BIJU PATNAIK UNIVERSITY OF TECHNOLOGY, ODISHA
ROURKELA

Curriculum and Syllabus

of

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

Semester (3rd)

Director, Curriculum Development
Biju Patnaik University of Technology, Odisha
Rourkela

Third Semester							
Theory							
Sl No	**Category**	**Course Code**	**Course Title**	**L-T-P**	**Credit**	**University Marks**	**Internal Evaluation**
1	BS	RMA3A001	Mathematics - III	3-0-0	3	100	50
2	ES	ROP3B001	Object Oriented Programming Using JAVA	3-0-0	3	100	50
3	HS	REN3E001 / ROB3E002	Engineering Economics / Organisational Behaviour	3-0-0	3	100	50
4	PC	RME3C001	Mechanics of Solid	3-0-0	3	100	50
5	PC	RME3C002	Fluid Mechanics and Hydraulic Machines	3-0-0	3	100	50
6	MC*	RES3F001	Environment Science	3-0-0	0	—	100 (Pass mark is 37)
Total Credit (Theory)					15		
Total Marks						**500**	**250**
Practical							
1	PC	RME3C201	Mechanics of Solid Lab.	0-0-3	2		100
2	PC	RME3C202	Fluid Mechanics and Hydraulic Machines Lab.	0-0-3	2		100
3	ES	ROP3B201	OOP Using JAVA Lab.	0-0-3	2		100
4	PSI	RIP3H201	Evaluation of Internship - I	0-0-3	1		100
Total Credit (Practical)					**7**		
Total Semester Credit					**22**		
Total Marks							**400**

***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.**

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3rd Semester	RMA3A001	MATHEMATICS – III	L-T-P 3-0-0	3 CREDITS

Module-I (10 Hours)

Solution of Non-linear equation in one variable (Bisection, Secant, Newton Rapson Method, Fixed Point Iteration method). Numerical Solutions of system of Linear equations (Gauss-Seidel, Successive Over Relaxation, Doolittle method, Crouts method, Choleskys Method).
Interpolation: Newton's forward and backward interpolation, Newton divided difference interpolation, Lagrange Interpolation.

Module-II (8 Hours)

Numerical Differentiation, integration and Solution of Differential Equations: Numerical Differentiation, The trapezoidal rule, The Simpson's rule, Gauss Integration formulas. Solution of ordinary differential equation: Euler's method, Improvement of Euler's method, Runge-Kutta methods, multi step methods, Methods for system and higher order ordinary differential equations.

Module-III (8 Hours)

Sample Space, Probability, Conditional Probability, Independent Events, Bayes' Theorem, Random variables, Probability distributions, Expectations, Mean and variance, Moments.

Module-IV (9 Hours)

Bernoulli Trials, Binomial, Poisson, Hyper Geometirc Distribution, Uniform., Exponential and Normal distribution, Bivariate Distributions.

Module-V (10 Hours)

Correlation and Regression Analysis, Rank Correlation, Maximum Likely hood estimate, Method of Moments, Confidence intervals mean and variance of a Normal Distribution, p-value. Testing of hypothesis: test for goodness of fit, Test for single mean and variance of a Normal Distribution.

Books:

1. E. Kreyszig," Advanced Engineering Mathematics:,Tenth Edition, Wiley India
2. S.Pal and S.C. Bhunia, "Engineering Mathematics" Oxford University Press
3. Jay L. Devore, "Probability and Statistics for Engineering and Sciences", Seventh Edition, Thomson/CENGAGE Learning India Pvt. Ltd
4. R. E. Walpole, R. h. Myers, S. L. Myers, K. E. Ye; "Probability and Statistics, Pearson".
5. R. L. Burden, J. D. Faires, " Numerical Analysis, Cenage Learning India Pvt. Ltd"
6. B.V.RAMANA,"Higher Engineering Mathematics"Tata Magraw Hill

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3rd Semester	ROP3B001	OBJECT ORIENTED PROGRAMMING USING JAVA	L-T-P 3-0-0	3 CREDITS

Module-I (10 Hrs)

Chapter 1-: An introduction to programming.

Different types of programming languages, Description of Compiler and Interpreter, Advantage of Object Oriented Programming, Object Oriented Programming, Features of Object Oriented Programming.

Chapter 2-: Introduction to Java.

What is Java?, Why Java?, History behind Java, Different versions of Java, Difference between C/C++ and Java, Features of Java, First Java Program, Prerequisites Before start writing a java program, Writing the program, Compiling the program, How Java program compiles?, Executing the program, How Java program executes?, What is JVM and its significance in executing a program?, Architecture of JVM.

Chapter 3-: Understanding First Program and a step forward, Understanding every term of the program, Java Tokens, Datatypes, Operators, What are Operators?, Different types of Operators, Typecasting, Control Structures and Arrays, Different types of control structures, Conditional Statements, Loops/ Iterators, Jumping Statements, Java Arrays, Multidimensional Arrays, Taking Input from keyboard, Command Line Arguments, Using Scanner Class, Using Buffered Reader class.

Module-II: (08 Hrs.)

Chapter 1-: Introduction to Classes and Objects.

Classes, Methods, Objects, Description of data hiding and data encapsulation, Constructors, Use of static Keyword in Java, Use of this Keyword in Java, Array of Objects, Concept of Access Modifiers (Public, Private, Protected, Default).

Chapter 2-: Inheritance

Understanding Inheritance, Types of Inheritance and Java supported Inheritance, Significance of Inheritance, Constructor call in Inheritance, Use of super keyword in Java, Polymorphism, Understanding Polymorphism, Types of polymorphism, Significance of Polymorphism in Java, Method Overloading, Constructor Overloading, Method Overriding, Dynamic Method Dispatching.

Chapter 3-: String Manipulations.

Introduction to different classes, String class, String Buffer, String Builder, String Tokenizer, Concept of Wrapper Classes, Introduction to wrapper classes, Different predefined wrapper classes, Predefined Constructors for the wrapper classes. Conversion of types from one type (Object) to another type (Primitive) and Vice versa, Concept of Auto boxing and unboxing.

Module-III: (09 Hrs.)

Chapter 1:-Data Abstraction

Basics of Data Abstraction, Understanding Abstract classes, Understanding Interfaces, Multiple Inheritance Using Interfaces, Packages, Introduction to Packages, Java API Packages, User-Defined Packages, Accessing Packages, Error and Exception Handling, Introduction to error and exception, Types of exceptions and difference between the types, Runtime Stack Mechanism, Hierarchy of Exception classes, Default exception handling in Java, User defined/Customized Exception Handling, Understanding different keywords (try, catch, finally, throw, throws), User defined exception classes, Commonly used Exceptions and their details.

Chapter 2:-Multithreading

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Introduction of Multithreading/Multitasking, Ways to define a Thread in Java, Thread naming and Priorities, Thread execution prevention methods. (yield(), join(), sleep()), Concept of Synchronisation, Inter Thread Communication, Basics of Deadlock, Demon Thread, Improvement in Multithreading, Inner Classes, Introduction, Member inner class, Static inner class, Local inner class, Anonymous inner class.

Module-IV: (10 Hrs.)

Chapter 1:-IO Streams (java.io package)
Introduction, Byte Stream and Character Stream, Files and Random Access Files, Serialization, Collection Frame Work (java.util), Introduction, Util Package interfaces, List, Set, Map etc, List interfaces and its classes, Setter interfaces and its classes.

Chapter 2:-Applet
Introduction, Life Cycle of an Applet, GUI with an Applet, Abstract Window Toolkit (AWT), Introduction to GUI, Description of Components and Containers, Component/Container hierarchy, Understanding different Components/Container classes and their constructors, Event Handling, Different mechanisms of Event Handling, Listener Interfaces, Adapter classes.

Module-V: (08 Hrs.)

Chapter 1:-Swing (JFC)
Introduction Diff b/w awt and swing, Components Hierarchy, Panes, Individual Swings Components JLabel, JButton, JTextField, JTextArea.

Chapter 2:-JavaFX
Getting started with JavaFX, Graphics, User Interface Components, Effects, Animation, and Media, Application Logic, Interoperability, JavaFX Scene Builder 2, Getting Started with scene Builder.
Working with scene Builder.

Books :-

1. Programming in Java. Second Edition. OXFORD HIGHER EDUCATION. (SACHIN MALHOTRA/SAURAV CHOUDHARY)
2. CORE JAVA For Beginners. (Rashmi Kanta Das), Vikas Publication
3. JAVA Complete Reference (9th Edition) Herbalt Schelidt.

3rd Semester	**ROP3B201**	**OOP USING JAVA LAB.**	**L-T-P 0-0-3**	**2 CREDITS**

JAVA programs on:

1. Introduction, Compiling & executing a java program.
2. Data types & variables, decision control structures: if, nested if etc.
3. Loop control structures: do, while, for etc.
4. Classes and objects.
5. Data abstraction & data hiding, inheritance, polymorphism.
6. Threads, exception handlings and applet programs
7. Interfaces and inner classes, wrapper classes, generics

3rd Semester	REN3E001	ENGINEERING ECONOMICS	L-T-P 3-0-0	3 CREDITS

Module - I (08 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 (06 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.

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3rd Semester	ROB3E002	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.

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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

3rd Semester	RME3C001	Mechanics of Solid	L-T-P 3-0-0	3 CREDITS

MODULE – I (10 Hrs.)

Concept of Stress: Load, Stress, Principle of St.Venant, Principle of Superposition, Strain, Hooke's law, Modulus of Elasticity, Stress-Strain Diagrams, Working Stress, Factor of safety, Strain energy in tension and compression, Resilience, Impact loads,
Analysis of Axially Loaded Members: Composite bars in tension and compression - temperature stresses in composite rods, Concept of Statically indeterminate problems. Shear stress, Complimentary shear stress, Shear strain, Modulus of rigidity, Poisson's ratio, Bulk Modulus, Relationship between elastic constants.

MODULE – II (09 Hrs.)

Biaxial State of Stress and Strain : Analysis of Biaxial Stress. Plane stress, Principal plane, Principal stress, Mohr's Circle for Biaxial Stress. Two dimensional state of strain, Principal strains, Mohr's circle for strain, Calculation of principal stresses from principal strains, Strain Rossette.

Thin Cylinder: Stresses in thin cylinders and thin spherical shells under internal pressure, wire winding of thin cylinders.

MODULE - III (09 Hrs.)

Shear Force and Bending Moment Diagrams: Shear force and bending moment. Types of load and Types of support. Support reactions, Relationship between bending moment and shear force, Point of inflection, Point of contraflexture. Shear Force and Bending Moment diagrams.
Bending of Beams: Theory of simple bending of initially straight beams, Bending stresses, Shear stresses in bending, Distribution of normal and shear stress, Composite beams.

MODULE - IV (9 Hrs.)

Deflection of Beams : Differential equation of the elastic line, Slope and deflection of beams by integration method and area - moment method.
Theory of Columns: Long columns, Euler's column formula, Lateral buckling, Critical Load, Slenderness ratio, Eccentric loading of short column

MODULE – V (08 Hrs.)

Torsion: Torsion in solid and hollow circular shafts, Twisting moment, Strain energy in shear and torsion, strength of solid and hollow circular shafts. Strength of shafts in combined bending and twisting, Close - Coiled helical springs.
Testing of materials with UTM; testing of hardness and impact strength.

