Electronic Diesel Injection System.

Ignition : Energy requirement for ignition, requirements of an ignition system, conventional ignition systems, modern ignition systems (TCI and CDI), firing order, Ignition timing, Spark advance mechanism.

MODULE III (10 hrs)

Combustion : Stages of combustion in SI and CI engines, effects of engine variables on flame propagation and ignition delay, Abnormal combustion, Preignition & Detonation, Theory of Detonation. Effect of engine variables on Detonation, control of Detonation. Diesel Knock & methods to control diesel knock, Requirements of combustion chambers. Features of different types of combustion chambers system for S.I. engine. (I-head, F-head combustion chambers), C.I. engine combustion chambers -Open and divided type, Air swirl turbulence-M. type combustion chamber. Comparison of various types of combustion chambers.

Super Charging &Scavenging : Thermodynamics Cycles of supercharging. Effect of supercharging, Efficiency of supercharged engines. Methods of super charging, supercharging and scavenging of 2stroke engines.

Module-IV (8 hrs)

Testing and Performances : Power, fuel & air measurement methods, Performance characteristic curves of SI & CI engines, variables affecting performance and methods to improve engine performance.

Cooling & Lubricating Systems, Engine Emission &Controls : Air cooling & water cooling systems, Effect of cooling on power output & efficiency, Properties of lubricants and different types of lubricating system. Modern developments in IC Engines, EGR, MPFI, CRDI, GDI, HCCI, dual fuel engine, Lean burn engine, Stratified engine (basic principles).

Emission and control : Mechanism of pollutant formation and its harmful effects. Methods of measuring pollutants and control of engine emission.

Module-V (07 hrs)

Gas Turbines :Introduction, Open and closed cycle gas turbines, Analysis of practical gas turbine cycle.

Air Craft Propulsion : Analysis of Turbo Jet, Turbo Prop, Turbo fan & Ram jet engines.

Axial Flow & Centrifugal Compressor : Basic construction of centrifugal and axial flow compressor, Velocity diagram, performance characteristics of centrifugal and axial flow compressor, effects of slip, surging and stalling on compressor.

Books:

- IC Engines, Mathur & Sharma
- Internal Combustion Engines, V. Ganesan, TMH, 3 rd
- edition
- Gas Turbines, V.Ganesan, TMH, 3rd edition
- Fundamentals IC Engines, J.B.Heywood, McGraw Hill
- A course in IC Engines, V.M.Domkundwar, Dhanpat rai and sons
- Gas Turbines, Cohen and Roser
- An Introduction to Energy Conversion, Vol.III, V.Kadambi and Manohar Prasad, New Age International
- Fundamentals of Internal Combustion Engines, H.N.Gupta, PHI
- Internal Combustion Engines, K.K.Ramalngam, Scitech Publications

4th Semester	RME4D002	Mechanical Measurement, Metrology & Reliability	L-T-P 3-0-0	3 CREDITS

MODULE – I (08 hrs)

Definition and methods of measurement, classification of measuring instruments, Measuring systems, performance characteristics of measuring devices, types of errors. Functional elements of measuring system.

Static and Dynamic Characteristics of Instruments: Static Performance Parameters, Impedance Loading and Matching, Selection and Specifications ofInstruments, Dynamic Response, Compensation.

MODULE-II (09 hrs)

Transducer Elements: Analog Transducers, Digital Transducers, Basic detector transducer elements: Electrical transducer, Sliding Contract devices, Variable-inductance transducer elements, the differential transformer, Variable-reluctance transducers, Capacitive transducers. The piezoelectric effect, photo-electric transducer, electronic transducer element.
Intermediate Elements: Amplifier, Operational Amplifier, Diffential and Integrating Elements, Filters, A-D and D-A Converters.

Strain Measurement: The electrical resistance strain gauge. The metallic resistance strain gauge, Selection and installation factors for metallic strain gauge, Circuitry, metallic strain gauge. The strain gauge ballast circuit, the staring gauge bridge circuit, Temperature compensation.

MODULE-III (08 hrs)

Measurement of Pressure: Pressure measurement systems, Pressure measurement transducers, Elastic diaphragms, strain gauge pressure cells, measurement of high pressure, Measurement of low pressures, dynamic characteristics of pressure measuring systems.Measurement of Fluid Flow,Flow characteristics obstruction meters, Obstruction meter for compressible fluids- Orifice, Venturimeter and Pitot tube, The variable-area meter, Turbine Flow meters.
Temperature Measurement: Use of bimetals pressure thermometers, Thermocouples, Pyrometry, Calibration of temperature measuring devices.Force, Power, Speed and Torque Measurement :Load Cell, Dynamometers, Tachometer and Tacho-generator, Stroboscope, The seismic instrument.-Vibrometers and accelerometers

MODULE – IV (10 hrs)

Principles of Measurements: Line and End & optical Standards, Calibration, accuracy and Precision,Random error and systemic error. Measurement of Surface Roughness, Screw Thread and Gears. Measurement of straightness, Flatness and circularity.