Books:

- Strength of Materials by G. H. Ryder, Macmillan Press
- Elements of Strength of Materials by S.P.Timoshenko and D.H.Young, Affiliated EastWest Press
- Strength of Materials by R.Subramaniam, Oxford University 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 and Don H.Morris,Wiley

- Mechanics of Materials by James M. Gere, Thomson Learning
- Strength of Materials by James M. Gere and Barry J. Goodno, Cengage Learning
- Strength of Materials by S.S.Rattan, Tata Mc Graw Hill
- Engineering Mechanics of Solids by Egor P. Popov, Prentice Hall of India

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3rd Semester	RME3C201	Mechanics of Solid Lab.	L-T-P 0-0-3	2 CREDITS

Laboratory Experiments (Minimum 8 experiments)

1. Determination of tensile strength of materials by Universal Testing Machine
2. Determination of compressive strength of materials by Universal Testing Machine
3. Determination of bending strength of materials by Universal Testing Machine
4. Double shear test in Universal Testing Machine
5. Determination of Rigidity modulus of material
6. Determination of Fatigue strength of material
7. Estimation of Spring Constant under Tension and Compression.
8. Load measurement using Load indicator, Load Cells.
9. Strain measurement using Strain Gauge.
10. Stress measurement using strain rosette.

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3rd Semester	RME3C002	Fluid Mechanics and Hydraulic Machines	L-T-P 3-0-0	3 CREDITS

Module - I (12 Hrs.)

Introduction: Scope of fluid mechanics and its development as a science Physical property of Fluid: Density, specific gravity, specific weight, specific volume, surface tension and capillarity, viscosity, compressibility and bulk modulus, Fluid classification.

Fluid statics: Pressure, Pascal's Law, Pressure variation for incompressible fluid, atmospheric pressure, absolute pressure, gauge pressure and vacuum pressure, manometer. Hydrostatic process on submerged surface, force on a horizontal submerged plane surface, force on a vertical submerged plane surface. Buoyancy and floatation, Archimedes' principle, stability of immersed and floating bodies, determination of metacentric height.

Module – II (08 Hrs.)

Fluid kinematics: Introduction, description of fluid flow, classification of fluid flow. Reynold's number, Acceleration of fluid particles, flow rate and continuity equation, differential equation of continuity, Mathematical definitions of irrotational and rotational motion. Circulation, potential function and stream function. Flow net.

Module - III (08 Hrs.)

Fluid dynamics : Introduction to N-S equation and non-dimensional number, Euler's equation along a streamline, energy equation, Bernoulli's equation and its application to siphon, venturimeter, orificemeter, pitot tube. Flow in pipes and ducts: Loss due to friction, Minor energy losses in pipes Hydraulic Gradient Line (HGL), Total Energy Line (TEL), Power transmission in the fluid flow in pipes, fluid flow in pipes in series and parallel. Flow through nozzles.

Module - IV (10 Hrs.)

Impact of Jets : Flat, inclined and curved plates with stationary and moving case.
Hydraulic turbines: Classification, Impulse and Reaction turbine; Tangential, Radial and axial turbine. Impulse turbine, Pelton wheel, bucket dimensions, number of buckets in pelton wheel, efficiency and performance curves.

Reaction Turbines: Francis turbine and Kaplan turbine, velocity triangle and efficiencies, performance curve. Function of draft tube and casing cavitation.

Module - V (07 Hrs.)

Centrifugal Pump: constructional features, vane shape, velocity triangles, Efficiencies, Multi stage centrifugal pumps, Pump Characteristic, NPSH and Cavitation.
Positive displacement pumps: Reciprocating Pump, Working principle, Discharge, work done and power requirement, Slip, Indicator diagram

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Books:

- Fluid Mechanics, Y A Cengel, TMH
- Fluid Mechanics and Hydraulic Machines, Modi & Seth
- Introduction to Fluid Mechanics and Fluid Machines, S.K. Som and G. Biswas, TMH
- Fluid Mechanics and Machinery, Mohd. Kareem Khan, OXFORD
- Introduction to Fluid Mechanics, Fox, McDonald, Willey Publications
- Fluid Mechanics and Fluid Machines by A.K.Jain, Khanna Publishers
- Fluid Mechanics and Machinery, CSP Ojha and P.N. Chandramouli, Oxford University Press
- Fluid Mechanics by Kundu, Elsevier
- An Introduction to Fluid Dynamics, G.K.Batchelor, Cambridge University Press
- Engineering Fluid Mechanics by Garde et. al., Scitech
- Fluid Mechanics by J.F.Douglas, J.M.Gasiorek, J.A.Swaffield and L.B.Jack, Pearson Education
- Fluid Mechanics and Machines, Sukumar Pati, TMH

3rd Semester	**RME3C202**	**Fluid Mechanics and Hydraulic Machines Lab.**	**L-T-P 0-0-3**	**2 CREDITS**

Laboratory Experiments (Minimum 8 experiments)

1. Determination of Metacentric Height and application to stability of floating bodies.
2. Determination of Cv and Cd of Orifices.
3. Experiments on impact of Jets
4. Experiments on performance of Pelton Turbine
5. Experiments on performance of Francis Turbine
6. Experiments on performance of Kaplan Turbine
7. Experiments on performance of centrifugal pump
8. Experiments on performance of reciprocating pump
9. Experiments on Reynold's Apparatus
10. Experiments on Flow through pipes
11. Experiments on performance of Gear pump
12. Verifications of momentum equation

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3rd Semester	RES3F001	ENVIORMENT SCIENCE	L-T-P 3-0-0	0 CREDIT

We as human being are not an entity separate from the environment around us rather we are a constituent seamlessly integrated and co-exist with the environment around us. We are not an entity so separate from the environment that we can think of mastering and controlling it rather we must understand that each and every action of ours reflects on the environment and vice versa. Ancient wisdom drawn from Vedas about environment and its sustenance reflects these ethos. There is a direct application of this wisdom even in modern times. Idea of an activity based course on environment protection is to sensitize the students on the above issues through following two type of activities.

(a) Awareness Activities:

i) Small group meetings about water management, promotion of recycle use, generation of less waste, avoiding electricity waste
ii) Slogan making event
iii) Poster making event
iv) Cycle rally
v) Lectures from experts

(b) Actual Activities:

i) Plantation
ii) Gifting a tree to see its full growth
iii) Cleanliness drive
iv) Drive for segregation of waste
v) To live some big environmentalist for a week or so to understand his work
vi) To work in kitchen garden for mess
vii) To know about the different varieties of plants
viii) Shutting down the fans and ACs of the campus for an hour or so

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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.

BIJUPATNAIKUNIVERSITY OF TECHNOLOGY, ODISHA

ROURKELA

Curriculum and Syllabus

B. Tech (Mechanical Engineering) for the Batch

2018-19 and Onwards

Semester (5^{th})

B. Tech in Mechanical Engineering

(Admission Batch: 2018-2019 and Onwards)

5th Semester

Fifth Semester					
Theory					
Sl. No.	Category	Course Code	Course Title	L-T-P	Credit
1	PC 11		Basic Manufacturing Processes	3-0-0	3
2	PC 12		Mechanisms and Machines	3-0-0	3
3	PC 13		Heat Transfer	3-0-0	3
4	PE 2		Automobile Engineering	3-0-0	3
			CAD/CAM	3-0-0	
			Tribology	3-0-0	
5	PE 3		Non-Conventional Energy Sources	3-0-0	3
			Rapid Manufacturing Processes	3-0-0	
			Finite Element Methods in Engineering	3-0-0	
6	MC 5		Universal Human Values		0
Total Credit (Theory)					**15**
Practical					
1	PC 14		Basic Manufacturing Processes Lab	0-0-3	2
2	PC 15		Mechanisms and Machines Lab	0-0-3	2
3	PC 16		Heat Transfer Lab	0-0-3	2
4	PSI 2		Evaluation of Summer Internship	0-0-3	1
Total Credit (Practical)					**7**
Total Semester Credit					**22**

5th Semester

PC 11: Basic Manufacturing Processes

MODULE - I **(10 LECTURES)**

Foundry :Types of patterns, pattern materials and pattern allowances. Moulding Materials - sand moulding, metal moulding, investment moulding, shell moulding. Composition of molding sand, Silica sand, Zircon sand, binders, additives, Binders - clay, binders for CO_2, sand, binder for shell moulding, binders for core sand. Properties of moulding sand and sand testing, Melting furnaces - cupola, resistance furnace, induction and arc furnace, Solidification of castings, design of risers and runners, feeding distance, centre line freezing resistance chills and chaplets. Degasification and inoculation of metals. Casting methods like continuous casting, centrifugal casting, disc casting. Casting defects.

MODULE – II **(8 LECTURES)**

Welding and cutting: Introduction to gas welding, cutting, Arc welding and equipment's. TIG (GTAW) and MIG (GMAW) welding, resistance welding and thermit welding. Weldablity Modern Welding methods like plasma Arc, Laser Beam, Electron Beam, Ultrasonic, Explosive and friction welding, edge preparation in butt welding. Brazing and soldering, welding defects. Destructive and non-destructive testing of castings and welding.

MODULE – III **(08 LECTURES)**

Brief introduction to powder metallurgy processes. Plastic deformation of metals: Variables in metal forming and their optimization. Dependence of stress strain diagram on Strain rate and temperature. Hot and cold working of metals, classification of metal forming processes. Rolling: Pressure and Forces in rolling, types of rolling mills, Rolling defects. Forging: Smith Forging, Drop and Press forging, M/c forging, Forging defects.

MODULE – IV **(08 LECTURES)**

Extrusions: Direct, Indirect, Impact and Hydrostatic extrusion and their applications, Extrusion of tubes. Wire drawing methods and variables in wire-drawing, Optimum dies shape for extrusion and drawing. Brief introduction to sheet metal working: Bending, Forming and Deep drawing, shearing. Brief introduction to explosive forming, coating and deposition methods.

BOOKS

[1] Manufacturing technology by P.N.Rao, Tata McGraw Hill publication.
[2] Welding Technology by R.A. Little, TMH
[3] Manufacturing Science by A.Ghosh and A K Malick, EWP

[4] Fundamentals of metal casting technology by P.C. Mukherjee, Oxford PIBI.

[5] Mechanical Metallurgy by Dieter, Mc-Graw Hill
[6] Processes and Materials of Manufacture by R.A Lindberg, Prentice hall (India)
[7] A Text Book of Production Engineering by P.C.Sharma, S.Chand.

Digital Learning Resources:

NPTEL MOOCs:

Course Name:	Fundamentals of Manufacturing Processes
Course Link:	https://nptel.ac.in/courses/108/102/108102047/
Course Instructor:	Prof. D K Dwivedi, IIT Roorkee

5th Semester

PC 12: Mechanisms and Machines

MODULE – I **(12 HOURS)**

Mechanisms with lower pairs : Motor Vehicle Steering Gears - Davis Steering Gear &Ackermann Steering Gear, Hooke's Joint.
Cams Design: Fundamental law of Cam, Cam Terminology, Classification of Cams and followers, Analysis of follower motions (Displacement, velocity, Acceleration and jerk) – Simple Harmonic, Uniform Velocity and Constant Acceleration & Retardation Types, Generation of Cam Profiles by Graphical Method, Introduction on Cams with specified contours.
Turning Moment Diagram and Flywheel: Turning moment diagram. Turning moment diagrams for different types of engines, Fluctuation of energy and fluctuation of speed. Dynamic. Theory of Flywheel, Flywheel of an internal combustion engine and for a punch machine. Determination of flywheel size from Turning Moment Diagram.

MODULE II **(8 HOURS)**

Mechanism for Control (Governors): Governors - Watt, Porter, Proell, Hartnell, Wilson-Hartnell Governor. Performance parameters: Sensitiveness, Stability, Hunting, Isochronism. Governor Effort and Power, Controlling Force & Controlling Force Curve, Friction & insensitiveness, Comparison between governor and flywheel.
Mechanism for Control (Gyroscope): Introduction to Gyroscopes. Gyroscopic forces and Couple. Effect of Gyroscopic Couple on Aeroplanes, Gyroscopic stabilization of ship, Stability of Two Wheelers and Four Wheelers. Rigid disc at an angle fixed to rotating shaft.

MODULE III **(12 HOURS)**

Balancing of rotating components and linkages:
Static and Dynamic Balancing, Balancing of Single Rotating Mass by Balancing Masses in Same plane and in Different planes. Balancing of Several Rotating Masses rotating in same plane and in Different planes. Effect of Inertia Force due to Reciprocating Mass on Engine

Frame, Partial balance of single cylinder engines. Primary andSecondary Balance of Multi-cylinder In-line Engines. Balancing of locomotive: variation of tractiveforce, swaying couple, hammer blow. Direct and Reverse Crank method of balancing for radialengines. Balancing of V-engine. Balancing machines: Pivoted-Cradle Balancing Machine.

Vibrations: Introduction to Mechanical Vibration – Definitions, elements of vibratory system, Longitudinal, Torsional & Transverse Systems. Determination of natural frequency of vibratory systems using energy method, equilibrium method and Rayleigh's method, Free and Forced Vibration of Un-damped and Damped Single Degree Freedom Systems, Logarithmic decrement, Magnification factor, Vibration isolation and transmissibility, whirling of shafts and Evaluation of Critical Speeds of shafts.

BOOKS

[1] Theory of Machines by S.S.Rattan, Tata Mac Graw Hill
[2] Theory of Machines and Mechanisms (India Edition) by John J. Uicker Jr., Gordon R. Pennock and Joseph E. Shigley, Oxford University Press
[3] Mechanism and Machine Theory by J.S.Rao and R.V.Dukipatti, New Age International.
[4] Theory of Mechanisms and Machines by A. Ghosh & A. K. Mallick, East West Press.

[5] Theory of Machines by Thomas Bevan, CBS Publications.
[6] Kinematics and Dynamics of Machinery by R.L.Norton, Tata MacGraw Hill
[7] Kinematics & Dynamics of Machinery-Charles E. Wilson &J.PeterSaddler,Pearson Ed.
[8] Theory of Mechanisms and Machines by C.S.Sharma and K.Purohit, PHI
[9] Theory of Machines by Shah Jadwani, Dhanpat Rai
[10] Theory of Machines by Abdulla Shariff, Dhanpat Rai
[11] Theory of Machines by Sadhu Singh, Pearson Education.

5th Semester

PC 13:Heat Transfer

MODULE-I **(12 HOURS)**

Introduction:
Modes of heat transfer: conduction, convection, and radiation ,Mechanism & basic laws governing conduction, convection, and radiation heat transfer; Thermal conductivity, Thermal conductance &Thermal resistance, Contact resistance, convective heat transfer coefficient, radiation heat transfer coefficient , Electrical analogy, combined modes of heat transfer. Initial conditions *and* Boundary conditions of 1st, 2nd and 3rd Kind.

Heat Conduction:
The General heat conduction in Cartesian, polar-cylindrical and polar-spherical coordinates, Simplification of the general equation for one and two dimensional steady transient conduction with constant/ variable thermal conductivity with / without heat generation. Solution of the one dimensional steady state heat conduction problem in case of plane walls, cylinders and spheres for simple and composite cases. Critical insulation thickness, Heat transfer in extended surfaces (pin fins) without heat generation, Long fin, short fin with

insulated tip and without insulated tip and fin connected between two heat sources. Fin efficiency and fin effectiveness. Conduction in solids with negligible internal temperature gradient (Lumped heat analysis).

MODULE-II (12 HOURS)

Convective Heat Transfer:
Introduction to convective flow - forced and free. Dimensional analysis of forced and free connective heat transfer. Application of dimensional analysis, physical significance of Grashoff , Reynolds, Prandtl, Nusselt and Stanton numbers. Conservation equations for mass, momentum and energy for 2-dimensional convective heat transfer in case of incompressible flow, Hydrodynamic and thermal boundary layers for flow over a flat plate. Critical Reynolds number; general expressions for drag coefficient and drag force Reynolds- Colbourn analogy. Thermal boundary layer; general expression for local heat transfer coefficient; Average heat transfer Coefficient; Nusselt number. Flow inside a duct- velocity boundary layer, hydrodynamic entrance length and hydrodynamically developed flow; flow through tubes (internal flow). Use of empirical relations for solving turbulent conditions for external and internal flow. Mechanism of heat transfer during natural convection, Experimental heat transfer correlations for natural convection in the following cases(a) Vertical and horizontal plates(b) Inside and outside flows in case of tubes

Module-III (8 HOURS)

Radiative heat exchange :
Introduction, Radiation properties, definitions of various terms used in radiation heat transfer; Absorptivity, reflectivity & transmissivity. Emissive power & emissivity, Kirchoff'sidentity, Planck's relation for monochromatic emissive power of a black body, Derivation of Stefan-Boltzmann law and Wien's displacement law from Planck's relation, Radiation shape factor, Relation for shape factor and shape factor algebra. Heat exchange between blackbodies through non-absorbing medium. Gray bodies and real bodies, Heat exchange between gray bodies. Radiosity and Irradiation, Electrical analogy and radiation network for 2-body and 3-body radiations exchange in non-absorbing medium, Radiation shields.

Module-IV (8 HOURS)

Heat transfer for boiling liquids and condensing vapours :
Types of condensation, use of correlations for condensation on vertical flat surfaces, horizontal tube and; regimes of pool boiling, pool boiling correlations. Critical heat flux, concept of forced boiling. Numerical problems.
Heat Exchangers :
Introduction, Types of heat exchanger, The overall heat transfer coefficient and fouling factors, LMTD and _ - NTU analysis of heat exchangers.

Books :

[1] Heat Transfer Incropera and Dewitt, Willey publications
[2] Heat Transfer :J.P.Holman, TMH Publications
[3] Heat Transfer: P.S.Ghosdastidar, Oxford University Press
[4]Fundamentals of Engineering Heat and Mass Transfer: R.C.Sachdeva, New Age InternationalPublishers, 4th Edition

[5] Heat Transfer by P.K. Nag, TMH
[6] Heat Transfer by S.P. Sukhatme, TMH
[7] Heat Transfer: A.F.Mills and V.Ganesan, Pearson Education, 2nd Edition
[8] Heat and Mass Transfer: Domkundwar and Arora, Danpatrai and sons
[9] Heat Transfer : R. K. Rajput, Laxmi Publications
[10] Heat and Mass Transfer: A Practical Approach, Y.A.Cengel, Tata Macgraw Hills Education Private Limited

Digital Learning Resources:

NPTEL MOOCs:

Course Name:	Heat Transfer
Course Link:	https://nptel.ac.in/courses/103/105/103105140/
Course Instructor:	Prof. Sunando Dasgupta, IIT Kharagpur
Course Name:	Fundamentals of Convective Heat Transfer
Course Link:	https://swayam.gov.in/nd1_noc20_me81/preview
Course Instructor:	Prof. AmareshDalal, IIT Guwahati

5th Semester

PE 2: Automobile Engineering

MODULE I **(14 HOURS)**

Introduction
Main units of automobile chassis and body, different systems of the automobile, description of themain parts of the engine, motor vehicle act.
Power for Propulsion
Resistance to motion, rolling resistance, air resistance, gradient resistance, power required for propulsion, tractive effort and traction, road performance curves.

Breaking systems
Hydraulic breaking system, breaking of vehicles when applied to rear, front and all four wheel,theory of internal shoe brake, design of brake lining and brake drum, different arrangement ofbrake shoes, servo and power brakes.

MODULE II **(12 HOURS)**

Transmission Systems
Layout of the transmission system, main function of the different components of the transmission system, transmission system for two wheel and four-wheel drives. Hotchkiss and torque tube drives.
Gear box Sliding mesh, constant mesh and synchromesh gearbox, design of 3 speed and 4 speed gear box, over drive, torque converter, semi and fully automatic transmission.

Hookes joint, propeller shaft, differential, rear axles, types of rear axles, semi floating, there quarter floating and full floating types.

MODULE III **(14 HOURS)**

Front wheel Geometry and steering systems: Camber, castor, kingpin inclination, toe-in and toe out, centre point steering condition for true rolling, components of steering mechanism, power steering.

Electrical System of an Automobile: Starting system, charging system, ignition system, other electrical system.

Electrical vehicles:

History, electrical vehicles and the environment pollution, description of electric vehicle, operational advantages, present EV performance and applications, battery for EV, Battery types and fuel cells, Solar powered vehicles, hybrid vehicles.

BOOKS :

[1] Automobile Mechanics ,N.K.Giri, Khanna publishers
[2] Automobile Engineering, K.M. Gupta, VolI& II, Umesh Publication
[3] Automotive mechanics: William h. Crouse and Donald L. Anglin, TMH
[4] The motor vehicle, Newton and Steeds
[5] Automobile Mechanics, J. Heitner, East West Press
[6] Automobile Engineering, Jain and Asthana, Tata McGraw Hill
[7] Automobile Engineering, K.K.Ramalingam, Scitech
[8] Automobile Engineering, Vol. I & II, Kirpal Singh, Standard Publications
[9] A Text Book of Automobile Engineering, R.K.Rajput, Laxmi Publishers

5th Semester

PE 2: CAD/CAM

MODULE – I **(14 HOURS)**

Fundamentals of CAD: Design process, Applications of computer for design, Creating the Manufacturing Database, The Design workstation, Graphical Terminal, Operator input Devices, Plotters and other devices, Central Processing Unit, Memory types.

MODULE – II **(14 HOURS)**

Computer graphics Software and Database: Configuration, Graphics Packages, Constructing the Geometry, Transformations of geometry, Database structure and content, Wire frame versus solid modeling, Constraint– Based modeling, Geometric commands, Display control commands, Editing.

MODULE III **(14 HOUR)**

CAM - Numerical Control and NC Part Programming: Numerical Control, Numerical Control elements, NC Coordinate system, NC motion control system, Manual and Computer Aided programming, the APT language, Miscellaneous Functions, M, Advanced part-programming methods. Problems with conventional NC, NC technology: CNC, DNC, Combined DNC/ CNC system, Adaptive control manufacturing systems, Computer Integrated Manufacturing system, Machine Tools and related equipment, Materials Handling system: AGV, Robots, Lean manufacturing.

BOOKS :

[1] CAD/CAM Computer Aided Design and Manufacturing, M.P.Goover and E.W.Zimmers, Jr.,Pearson.
[2] CAD & CAM, J Srinivas, Oxford University Press.