Limits, Fits and Gauges, Assembly by full, partial and group interchangeability, geometric tolerances.

MODULE – V (10 hrs)

Definition, bath-tub-curve, system reliability, reliability improvement, maintainability and availability. Availability of single repairable system using Markov model, Life tests, acceptance sampling plan based on life tests, Sequential acceptance sampling plan based on **MTTF & MTBF.**

Books :

- Engineering Metrology & Measurement, N.V.Raghavendra and L. Krishnamurthy,
- OXFORD University Press
- Instrumentation Measurement and Analysis, B.C.Nakra and KK.Chaudhry, Tata Mc Graw
- Hill, Third Edition.
- Engineering Metrology,R.K. Jain, Khanna Publisher, Delhi
- Reliability Engg. And Terotechnology , A.K. Gupta, Macmillan India.
- Metrology & Measurement, A. K. Bewoor and V.A.Kulkarni, Mc Graw hill
- Mechanical Measurements, T.G. Beckwith and N. Lewis Buck, Oxford and IBH Publishing Co.
- A text book of Engineering Metrology I.C. Gupta, Dhanpat Rai & sons, Delhi.
- Introduction to /reliability and Maintainability Engg. E. Ebeling, MC-Graw Hill.

4th Semester	**RME4D003**	**Advanced Mechanics of Solids**	**L-T-P 3-0-0**	**3 CREDITS**

MODULE – I(6 HOURS)

Elementary concept of elasticity, stresses in three dimensions, Principal Stresses, Stress Invariants, Mohr's Circle for 3-D state of stress, Octahedral Stresses, State of pure shear,. plane stress. Differential equations of equilibrium.

MODULE-II(10 HOURS)

Analysis of strain, State of strain at a point, Strain Invariant, Principal Strains, Plane state of strain, Strain measurements. compatibility conditions.

Energy Methods: Work done by forces and elastic strain energy stored. Reciprocal relations, Theorem of virtual work, Castigliano's theorems,

MODULE – III(10 HOURS)

Bending of beams: Asymmetrical bending, Shear centre, Bending of curved beams, Stress distribution in beam with rectangular, circular and trapezoidal cross section, stresses in crane hooks, ring and chain links., Deflection of thick curved bars.

Axisymmetric problems: Thick walled cylinder subjected to internal and external pressures, Compound cylinders, Shrink fit,

MODULE – IV(6 HOURS)

Repeated stresses and fatigue in metals, Fatigue tests and fatigue design theory, Goodman, Gerber and Soderberg criteria, Concept of stress concentration, Notch sensitivity.

MODULE-V(8 HOURS)

Introduction to Mechanics of Composite Materials: Lamina and Laminates, Micromechanics of FRP Composites.

Introduction to Fracture Mechanics: Basic modes of fracture, Fracture toughness evaluation.

Books:

- Advanced Mechanics of Solids, L.S. Srinath, Tata McGraw Hill
- Advanced Mechanics of Materials : Boresi and Schmdt, Willey
- Advanced Mechanics of Materials : Siley and Smith
- Strength of Materials Vol.II, by S.Timoshenko
- Mechanical Metallurgy by Dieter
- Strength of Materials by G. H. Ryder, Macmillan Press
- Mechanics of Materials by Beer and Johnston, Tata McGraw Hill
- Mechanics of Materials by R.C.Hibbeler, Pearson Education
- Mechanics of Materials by William F.Riley, Leroy D.Sturges & Don H.Morris, Wiley Student.
- Mechanics of Materials by James M. Gere, Thomson Learning
- Engineering Machanics of Solids by Egor P. Popov, Prentice Hall of India
- Strength of Materials by S.S.Rattan, Tata Mc Graw Hill

4th Semester	RME4G001	Digital Systems Design	L-T-P 3-0-0	3 CREDITS

MODULE – I (10 Hours)

Revision of Number System: Introduction to various number systems and their Conversion. Arithmetic Operation using 1's and 2`s Compliments, Signed Binary and Floating Point Number Representation Introduction to Binary codes and their applications.