[2] CAD/CAM Theory and Practice, Zeid and Subramanian, TMH
[3] CAD/CAM Principles, Practice and Manufacturing Management, McMahon and Browne, Pearson Education
[4] CAD/CAM Concepts and Applications, C.R.Alavala, PHI
[5] Computer Aided Design and Manufacturing, Lalit Narayan, Mallkarjuna Rao and Sarcar, PHI
[6] CAD/CAM Theory and Conepts, K.Sareen and C.Grewal, S.Chand Publication
[7] CAD/CAM/CAE, N.K.Chougule, Scitech

5th Semester

PE 2: Tribology

MODULE - I **(12 HOURS)**

Introduction : Lubricant and lubrication, Types of bearings, properties and testing of lubricants,Basic equations: Generalized Reynolds equation, Flow and Shear Stress, Energy equation, Equationof stateHydro dynamic lubrication :Mechanism of pressure development and load carrying capacity, Plane-slider bearing, Idealizedslider bearing with a pivoted shoe, Step bearing, Idealized journal bearing. – infinitely long journalbearing, Petroffs equation for a lightly loaded bearing, narrow bearing,

MODULE - II **(11 HOURS)**

Oil flow and thermal equilibrium - Heat balance of lubricantsHydrostatic Bearing **:**Principles, Component of hydrostatic lubrication , Hydrostatic circular thrust bearing , calculationof pressure, load carrying capacity, flow rate , power loss in bearing due to friction.

MODULE - III **(12 HOURS)**

Concept of gas lubricated bearingConcept of Elastohydrodynamic lubrication, Design and selection of antifiction bearingFriction and wear of metals :Theories of friction, surface

contaminants, Effect of sliding speed on friction, classification andmechanism of wear, Wear resistant materials.

BOOKS :

[1] Introduction to Tribology of Bearing , B.C .Majumdar , S. Chand & Co
[2] Fundamentals of Tribiology , Basu S K., Sengupta A N., Ahuja B. B., , PHI 2006
[3] Basic Lubrication theory, A. Cameron, John Wiley & sons
[4] Lubrication Fundamentals, D.M.Pirro and A.A.Wessol, CRC Press
[5] Theory and Practice of Lubrication for Engineers**,** Fuller, D., New York company 1998
[6] Principles and Applications of Tribiology**,** Moore, Pergamaon press 1998
[7] Tribiology in Industries**,** Srivastava S., S Chand and Company limited, Delhi 2002
[8] Lubrication of bearings – Theoretical Principles and Design**,** Redzimovskay E I., Oxford press company 2000

5th Semester

PE3: Non-Conventional Energy Sources

MODULE I (6 CLASSES)

Energy, Ecology and environment: Introduction, Classification of Energy Resources,Common Forms of Energy, Energy Chain, Advantages and Disadvantages of ConventionalEnergy Sources, Importance and Salient Features of Non-Conventional Energy Sources,Environmental and ecological Aspects of Energy use, Environment-Economy-Energy andSustainable Development, World Energy Status, Energy Scenario in India.Energy Conservation and Energy Storage: Salient Features of "Energy Conservation Act,2001", Various Aspects of Energy Conservation, Principles of Energy Conservation, GeneralElectrical ECO's (Energy Conservation Opportunities)

MODULE II (15 CLASSES)

Solar Energy: Basics, The Sun as a Source of Energy, Sun, Earth Radiation Spectrums,Extraterrestrial and Terrestrial Radiations, Spectral Energy Distribution of Solar Radiation,Depletion of Solar Radiation, Measurements of Solar Radiation, Solar Time (Local Apparent
Time), Solar Radiation Geometry, Solar Day Length, Empirical Equations for EstimatingSolar Radiation(Hourly Global, Diffuse and Beam Radiations) on Horizontal Surface Under
loudless and Cloudy Skies, Solar Radiation on Inclined Plane Surface only (empiricalrelations for numerical). Solar Thermal Systems: Solar Collectors: Flat plate and concentric collectors, Solar WaterHeater, Solar Passive Space - Heating and Cooling Systems, Solar Refrigeration and Air-Conditioning Systems, Solar Cookers, Solar Furnaces, Solar Green House, Solar Dryer, SolarDistillation (or Desalination of Water), Solar Photovoltaic Systems: Solar CellFundamentals, Solar Cell Characteristics, Solar Cell Classification, Solar Cell, Module, Paneland Array Construction, Solar PV Systems, Solar PV Applications.

MODULE III **(08 CLASSES)**

Wind Energy: Origin of Winds, Nature of Winds, Wind Turbine Siting, Major Applications ofWind Power, Wind Turbine Types and Their Construction, Wind Energy ConversionSystems (WECS), Effects of Wind Speed and Grid Condition (System Integration),Biomass Energy: Photosynthesis Process, Usable Forms of Biomass, their Composition andFuel Properties, Biomass Resources , Biomass Conversion Technologies, Urban Waste toEnergy Conversion, Biomass Gasification ,Biomass Liquefaction, Biomass to EthanolProduction, Biogas Production from Waste Biomass, Energy Farming.

MODULE IV **(08 CLASSES)**

Geothermal Energy: Applications, Origin and Distribution of Geothermal Energy, Types of Geothermal Resource.Ocean Energy: Tidal Energy, Wave Energy, Ocean Thermal Energy Fuel Cell Technology: Types, Principle of operation, Advantages and disadvantages.

BOOKS:

[1] Solar Energy Technology: Sukhatme and Nayak, TMH
[2] Renewable Energy Sources and Emerging Technology: D.P.Kothari and etal., PHI
[3] Renewable Energy Sources & Conversion Technology: N.K.Bansal, Manfred Kleenman&Michael Meliss, TMH Publication.
[4] Non Conventional Energy Sources: B.M Khan, TMH Publications
[5] Renewable Energy Sources:Fundamentals & Applications:G.N.Tiwari&M.K.Ghosal, NarosaPub
[6] Non-Conventional Energy Resources: D.S. Chauhan and S.K.Srivastava, New Age International
[7] Non-Conventional Energy Sources: H.P.Garg
[8] Non-Conventional Energy Systems: G.D.Rai, Khanna publications
[9] Renewable Energy, Godfrey Boyle, Oxford University Press

Digital Learning Resources:

NPTEL MOOCs:

Course Name:	Solar Energy Engineering and Technology
Course Link:	https://swayam.gov.in/nd1_noc20_ph14/preview
Course Instructor:	Prof. P Kalita, IIT, Guwahati.

5th Semester

PE 3: Rapid Manufacturing Process

MODULE – I **(14 HOURS)**

Product Development: Classification of manufacturing processes, Different manufacturing systems, Introduction to rapid Prototyping (RP), Need of RP in context to batch production, FMS and CIMand its application. Product prototyping – solid modeling and prototype representation, reverse engineering, prototyping and manufacturing using CNC machining. Basic principles of RP steps in RP, Process chain in RP in integrated CAD-CAM environment, Advantages of RP

MODULE – II **(14 HOURS)**

Rapid Manufacturing Process Optimization: factors influencing accuracy. Data preparation errors,Part building errors, Error in finishing, influence of build orientation. Classification of different RPtechniques based on raw materials, layering technique (2D or 3D) and energy sources.Process technology and comparative study of stereo lithography (SL) with photopolymerisation, SLwith liquid thermal polymerization, solid foil polymerization, selective laser sintering, selective powder binding, Ballastic particle manufacturing – both 2D and 3D, Fused deposition modeling, Shape melting

MODULE – III **(16 HOURS)**

Laminated object manufacturing solid ground curing, Repetitive masking and deposition. Beam interference solidification, Holographic interference solidification special topic on RP using metallic alloys, Programming in RP modelling, Slicing, Internal Hatching, Surface skin films, support structure. Software for RP: STL files, Overview of Solid view, magics, imics, magic communicator, etc. Internet based software, Collaboration tools.

BOOKS :

[1] Rapid Prototyping and Engineering Applications, Frank W. Liou, CRC Press
[2] Introduction to Rapid Prototyping, Amitav Ghosh, North West Publication, New Delhi.
[3] Rapid Manufacturing, Flham D.T &Dinjoy S.S Verlog London 2001. \
[4] Rapid Prototyping Materials, Gurumurthi, IISc Bangalore.
[5] Rapid Automated, Lament wood. Indus press New York
[6] Stereo Lithography and other RP & M Technologies**,** Paul F. Jacobs: SME, NY 1996

Digital Learning Resources:

Course Name:	Rapid Manufacturing
Course Link:	https://nptel.ac.in/courses/112/102/112102284/
Course Instructor:	Prof. J Ramkumar, Prof Amardeep Singh, IIT Kanpur

5th Semester

PE 3: Finite Element Methods in Engineering

MODULE – I **(12 HOURS)**

Review of 2-D and 3-D stress analyses, vibration, fluid flow and heat conduction problems. FEM fundamental concepts, Variational principles, Rayleigh Ritz and Galerkin Methods. Finite Element Modeling of one dimensional problems. Finite Element Analysis of 2-D and 3-D framed structures.

MODULE – II **(12 HOURS)**

FEM formulation of 2-D and 3-D stress analysis problems. Axisymmetric solids subjected to axisymmetric loadings. Two-dimensional isoparametric elements and numerical integration.

MODULE – III **(12 HOURS)**

FE modeling of basic vibration problemsFinite element modeling of fluid flow and heat conduction problems Computer programs: preprocessing and post processing.Exposure to commercial FE codes such as ANSYS, NASTRAN and IDEAS etc.

TEXT BOOKS:

[1] Finite Elements in Engineering, T.R.Chandraputla and A.D.Belegundu, PHI
[2] The Finite Element Method – Its Basis & Fundamentals, Zienkiewicz, Taylor and Zhu, Elsevier, 6th Edn

[3] Introduction to Finite Element Method, C.Desai and J.F.Abel, CBS publishers
[4] Introduction to Finite Element Method, J.N.Reddy, Tata McGraw Hill
[5] Numerical Methods in Finite Element Analysis, K.J.Bathe and E.L.Wilson, PHI
[6] Concepts & Applications of Finite Element Analysis,Cook, D.S.Malkus&M.E.Plesha, Wiley
[7] The Finite Element Method in Engineering, S.S.Rao, Elsevier
[8] A First Course in the Finite Element Method, D.L.Logan, Cengage Learning
[9] Fundamentals of Finite Element Analysis, David V. Hutton, Tata McGraw Hill

Digital Learning Resources:

Course Name:	Basics Of Finite Element Analysis-I
Course Link:	https://nptel.ac.in/courses/112/104/112104193/
Course Instructor:	Prof. Nachikata Tiwari, IIT Kanpur

5th Semester

PC14: Basic Manufacturing Processes Lab

LIST OF EXPERIMENTS:

[1] Determination of grain size, clay content, permeability and green compressive strength of Moulding sand. (2 to 3 experiments)
[2] Foundry Practices
[3] Preparation of a wood pattern.
[4] Determination of strength of brazed and solder joints
[5] Practice and preparation of job in TIG/MIG welding
[6] Practice and preparation of job in sheet metal using processes like forming and deep drawing.
[7] Demonstration of different rolling mills
[8] Demonstration of Extrusion processes

5th Semester

PC15: Mechanisms and Machines Lab

LIST OF EXPERIMENTS:

[1] Design of any one working model related to Mechanisms and Machines, Module I &II.
[2] Design of any one working model related to Mechanisms and Machine, Module III &IV.
[3] Determination of gyroscopic couple using gyroscopic test rig.
[4] Performance characteristics of a spring loaded governor
[5] Determination of critical speed of rotating shaft
[6] Experiment on static and dynamic balancing apparatus
[7] Determination of natural frequencies of un-damped as well as damped vibratingsystems.
[8] Study of interference and undercutting for gear drives
[9] Experiment on Cam Analysis Apparatus.
[10] Experiment on evaluation of damping in a vibrating system

5th Semester

PC16: Heat Transfer Lab

LIST OF EXPERIMENTS:

[1] Determination of Thermal conductivity of composite slab
[2] Determination of heat transfer coefficient in natural/forced convention.
[3] Determination of surface emissivity
[4] Performance test on parallel flow and counter flow heat exchanger
[5] Efficiency and effectiveness of fins (Natural / Forced convection)
[6] Determination of Critical heat flux during boiling heat transfer.
[7] Verification of Stefan Boltzman's law.