Revision Boolean Algebra and Logic Gates: Boolean algebra and identities, Complete Logic set, logic gates and truth tables. Universal logic gates, Algebraic Reductionand realization using logic gates

MODULE – II (11 Hours)

Combinational Logic Design: Specifying the Problem, Canonical Logic Forms, Extracting Canonical Forms, EX-OR Equivalence Operations, Logic Array, K-Maps: Two, Three and Four variable K-maps, NAND and NOR Logic Implementations.

Logic Components: Concept of Digital Components, Binary Adders, Subtraction and Multiplication, An Equality Detector and comparator, Line Decoder, encoders, Multiplexers and De-multiplexers.

MODULE – III (8 Hours)

Synchronous Sequential logic Design: sequential circuits, storage elements: Latches (SR, D), Storage elements: Flip-Flops inclusion of Master-Slave, characteristics equation and state diagram of each FFs and Conversion of Flip-Flops. Analysis of Clocked Sequential circuits and Mealy and Moore Models of Finite State Machines**.**

MODULE – IV (9 Hours)

Binary Counters : Introduction, Principle and design of synchronous and asynchronous counters, Design of MOD-N counters, Ring counters. Decade counters, State Diagram of binary counters.
Shift resistors: Principle of 4-bit shift resistors. Shifting principle, Timing Diagram, SISO, SIPO, PISO and PIPO resistors.

Memory and Programmable Logic: Types of Memories, Memory Decoding, error detection and correction), RAM and ROMs. Programmable Logic Array, Programmable Array Logic, Sequential Programmable Devices.

MODULE – V (7 Hours)

IC Logic Families: Properties DTL, RTL, TTL, I^2L and CMOS and its gate level implementation. A/D converters and D/A converters**.**

College Level (20%)
Basic hardware description language: Introduction to Verilog/VHDL programming language, Verilog/VHDL program of logic gates, adders, Substractors, Multiplexers, Comparators, Decoders flip-flops, counters, Shift resistors.

Books:

- Digital Design, 3rd Edition, Moris M. Mano, Pearson Education.
- Fundamentals of digital circuits, 8th edition, A. Anand Kumar, PHI
- Digital Fundamentals, 5th Edition, T.L. Floyd and R.P. Jain, Pearson Education, New Delhi.
- Digital Electronics, G. K. Kharate, Oxford University Press.
- Digital Systems – Principles and Applications, 10th Edition, Ronald J. Tocci, Neal S. Widemer and Gregory L. Moss, Pearson Education.
- A First Course in Digital System Design: An Integrated Approach, India Edition, John P. Uyemura, PWS Publishing Company, a division of Thomson Learning Inc.
- Digital Systems – Principles and Applications, 10th Edition, Ronald J. Tocci, Neal S. Widemer and Gregory L. Moss, Pearson Education.

4th Semester	**RME4G002**	**Microprocessor and Microcontroller**	**L-T-P 3-0-0**	**3 CREDITS**

Module-I (10 Hours)

Introduction to 8 bit and 16 bit Microprocessors-H/W architecture

Introduction to microprocessor, computer and its organization, Programming system; Address bus, data bus and control bus, Tristate bus; clock generation; Connecting Microprocessor to I/O devices; Data transfer schemes; Architectural advancements of microprocessors. Introductory System design using microprocessors; 8086 – Hardware Architecture; External memory addressing; Bus cycles; some important Companion Chips; Maximum mode bus cycle; 8086 system configuration; Memory Interfacing; Minimum mode system configuration, Interrupt processing.

Module -II (08 Hours)

16-bit microprocessor instruction set and assembly language programming: Programmer's model of 8086; operand types, operand addressing; assembler directives, instruction Set-Data transfer group, Arithmetic group, Logical group.

Module-III (08 Hours)

Microprocessor peripheral interfacing:

Introduction; Generation of I/O ports; Programmable Peripheral Interface (PPI)-Intel 8255; Sample-and-Hold Circuit and Multiplexer; Keyboard and Display Interface; Keyboard and Display Controller (8279).

Module-IV (12 Hours)

8-bit microcontroller- H/W architecture instruction set and programming:

Introduction to 8051 Micro-Controllers, Architecture; Memory Organization; Special Function register; Port Operation; Memory Interfacing, I/O Interfacing; Programming 8051 resources, interrupts; Programmer's model of 8051; Operand types, Operand addressing; Data transfer instructions, Arithmetic instructions, Logic instructions, Control transfer instructions; Programming.

Module-V (07 Hours)

8086: Maximum mode system configuration, Direct memory access, Interfacing of D-to-A converter, A-to-D converter, CRT Terminal Interface, Printer Interface, Programming of 8051 timers, 8051 serial interface, Introduction to 80386 and 80486 Microprocessor family.