BIJU PATNAIK UNIVERSITY OF TECHNOLOGY, ODISHA

ROURKELA

Curriculum and Syllabus

B. Tech (*Mechanical Engineering*) from the Admission Batch

2018-19

Semester (6th)

Sixth Semester							
Theory							
Sl. No.	**Category**	**Course Code**	**Course Title**	**L-T-P**	**Credit**	**University Marks**	**Internal Evaluation**
1	PC	RME6C001	Design of Machine Elements	3-0-0	3	100	50
2	PC	RME6C002	Machining Science and Technology	3-0-0	3	100	50
3	BS		Optimization in Engineering	3-0-0	3	100	50
4	PE	RME6D001	Smart and Composite Materials	3-0-0	3	100	50
		RME6D002	Compressible Flow and Gas Dynamics	3-0-0			
		RME6D003	Computer Integrated Manufacturing and FMS	3-0-0			
5	OE		Artificial Intelligence and Machine Learning	3-0-0	3	100	50
			Electrical Energy Conservation and Auditing	3-0-0			
			Control System	3-0-0			
6	MC*	RIK6F001	Essence of Indian Knowledge Tradition - I	3-0-0	0	-	100 (Pass mark is 37)
Total Credit (Theory)					**15**		
Total Marks						**500**	**250**
Practical							
1	PC	RME6C201	Design of Machine Elements Lab	0-0-3	2		100
2	PC	RME6C202	Machining Science and Technology Lab	0-0-3	2		100
3	PSI		Future Ready Contributor Program	0-0-3	2		100
4	PSI		Seminar - I	0-0-3	1		100
Total Credit (Practical)					**7**		
Total Semester Credit					**22**		
Total Marks							**400**
SUMMER INTERNSHIP TRAINING FOR 45 DAYS							

***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.**

6th Semester	RME6C001	Design of Machine Elements	L-T-P 3-0-0	3 Credits

Module - I **(10 Lectures)**

1. Mechanical engineering design: Introduction to design procedure, Stages in design, Code andStandardization, Interchangeability, Preferred numbers, Fits and Tolerances, Engineeringmaterials: Ferrous, Non-ferrous, Non-metals, design requirements – properties of materials,Material selection, Use of Data books.

2. Fundamentals of Machine Design: Types of load, Modes of failure, factor of safety concepts,Theories of Failure, concept and mitigation of stress concentration, Fatigue failure and curve,endurance limit and factors affecting it, Notch sensitivity, Goodman, Gerber and Soderberg criteria.

Module – II **(08 Lectures)**

3. Machine Element Design: Design of Joints: Rivets, welds and threaded fasteners based on different types of loading, Boiler joints, cotter joints and knuckle joints.

Module – III **(10 Lectures)**

4. Design of Keys, Shaft and Couplings: Classification of keys and pins, Design of keys and pins, Theories of failure, Design of shafts: based on strength, torsional rigidity and fluctuating load, ASME code for shaft design, Design of couplings: Rigid coupling, Flexible coupling.

5. Design of Mechanical Springs: Types of helical springs, Design of Helical springs, bulking of spring, spring surge, end condition of springs, Design of leaf springs: nipping.

Module – IV **(08 Lectures)**

6. Bearings: Types and selection of ball and roller bearings, Dynamic and static load ratings, Bearing life, Design of sliding contact bearings, Journal bearing, foot step bearing.

Books:

1. Design of Machine Elements, V.B. Bhandari, Tata McGraw Hill
2. Mechanical Engineering Design, J.E.Shigley, C.R.Mischke, R.G.Budynas and K.J.Nisbett, TMH
3. Machine Design, Pandya and Shah, Charotar Book Stall
4. Fundamentals of Machine Component Design by R.C.Juvinall and K.M.Marshek, John Wiley & Sons.
5. Machine Drawing by N.Sidheswar, McGraw-Hill
6. Machine Design, P.C.Sharma and D.K.Agrawal, S.K.Kataria& Sons
7. Machine Design, P. Kanaiah, Scietech Publications
8. Machine Design, Robert L. Norton, Pearson Education Asia.
9. Design of Machine Elements by C. S. Sharma and K. Purohit, PHI

DESIGN DATA HAND BOOKS:

1. Design Hand Book by S.M.Jalaluddin, Anuradha Agencies Publications
2. P.S.G. Design Data Hand Book, PSG College of Tech Coimbature
2. Design Data Hand Book, K. Lingaiah, McGraw Hill, 2nd Ed. 2003.
3. Design Data Hand Book by K.Mahadevan and B.Reddy,CBS Publishers

6th Semester	RME6C002	Machining Science and Technology	L-T-P 3-0-0	3 Credits

MODULE – I **(13 HOURS)**

Geometry of cutting tools in ASA and ORS, Effect of Geometrical parameters on cutting force andsurface finish, Mechanics of chip formation, Merchant's theory, Force relationship and velocityrelationship, Cutting tool materials. Types of Tool Wear: Flank wear, Crater wear, Wearmeasurement, Cutting fluid and its effect; Machinability Criteria, Tool life and Taylor's equation,Effect of variables on tool life and surface finish, Measurement of cutting force, Lathe tooldynamometer, Drill tool dynamometer. Economics of machining.

MODULE II **(13 HOURS)**

Conventional machining process and machine tools – Turning, Drilling, Shaping, Planning, Milling,Grinding. Machine tools used for these processes, their specifications and various techniques used.Principles of machine tools : Kinematics of machine tools, speed transmission from motor to spindle, speed reversal mechanism, mechanism for feed motion, Tool holding and job holding methods indifferent Machine tools, Types of surface generated, Indexing mechanism and thread cuttingmechanism, Quick return mechanism

Production Machine tools – Capstan and turret lathes, single spindle and multi spindlesemiautomatics, Gear shaper and Gear hobbing machines, Copying lathe and transfer machine

MODULE III **(10 HOURS)**

Non-traditional Machining processes :

Ultrasonic Machining, Laser Beam Machining, Plasma Arc Machining, Electro Chemical Machining,Electro Discharge Machining, Wire EDM , Abrasive Jet Machining

Books :

3. Fundamentals of Machining and Machine Tools, G.Boothroyd and W.A.Knight, CRC Press
2. Metal Cutting Principles, M.C.Shaw, Oxford University Press
1. Metal Cutting Theory and Practice, A.Bhattacharya, Central Book Publishers
4. Manufacturing Technology – by P.N.Rao, Tata McGraw Hill publication.
5. Modern Manufacturing Processes, P.C.Pandey, H.S.Shan, Tata McGraw Hill
6. Manufacturing Science, Ghosh and Mallik, East West Press.
7. Metal Cutting Theory and Practice, D.A.Stephenson and J.S.Agapiou, CRC Press
8. Machining Technology; Machine Tools and Operation, H.A.Youssef and H. El-Hofy, CRC Press
9. Machine Tools and Manufacturing Technology, Krar, Rapisarda and Check, Cengage Learning
10. Technology of Machine Tools, Krar, Gill and Smidt, Tata McGraw Hill
11. Principles of Metal Cutting, G.Kuppuswamy, Universities Press
12. Metal Cutting and Machne Tools, G.T.Reddy, Scitech
13. Fundamentals of tool Engineering Design, S.K.Basu, S.K.Mukherjee, R. Mishra , Oxford & IBH Pub Co.
14. Machine Tools, R.N.Datta, New Central Book Agency

Course Name: Machining Science

Course Lik: https://onlinecourses.nptel.ac.in/noc21_me39/preview

Course Instructor: Prof. Sounak Kumar Choudhury, IIT Kanpur

Course Name: Mechanics of Machining

Course Lik: https://onlinecourses.nptel.ac.in/noc21_me29/preview

Course Instructor: Prof. Uday S. Dixit, IIT Guwahati.

6th Semester		Optimization in Engineering	L-T-P 3-0-0	3 Credits

Module I: **(10 Hours)**

Idea of Engineering optimization problems, Classification of optimizationalgorithms, modeling of problems and principle of modeling. Linear Programming:Formulation of LPP, Graphical solution, Simplex method, Big-M method, Revised simplex method, Duality theory and its application, Dual simplex method , Sensitivity analysis in linear programming.

Module II: **(10 Hours)**

Transportation problems:Finding an initial basic feasible solution by NorthwestCorner rule, Least Cost rule, Vogel's approximation method, Degeneracy, Optimalitytest, MODI method, Stepping stone method. **Assignment problems:** Hungarian method for solution of Assignment problems. Integer Programming: Branch and Bound algorithm for solution of integer programming problems.

Module III: **(12 Hours)**

Non-linear programming: Introduction to non-linear programming. Unconstraintoptimization: Fibonacci and Golden Section Search method. Constrained optimization with equality constraint: Lagrange multiplier, Projected gradient method. Constrained optimization with inequality constraint: Kuhn-Tucker condition, Quadratic programming.

Module IV: **(6 Hours)**

Queuing models: General characteristics, Markovian queuing model, M/M/1model, Limited queue capacity, multiple server, Finite sources, Queue discipline.

Books:

[1] Operations Research- Principle and Practice, A. Ravindran, D. T. Philips, J. Solberg, Second edition, Wiley India Pvt Ltd.
[2] Operation Research, Prabhakar Pai ,Oxford University Press
[3] Optimization for Engineering Design, Kalyanmoy Deb, PHI Learning Pvt Ltd.
[2] Operations Research, H.A.Taha, A.M.Natarajan, P.Balasubramanie, A.Tamilarasi, Pearson Education, Eighth Edition.
[5] Engineering Optimization, S S Rao, New Age International Pvt Ltd, 2003.
[6] Linear and Non-linear Optimization, **S**tephen G. Nash, A. Sofer, McGraw Hill, 2nd Edition.
[7] Engineering Optimization, A.Ravindran, K.M.Ragsdell, G.V.Reklaitis, Wiley India Pvt. Ltd, Second edition.
[3] Operations Research, F.S.Hiller, G.J.Lieberman, Tata McGraw Hill, Eighth Edition, 2005.
[9] Operations Research, P.K.Gupta, D.S.Hira, S.Chand and Company Ltd, 2014.

Digital Learning Resources:

Course Name:	Foundations of Optimization
Course Link:	https://nptel.ac.in/courses/111/104/111104071/
Course Instructor:	Dr. Joydeep Dutta, IIT Kanpur

6th Semester	RME6D001	Smart and Composite Materials	L-T-P 3-0-0	3 Credits

MODULE I (7 HOURS)

Introduction: definitions and classifications; natural composites; role of matrix and reinforcement; factors which determine properties; the benefits of composites.

Reinforcements and the reinforcement matrix interface: natural fibers; synthetic organic fibers – aramid, polyethylene; and synthetic inorganic fibers – glass, alumina, boron, carbon, silicon based fibers; particulate and whisker reinforcements, reinforcement-matrix interface – wettability, interfacial bonding, methods for measuring bond strength.

MODULE II (8 HOURS)

Metal matrix composites: Introduction, important metallic matrices; metal matrix composite processing: solid state processing – diffusion bonding, powder metallurgy; liquid state processing – melt stirring, compocasting (rheocasting), squeeze casting, liquid infiltration under gas pressure; deposition – spray co-deposition and other deposition techniques like CVD and PVD; in situ processes. Interface reactions. Properties of MMCs – physical properties; mechanical properties like elastic properties, room temperature strength and ductility, properties at elevated temperatures, fatigue resistance. Processing, structure of multifilamentary superconductors, properties of aluminium reinforced with silicon carbide particles

MODULE III (7 HOURS)

Ceramic matrix composites: Introduction; processing and structure of monolithic materials – technical ceramics, glass-ceramics. Processing of ceramics: conventional mixing and pressing – cold pressing and sintering, hot pressing, reaction bonding processes, techniques involving slurries, liquid state processing – matrix transfer moulding, liquid infiltration, sol-gel processing, vapour deposition techniques like CVD, CVI, liquid phase sintering, lanxide process and in situ processes. Processing, properties and applications of alumina matrix composites - SiC whisker reinforced, zirconia toughened alumina; Glass-ceramic matrix composites; Carbon-carbon composites - porous carbon-carbon composites, dense carbon-carbon composites.

MODULE IV (6 HOURS)

Polymer matrix composites: Introduction; polymer matrices – thermosetting, thermoplastic, rubbers. Processing of PMCs: Hand methods – hand lay-up, spray-up methods; Moulding methods – matched die moulding, bag moulding processes (autoclave moulding), resin transfer moulding, pultrusion; Filament winding; Injection moulding. Processing, properties and applications of fibre-reinforced epoxies, PEEK matrix composites, rubber matrix composites. Damping characteristics. Environmental effects in polymer matrix composites. Recycling of PMCs.

MODULE V (8 HOURS)

Sandwich structures, foam core type arrangements; Honey comb structures. Micromechanics of unidirectional composites: micromechanics models for stiffness – longitudinal stiffness, transverse stiffness, shear modulus, poisson's ratio. Micromechanics models for strength – longitudinal tensile strength, longitudinal compressive strength, transverse tensile strength, transverse compressive strength, inplane shear failure, thermal and moisture effects. Short fibre composites: reasons for using short fibre composites, fibre length, fibre orientation, stress and strain distribution at fibres, critical fibre length and average fibre stress, stiffness and strength: stiffness of aligned systems, non-aligned systems and variable fibre orientation, strength of aligned systems, 2-D composites, variable fibre orientation.

Books:

[1] Composite Materials: Engineering and Science, by Matthews and Rawlings, CRC Press.

[2] An Introduction to composite material, by D.Hull and T.W. Clyne, Cambridge University press.

[3] Metal Matrix Composites, Thermomechanical Behaviour by M.Taya, and R.J.Arsenault, Pergamon Press, Oxford.

[4] Fundamentals of Metal Matrix Composites by S.Suresh, A.Martensen, and A.Needleman, Butterworth, Heinemann

[5] Mechanics of composite materials, R. M. Jones, Mc Graw Hill Book Co.

[6] Mechanics of composite materials and structures, M Mukhopadhay, Universities Press.

[7] Fiber-Reinforced composite materials, Manufacturing & Design, P. K. Mallick, Marcel Dekken, Inc. New York & Basel.
[8] F.L. Matthews and R.D. Rawlings, Composite Materials: Engineering and Science, Chapman Hall, London, 1994.
[9] Weinheim, Structure and Properties of Composites, Materials ScienceTechnology, Vol. 13, VCH, Germany, 1993.

Digital learning Resources:

CourseName:	Introduction to Composites
CourseLink:	https://nptel.ac.in/courses/112/104/112104229/
CourseInstructor:	Dr Nachiketa Tiwari, IITKanpur

Course Name:	Processing of nonmetals
Course Link:	https://nptel.ac.in/courses/112/107/112107086/
Course Instructor:	Dr Indradeep Singh, IIT Roorkee

6th Semester	RME6D002	Compressible Flow and Gas Dynamics	L-T-P 3-0-0	3 Credits

Module I: (9 hours)
Fundamentals of Fluid dynamics and Thermodynamics: continuity equation, Momentum equation, Energy equation of incompressible flow Introduction to compressible flow: Introduction, Isentropic flow in a stream tube, speed of sound, Mach waves; One dimensional Isentropic Flow: Governing equations, stagnation conditions, critical conditions, maximum discharge velocity, isentropic relations

Module II: (9 hours)
Normal Shock Waves: Shock waves, stationary normal shock waves, normal shock wave relations in terms of Mach number; Oblique Shock Waves: Oblique shock wave relations, reflection of oblique shock waves, interaction of oblique shock waves, conical shock waves; Expansion Waves: Prandtl-Meyer flow, reflection and interaction of expansion waves, flow over bodies involving shock and expansion waves

Module III: (9 hours)
Variable Area Flow: Equations for variable area flow, operating characteristics of nozzles, convergent-divergent supersonic diffusers Adiabatic Flow in a Duct with Friction: Flow in a constant area duct, friction factor variations, the Fanno line; Flow with Heat addition or removal: One-dimensional flow in a constant area duct neglecting viscosity, variable area flow with heat addition, one-dimensional constant area flow with both heat exchanger and friction

Module IV: (9 hours)
Generalized Quasi-One-Dimensional Flow: Governing equations and influence coefficients, solution procedure for generalized flow with and without sonic point; Two-Dimensional Compressible Flow: Governing equations, vorticity considerations, the velocity potential, linearized solutions, linearized subsonic flow, linearized supersonic flow, method of characteristics.

Books

1. P. H. Oosthuizen and W. E. Carscallen. Compressible Fluid Flow. NY, McGraw-Hill, 1997.
2. H. W. Liepmann, and A. Roshko, Elements of Gas Dynamics, Dover Pub, 2001.
3. A. H. Shapiro, Compressible Fluid Flow 1 and 2. Hoboken NJ: John Wiley.
4. M. A. Saad, Compressible Fluid Flow. 2nd ed. Upper Saddle River, NJ: Prentice-Hall, 1993.
5. F. M. White, Viscous Fluid Flow. 2nd ed. New York: McGraw-Hill, 1991.

Course Name:	Gasdynamics: Fundamentals and Applications
Course Link:	https://onlinecourses.nptel.ac.in/noc21_ae03/preview
Course Instructor:	Prof. Srisha Rao M V, IISc Banglore

6^{th} Semester	RME6D003	Computer Integrated Manufacturing and FMS	L-T-P 3-0-0	3 Credits

MODULE – I (12 HOURS)

Fundamentals of Manufacturing and Automation: Production systems, automation principles and its strategies; Manufacturing industries; Types of production function in manufacturing;Automation principles and strategies, elements of automated system, automation functions and
level of automation; product/production relationship, Production concept and mathematicalmodels for production rate, capacity, utilization and availability; Cost-benefit analysis.Computer Integrated Manufacturing: Basics of product design, CAD/CAM, Concurrent engineering, CAPP and CIM.

MODULE – II (12 HOURS)

Industrial Robotics: Robot anatomy, control systems, end effectors, sensors and actuators; fundamentals of NC technology, CNC, DNC, NC part programming; Robotic programming, Robotic languages, work cell control, Robot cleft design, types of robot application, Processing operations, Programmable Logic controllers: Parts of PLC, Operation and application of PLC, Fundamentals of Net workings; Material Handling and automated storage and retrieval systems, automatic data capture, identification methods, bar code and other technologies.

MODULE – III (12 HOURS)

Introduction to manufacturing systems: Group Technology and cellular manufacturing, Partfamilies, Part classification and coding, Production flow analysis, Machine cell design, Applications and Benefits of Group Technology. Flexible Manufacturing system: Basics of FMS, components of FMS, FMS planning and implementation, flexibility, quantitative analysis of flexibility, application and benefits of FMS. Computer Aided Quality Control: objectives of CAQC, QC and CIM, CMM and Flexible Inspection systems.

Books :

1. Automation, Production Systems and Computer Integrated Manufacturing: M.P. Groover, Pearson Publication.
2. Automation, Production systems & Computer Integrated Manufacturing, M.P Groover, PHI.
3. CAD/CAM/CIM, P.Radhakrishnan, S.Subramanyam and V.Raju, New Age International
4. Flexible Manufacturing Systems in Practice, J Talavage and R.G. Hannam, Marcell Decker
5. CAD/CAM Theory and Practice, Zeid and Subramanian, TMH Publication
6. CAD/CAM Theory and Concepts, K. Sareen and C. Grewal, S Chand publication
7. Computer Aided Design and Manufacturing, L. Narayan, M. Rao and S. Sarkar, PHI.
8. Principles of Computer Integrated Manufacturing, S.K.Vajpayee, PHI
9. Computer Integrated Manufacturing, J.A.Rehg and H.W.Kraebber, Prentice Hall

Course Name:	Computer Integrated Manufacturing
Course Link:	https://onlinecourses.nptel.ac.in/noc21_me65/preview
Course Instructor:	Prof. J Ramkumar, Prof Amandeep Singh, IIT Kanpur

6^{th} Semester		Artificial Intelligence and Machine Learning	L-T-P 3-0-0	3 Credits

Module-I: **(12 hours)**

INTRODUCTION –The Foundations of Artificial Intelligence; - INTELLIGENT AGENTS – Agents and Environments, Good Behaviour: The Concept of Rationality, the Nature of Environments, the Structure of Agents, SOLVING PROBLEMS BY SEARCH – Problem-Solving Agents, Formulating problems, Searching for Solutions, Uninformed Search Strategies, Breadth-first search, Depth-first search, Searching with Partial Information, Informed (Heuristic) Search Strategies, Greedy best-first search, A* Search, CSP, Means-End-Analysis.

Module-II: (12 hours)

ADVERSARIAL SEARCH – Games, The Mini-Max algorithm, optimal decisions in multiplayer games, Alpha-Beta Pruning, Evaluation functions, Cutting off search, LOGICAL AGENTS – Knowledge-Based agents, Logic, Propositional Logic, Reasoning Patterns in Propositional Logic, Resolution, Forward and Backward chaining - FIRST ORDER LOGIC – Syntax and Semantics of First-Order Logic, Using First-Order Logic , Knowledge Engineering in First-Order Logic - INFERENCE IN FIRST ORDER LOGIC – Propositional vs. First-Order Inference, Unification and Lifting, Forward Chaining, Backward Chaining, Resolution

Module-III: **(6 hours)**

UNCERTAINTY – Acting under Uncertainty, Basic Probability Notation, The Axioms of Probability, Inference Using Full Joint Distributions, Independence, Bayes' Rule and its Use, PROBABILISTIC REASONING – Representing Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks, Efficient Representation of Conditional Distribution, Exact Inference in Bayesian Networks, Approximate Inference in Bayesian Networks

Module-IV: **(10 hours)**

LEARNING METHODS – Statistical Learning, Learning with Complete Data, Learning with Hidden Variables, Rote Learning, Learning by Taking Advice, Learning in Problem-solving, learningfrom Examples: Induction, Explanation-based Learning, Discovery, Analogy, FormalLearning Theory, Neural Net Learning and Genetic Learning. Expert Systems: Representingand Using Domain Knowledge, Expert System Shells, Explanation, Knowledge Acquisition.

Books:

[1] Elaine Rich, Kevin Knight, & Shivashankar B Nair, Artificial Intelligence, McGraw Hill,3rd ed.,2009

[2] Stuart Russell, Peter Norvig, *Artificial Intelligence -A Modern Approach*, 2/e, Pearson, 2003.