Books:

- Microprocessor Architecture, Programming and application with 8085, R.S. Gaonkar, PRI Penram International publishing PVT. Ltd., 5th Edition
- Microprocessors and Interfacing, Programming and Hardware, Douglas V Hall, TMH Publication, 2006.
- Microprocessors and Interfacing, N. Senthil Kumar, M. Saravanan, S. Jeevananthan and S.K. Shah, Oxford University Press.
- The 8051 Microcontroller and Embedded Systems, Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D.M C Kinlay, Pearson Education, Second Edition, 2008.
- Microcontrollers: Principles and Application, Ajit Pal, PHI Publication
- Microprocessors and Microcontrollers Architecture, programming and system design using 8085, 8086, 8051 and 8096, Krishna Kant, PHI Publication, 2007.
- Advanced Microprocessors and Peripherals, A.K. Ray, K M Bhurchandi, TMH Publication, 2007.
- Textbook of Microprocessor and Microcontroller, Thyagarajan, Scitech Publication.

4th Semester	**RME4G003**	**Data Structure**	**L-T-P 3-0-0**	**3 CREDITS**

Module - I (12 Hrs.)

Introduction: Basic Terminologies: Elementary Data Organizations, Data Structure Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off.
Searching: Linear Search and Binary Search Techniques and their complexity analysis.

Module – II (08 Hrs.)

Stacks and Queues: ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation – corresponding algorithms and complexity analysis. ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each types of Queues: Algorithms and their analysis.

Module - III (08 Hrs.)

Linked Lists: Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis.

Module - IV (10 Hrs.)

Sorting and Hashing: Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods, Hashing.

Module - V (07 Hrs.)

Trees: Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees. B Tree, B+ Tree: definitions, algorithms and analysis.

Graph: Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.

Books:

- "Fundamentals of Data Structures", Illustrated Edition by Ellis Horowitz, Sartaj Sahni, Computer Science Press.
- Algorithms, Data Structures, and Problem Solving with C++", Illustrated Edition by Mark Allen Weiss, Addison-Wesley Publishing Company
- "How to Solve it by Computer", 2nd Impression by R.G. Dromey, Pearson Education.

4th Semester	RCN4F001	Constitution of India	L-T-P 3-0-0	0 CREDIT

Basic features and fundamental principles

The Constitution of India is the supreme law of India. Parliament of India can not make any law which violates the Fundamental Rights enumerated under the Part III of the Constitution. The Parliament of India has been empowered to amend the Constitution under Article 368, however, it cannot use this power to change the "basic structure" of the constitution, which has been ruled and explained by the Supreme Court of India in its historical judgments. The Constitution of India reflects the idea of "Constitutionalism" – a modern and progressive concept historically developed by the thinkers of "liberalism" – an ideology which has been recognized as one of the most popular political ideology and result of historical struggles against arbitrary use of sovereign power by state. The historic revolutions in France, England, America and particularly European Renaissance and Reformation movement have resulted into progressive legal reforms in the form of "constitutionalism" in many countries. The Constitution of India was made by borrowing models and principles from many countries including United Kingdom and America.

The Constitution of India is not only a legal document but it also reflects social, political and economic perspectives of the Indian Society. It reflects India's legacy of "diversity". It has been said that Indian constitution reflects ideals of its freedom movement, however, few critics have argued that it does not truly incorporate our own ancient legal heritage and cultural values. No law can be "static" and therefore the Constitution of India has also been amended more than one hundred times. These amendments reflect political, social and economic developments since the year 1950. The Indian judiciary and particularly the Supreme Court of India has played an historic role as the guardian of people. It has been protecting not only basic ideals of the Constitution but also strengthened the same through progressive interpretations of the text of the Constitution. The judicial activism of the Supreme Court of India and its historic contributions has been recognized throughout the world and it gradually made it "as one of the strongest court in the world".

Course content

1. Meaning of the constitution law and constitutionalism
2. Historical perspective of the Constitution of India
3. Salient features and characteristics of the Constitution of India
4. Scheme of the fundamental rights
5. The scheme of the Fundamental Duties and its legal status
6. The Directive Principles of State Policy – Its importance and implementation
7. Federal structure and distribution of legislative and financial powers between the Union and the States
8. Parliamentary Form of Government in India – The constitution powers and status of the President of India
9. Amendment of the Constitutional Powers and Procedure
10. The historical perspectives of the constitutional amendments in India

11. Emergency Provisions : National Emergency, President Rule, Financial Emergency
12. Local Self Government – Constitutional Scheme in India
13. Scheme of the Fundamental Right to Equality
14. Scheme of the Fundamental Right to certain Freedom under Article 19
15. Scope of the Right to Life and Personal Liberty under Article 21.