[3] Nils J Nilsson, *Artificial Intelligence: A New Synthesis*, Morgan Kaufmann Publications,2000

[4] Introduction to Artificial Intelligence & Expert Systems, Dan W Patterson, PHI.,2010

[5] S Kaushik, Artificial Intelligence, Cengage Learning, 1st ed.2011

Digital Learning Resources:

Course Name:	Artificial Intelligence Search Methods For Problem Solving
Course Link:	https://swayam.gov.in/nd1_noc20_cs81/preview
Course Instructor:	Prof. D. Khemani, IIT Madras

Course Name:	Fundamentals of Artificial Intelligence
Course Link:	https://swayam.gov.in/nd1_noc20_me88/preview
Course Instructor:	Prof. S. M. Hazarika, IIT Guwahati
Course Name:	Introduction to Machine Learning
Course Link:	https://nptel.ac.in/courses/106/105/106105152
Course Instructor:	Prof. S. Sarkar, IIT Kharagpur
Course Name:	Machine Learning
Course Link:	https://nptel.ac.in/courses/106/106/106106202
Course Instructor:	Prof. Carl Gustaf Jansson, IIT Madras

6th Semester		Electrical Energy Conservation and Auditing	L-T-P 3-0-0	3 Credits

MODULE – I **(12HOURS)**

Electrical energy conservation: Energy economics- discount rate, payback period, internal rate of return, net present value, and life cycle cost. Energy generation, energy distribution, energy usage by processes, technical and economic evaluation, understanding energy costs, classification of energy conservation measures, plant energy performance, benchmarking and energy performance, matching energy usage to requirement, maximizing energy system efficiency, optimizing the input energy requirements, fuel and energy substitution, and energy balancing.

EB billing- HT and LT supply, transformers, electric motors- motor efficiency computation, energy efficient motors, pumps, fans, blowers, compressed air systems, refrigeration and air conditioning systems, cooling towers, electric heaters (space and liquid), DG-sets, illuminating devices, power factor improvement, and harmonics.

MODULE – II **(08 HOURS)**

Electrical energy audit: Energy consumption pattern and scenario of any region; Energy auditing: Need, types, methodology and approaches; Preliminary energy audit methodology (initial site visit and preparation required for detailed auditing, detailed energy audit activities, information and data collection, process flow diagram and process steps); Procedure and techniques: Data gathering, evaluation of saving opportunities, and energy audit reporting; and Energy audit instruments.

MODULE – III **(15 HOURS)**

Illumination: Illumination, luminous flux, lumen, luminous intensity, candela power, brightness, glare, types of lighting (incandescent, CFL, and LED), requirements of lux for various purposes, determine the method of lighting, select the lighting equipments, and calculate the lighting parameters.

Books :

1. Callaghn, P. W." Design and Management for Energy Conservation", Pergamon Press, Oxford, 1981.
2. Dryden. I. G. C.," The Efficient Use of Energy", Butterworths, London, 1982.
3. Energy Economics -A. V. Desai (Wiley Eastern).
4. Handbook of Energy Efficiency - CRC Press
5. Energy Technology, OP Gupta, Khanna Book Publishing
6. Handbook of Energy Audits Albert Thumann, William J. Younger, Terry Niehus, 2009.
7. Handbook on Energy Audit and Environment Management, Y P Abbi and Shashank Jain, TERI, 2006.

6^{th} Semester		Control System	L-T-P 3-0-0	3 Credits

Module I: **(5 hours)**

Industrial Control examples. Mathematical models of physical systems. Control hardware and their models. Transfer function models of linear time-invariant systems. Feedback Control: Open-Loop and Closed-loop systems. Benefits of NegativeFeedback. Block diagram algebra. Signal Flow Graph and Mason'sGain formula.

Module II: **(10 hours)**

Standard test signals. Time response of first and second order systems for standard test inputs. Application of initial and final value theorem. Design specifications for second-ordersystems based on the time-response. Concept of Stability. Routh-Hurwitz Criteria. Relative Stability analysis. Root-Locus technique. Construction of Root-loci.

Module III: **(7 hours)**

Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stabilitycriterion. Relative stability using Nyquist stability criterion – gain and phase margins. Closed-loop frequency response: Constant M Circle, Constant N Circle, Nichols Chart.

Module IV: **(10 hours)**

Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness of control systems. Root-loci method of feedback controller design. Design specifications in frequency-domain. Frequency-domain methods of design. Application of Proportional, Integral and Derivative Controllers, Tuning of PID controllers, Lead and Lag and Lag-Lead compensator design.

Module V: **(10 hours)**

Concepts of state variables. State space model. Diagonalization of State Matrix. Solution of state equations. Eigenvalues and Stability Analysis. Concept of controllability and observability. Pole-placement by state feedback. Discrete-time systems. Difference Equations. State-space models of linear discrete-time systems. Stability of linear discrete-time systems.

Books:

[1] I. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International, 2009.
[2] K. Ogata, "Modern Control Engineering", Prentice Hall, 1991
[3] M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education, 1997.
[4] B. C. Kuo, "Automatic Control System", Prentice Hall, 1995.

Digital Learning Resources:

Course Name: Control System Engineering
Course Link: https://nptel.ac.in/courses/108/102/108102043/
Course Instructor: Prof. M Gopal, IIT Delhi

6^{th} Semester	RIK6F001	Essence of Indian Knowledge Tradition - I	L-T-P 3-0-0	0 Credits

Course Objective:

The course aims at imparting basic principles of thought process, reasoning and inferencing. Sustainability is at the core of Indian Traditional Knowledge Systems connecting society and nature.Holistic life style of Yogic-science and wisdom capsules in Sanskrit literature are also important in modern society with rapid technological advancements and societal disruptions. The course focuses on introduction to Indian Knowledge System, Indian perspective of modern scientific world-view and basic principles of Yoga and holistic health care system.

Course Outcomes:

- Ability to understand, connect up and explain basics of Indian Traditional knowledge modern scientific perspective.

Course Content:

- Basic Structure of Indian Knowledge System (i) वेद, (ii) उपवेद (आयुर्वेद, धनुर्वेद, गन्धर्वेद, स्थापत्य आदि) (iii) वेदांग (शिक्षा, कल्प, निरुत, व्याकरण, ज्योतिष छंद), (iv) उपाङ्ग (धर्म शास्त्र, मीमांसा, पुराण, तर्कशास्त्र)
- Modern Science and Indian Knowledge System
- Yoga and Holistic Health care
- Case Studies.

Books:

1. V. Sivaramakrishna (Ed.), Cultural Heritage of India-Course Material, Bharatiya Vidya Bhavan, Mumbai, 5th Edition, 2014

2. Swami Jitatmanand, Modern Physics and Vedant, Bharatiya Vidya Bhavan

3. Fritzof Capra, Tao of Physics

4. Fritzof Capra, The wave of Life

5. V N Jha (Eng. Trans,), Tarkasangraha of Annam Bhatta, Inernational Chinmay Foundation, Velliarnad, Amaku,am

6. Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkatta

7. GN Jha (Eng. Trans.) Ed. R N Jha, Yoga-darshanam with Vyasa Bhashya, VidyanidhiPrakasham, Delhi, 2016

8. RN Jha, Science of Consciousness Psychotherapy and Yoga Practices, VidyanidhiPrakasham, Delhi, 2016 9. P R Sharma (English translation), ShodashangHridayam

5^{th} Semester	RME5C201	Design of Machine Elements Lab	L-T-P 0-0-3	2 Credits

LIST OF EXPERIMENTS:

1. Design of any one working model related to Design of machine elements i.e., Module I and II.
2. Design of any one working model related to Design of machine elements i.e., Module III and IV.
3. Design & drawing of Riveted joint
4. Design and drawing of Cotter joint
5. Design and drawing of Knuckle joint
6. Design of shafts subjected to combined loading
7. Design and drawing of Flange coupling
8. Design of spring
9. Design of bearing

Total no. of Drawing: 6
3 in drawing sheets
3 in AutoCad/Pro-E/CATIA/ANSYS

5th Semester	RME5C202	Machining Science and Technology Lab	L-T-P 0-0-3	2 Credits

LIST OF EXPERIMENTS:

(Minimum 08 Experiments/Studies)

1. Job on lathe with tapper turning, thread cutting, knurling and groove cutting (3 experiments).
2. Gear cutting (with index head) on milling machine
3. Working with shaper, Planner and slotting machine.
4. Working with surface and cylindrical grinding.
5. Determination of cutting force using Lathe tool dynamometer.
6. Determination of cutting force in drilling using drill tool dynamometer.
7. Study of Non-traditional machining processes.(USM, AJM, EDM, ECM)
8. Study of CNC Lathe and demonstration of making job in CNC lathe.
9. Study of CNC Milling machine and demonstration of making job in CNC Milling machine

6th Semester		**Future-ready Contributor Program Laboratory**	**L-T-P 0-0-3**	**2 Credits**

Outcomes: The Future-ready Contributor Program aims to accomplish the following outcomes in the lives of students–

- Improve the employability of students by giving them the right work ethic and thinking that employers are looking for.
- Build their confidence with which they can go into any job and contribute meaningfully.
- Improve their ability to engage better in the workplace and to be able to handle the challenges that come up there.
- Build their career-worthiness and help them develop into future-ready contributors with ability to navigate a career in a volatile, changing world.
- Widen their choices of career and success, so that they are able to open up more opportunities for themselves and take up unconventional career pathways.
- Enable them recognize how they as technical professionals, can participate and make a positive contribution to their communities and to their state.

The Program content is also designed to expose students to real-world workplace scenarios and sensitize them to some of the challenges faced in society around them, especially in the local communities around them and in their own state of Odisha.

The Contributor Program syllabus has been evolved and fine-tuned over several years, to –

a) address the changing need and contemporary challenges being faced by industry and what employers of today are looking for in the people they hire;
b) working extensively with universities and students and an appreciation of their challenges and concerns;
c) guided by the higher ideas and principles of practical Vedanta in work.

Sr. No.		Content	Total Hrs
1	**Part 1 : Developing self-efficacy and basic inner strength**	**Who is a Future-ready Contributor?** *In this topic, students understand the new work environment, expectations from future workforce, and importance of being a future-ready contributor. This enables students to transform their expectation of themselves in work*	3 hrs lab sessions (discovery-based facilitator led)
2		**Self-esteem & Growth Identity** *In this topic, students learn how to develop a deeper and more resilient self esteem and how to adopt a growth identity/ mindset, that is more appropriate to the demands of the future workplace.*	Same as above
3		**Become a Creator of one's destiny** *In a "victim stance", we see the career environment as full of difficulties and hurdles. We feel powerless or blame our circumstances for not having many opportunities. This makes us fearful of uncertainty and makes us settle for jobs where we remain mediocre. In this topic, students discover the "creator of destiny stance" to challenges and situations. This stance helps them take ownership & responsibility to shape destiny, build a new future & find answers to challenges; and stop being complainers.*	Same as above
4	**Part 2 : Building ability to make more effective career choices**	**Achieving Sustainable Success** *In this topic, students discover how to achieve sustainable or lasting success, by making themselves success-worthy. Where their focus shifts to building one's "engine of success" rather than being on chasing the "fruits of success". This is important, because over a lifetime of work, all people go through ups and downs – where the fruits are not in their control. People who are focused on the fruits of success, fall prey to disappointment, loss in motivation, quitting too early, trying to find shortcuts – when fruits don't come. Whereas people focused on building their engine of success continue to contribute steadily, irrespective of whether fruits come or not.*	Same as above

		This helps them make better choices in life, that leads to steady success & long-term career fulfillment in an uncertain world.	
5		**Career Development Pathways for a changing world** *In this topic, students explore a range of diverse "career development models" and the possibilities for contribution each opens up to them. This helps them open up hidden opportunities that such an environment offers. And free themselves from a herd mentality when making career choices.*	Same as above
6		**Make an impact in every part of one's life** *In this topic, students learn how to expand the contribution possible in any role they have. This helps them take charge of own career growth & discover their power to contribute in any role or job.*	Same as above
7	**Part 3 : Building ability to become solution and value creating individuals in the world**	**Think Solutions** *The market environment in which organizations are operating, is becoming increasingly dynamic and uncertain. So, employers are increasingly seeking out people who can innovate and figure out solutions in the face of any challenge (unlike in the past when it was the people who were most efficient and productive, who were valued by organizations). At the heart of innovation lies this way of thinking of "finding solutions" rather than "seeing problems or roadblocks". Students learn how to build this way of thinking, in this topic.*	Same as above
8		**Value Thinking** *Companies are also looking for employees who do not just work hard, or work efficiently or productively - but those who will make a valuable difference to the fortunes of the company. This difference may come from innovation, but it may also come from focusing on the right things and identifying what really matters – both to the company and to the customers. In this topic, students learn how to build this capability.*	Same as above

9		**Engaging Deeply** *The environment we live in is becoming increasingly complex because more and more things are getting interconnected, new fields are emerging, technologies are rapidly changing, capabilities and knowledge one is trained in will become fast obsolete. In such a scenario, the student's ability to quickly understand and master what is going on, dive deep, get involved in any area, rapidly learn new capabilities that a job demands, is important. In this topic, students learn how to engage deeply. Learning how to dive deep, to quickly understand what is going on, get involved in any area, and rapidly learn.*	Same as above
10	**Part 4 : Building ability to work collaboratively and as good citizens of organizations and the country**	**Enlightened self-interest & collaboration at work** *The changing nature of work in organizations and in the global environment, is increasingly demanding that people work more collaboratively towards shared goals and more sustainable goals. A key to working successfully when multiple stakeholders are involved, is "thinking in enlightened self-interest". In this topic, students learn how to widen their thinking from "narrow self-interest" to "enlightened self-interest" to work more effectively in teams & collaboratives.*	Same as above
11		**Human-centered thinking & Empathy** *In this topic, students learn to recognize & respond to human needs and challenges – the way of thinking at the heart of user-centric designs & customer-centricity.*	Same as above
12		**Trust Conduct** *The biggest currency in a sustainable career is "trust" i.e. being trusted by team members, bosses, customers. When we are trusted, people listen to us, they are willing to give us the chance to grow, give us the space to make mistakes, and work seamlessly with each other without always having to "prove ourselves". In this topic, students learn how to build trust with people they engage with.*	Same as above
Contribution Project Lab Sessions		*3 Contribution projects that help them apply contributor thinking. After students complete their project work (beyond the classroom), each project ends with this 3 hr lab session where they build their project output and*	9 hrs (3 hr lab sessions for each of 3 projects)

	present.	
Project work	*The above Contribution Projects require research, and may need field work beyond the classroom that students are expected to do.*	Beyond classroom

Lab Sessions:

- Students will have to attend twelve discovery-based lab sessions to build new models of thinking & capacities (3 hrs per module)
- They will work closely with their peers to discuss and understand these new models of thinking.
- Their learning will be facilitated by trained college faculty.

Contribution Projects

- Three contribution projects that help them apply contributor thinking
- These will require research and also may need field work

Each ends with a 3 hr lab session where they build their project output

BIJUPATNAIKUNIVERSITY OF TECHNOLOGY, ODISHA

ROURKELA

Curriculum and Syllabus

B. Tech (*MechanicalEngineering*)from the Admission Batch 2018-19

Semester (7th)

Seventh Semester							
Theory							
Sl No	**Category**	**Course Code**	**Course Title**	**L-T-P**	**Credit**	**University Marks**	**Internal Evaluation**
1	HS	RED7E001	Entrepreneurship Development	3-0-0	3	100	50
2	PE	RME7D001	Power Plant Engineering	3-0-0	3	100	50
		RME7D002	Product Design and Production Tooling (PDPT)				
		RME7D003	Design of Machine Components				
3	PE	RME7D004	Mechanical Vibration	3-0-0	3	100	50
		RME7D005	Refrigeration and Air Conditioning				
		RME7D006	Micro and Nano Machining				
4	OE	REI6D001	Micro Electronic Mechanical Systems	3-0-0	3	100	50
		REC5D006	Digital VLSI Design				
		REC7D002	Embedded Systems				
5	OE	REV5D004	Disaster Management	3-0-0	3	100	50
		RIP7E002	Intellectual Property Right				
		RGT6A003	Green Technology				
6	OE	RIT7D001	Internet of Things	3-0-0	3	100	50
		RIS7B001	Industrial Safety Engineering				
		RCS7D007	Soft Computing				
7	MC*	RIK7F001	Essence of Indian Knowledge Tradition - II	3-0-0	0		100 (Pass Mark is 37)
Total Credit (Theory)					**18**		
Total Marks						**600**	**300**
Practical							
1	PSI	RMP7H201	Minor Project	0-0-6	3		200
2	PSI	RSM7H202	Seminar - II	0-0-3	1		100
3	PSI	RCV7H203	Comprehensive Viva	0-0-3	1		100
Total Credit (Practical)					**5**		
Total Semester Credit					**23**		
Total Marks							**400**

***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.**

7th Semester	RED7E001	Entrepreneurship Development	L-T-P 3-0-0	3 Credits

Module I: **(10 hours)**

Entrepreneurship: Concept of entrepreneurship and intrapreneurship, Types of Entrepreneurs, Nature and Importance, Entrepreneurial Traits and Skills, Entrepreneurial Motivation and Achievement, Entrepreneurial Personality

Module II: **(8 hours)**

Entrepreneurial Environment, Identification of Opportunities, Converting Business Opportunities into reality. Start-ups and business incubation, Setting up a Small Enterprise. Issues relating to location, Environmental Problems and Environmental pollution Act, Industrial Policies and Regulations

Module III: **(10 hours)**

Need to know about Accounting, Working capital Management, Marketing Management, Human Resources Management, and Labour Laws. Organizational support services - Central and State Government, Incentives and Subsidies.

Module IV: **(12 hours)**

Sickness of Small-Scale Industries, Causes and symptoms of sickness, cures of sickness, Role of Banks and Governments in reviving industries.

Books:

[1] Entrepreneurship Development and Management, Vasant Desai, HPH
[2] Entrepreneurship Management, Bholanath Dutta, Excel Books
[3] Entrepreneurial Development, Sangeeta Sharma, PHI
[4] Entrepreneurship, Rajeev Roy, Oxford University Press

Digital Learning Resources:

Course Name: Entrepreneurship
Course Link: https://nptel.ac.in/courses/110/106/110106141/
Course Instructor: Prof. C Bhaktavatsala Rao, IIT Roorkee

Course Name: Entrepreneurship Essentials
Course Link: https://nptel.ac.in/courses/127/105/127105007/
Course Instructor: Prof. Manoj Kumar Mondal, IIT Kharagpur

Module I: **(10 hours)**

1. INTRODUCTION
Different sources (Conventional and non-conventional) of energy and the principle of power generation only, Types of power plant and site selection, overall view of a steam power plant.
2. STEAM GENERATOR
Fossil fuel steam generators, classification, circulation in water tube boilers, Modern high pressure water tube boilers (both sub critical and super critical), Boiler mounting and accessories, Combustion equipment: air supply systems (Natural and Mechanical Draught Systems). Pulverized coal burning systems and Basics of Fluidized bed combustion, Feed water treatment (Necessity & general consideration only). Boiler performance calculations.

Module II: **(8 hours)**

3. FLOW THROUGH NOZZLES
Types of nozzles and their area of application & related calculation, critical pressure & chocked flow, super saturated flow. Effect of friction and nozzle efficiency
4. STEAM TURBINES
Turbine types, Variation of Pressure and Velocity in different types of turbines, Simple impulse Turbines, Flow through turbine blades and velocity diagram, Pressure - compounded impulse turbines and Velocity compounded impulse turbines. Turbine power and related calculations.

Module III: **(10 hours)**

5. REACTION TURBINES
Reaction turbines Flow through blades and velocity diagram, degrees of reaction, Parsons turbine, power and related calculations, Blade height calculations, Losses in steam turbines, Reheat factor & condition line, Governing of turbines.
6. STEAM CONDENSER & CIRCULATING WATER SYSTEMS
Types, Surface condenser, Performance calculation, Air removal methods, Vacuum & vacuum efficiency. Cooling towers. (types, principle of operation and performance)

Module IV: **(8 hours)**

7. NUCLEAR POWER PLANT
Introduction, Nuclear fuels, Nuclear fission, Reactor components, & materials and classification,, Boiling Water Reactor (BWR), Pressurized water Reactor (PWR),CANDU Reactor, Gas cooled Reactors, Liquid metal fast breeder Reactor. Heavy water Reactors .Waste disposal and Safety of Nuclear power plant
8. ECONOMICS OF POWER PLANT
Basic definitions, cost of electrical energy (Fixed cost and operating cost), Types of tariff, Types of loads (typical load curves), Economic Load sharing

Books:

1. Power plant Engineering ; - By P.K. Nag (2nd edition) TMH
2. Power Plant Engineering by Arora and Domkundwar, Dhanpat Rai publications
3. Power Plant Engineering by Yadav
4. Power Plant Engineering by Rajput
5. Power plant Technology : By E.I. Wakil TMH
6. Power Plant Engineering by C.Elanchezhian, Sarvanakumar, Vijayramnath, IK International Publishing House Pvt Ltd.

7th Semester	RME7D002	Production Design and Power Plant Engineering Production Tooling	L-T-P 3-0-0	3 Credits

Module I: **(12 Hours)**

Product Design-Product design considerations, product planning, product development, value analysis, product specification. Role of computer in product design.
Process Planning – selection of processes, machines and tools. Design of sequence of operations, Time & cost estimation

Module II: **(12 Hours)**

Forging design- allowances, die design for drop forging, design of flash and gutter, upset forging die design.
Sheet metal working- Design consideration for shearing, blanking piercing, deep drawing operation, Die design for sheet metal operations, progressive and compound die, strippers, stops, strip layout.

Module III: **(12 Hours)**

Design of jigs and fixtures, principle of location and clamping, clamping methods, locating methods,Drill Jig bushing, Indexing type drilling Jig.
Design of single point cutting tool, broach and form tool. Tooling design for turret lathe andautomats. Design of limit gauges.

Books:

[1] Product Design & Manufacturing, A K Chitale, R C Gupta, Eastern Economy Edition,PHI.
[2] Product Design & Development, Karl T Ulrich, Steven D Eppinger, Anita Goyal, Mc-Graw Hill.
[3] A Textbook of Production Engineering, P.C. Sharma, S. Chand & Co
[4] Fundamentals of Tool Engineering design, S.K. Basu, S.N. Mukherjee, R. Mishra, Oxford &IBH Publishing Co.
[5] Technology of Machine Tools, Krar, Gill, Smid, Tata Mc Graw Hill
[6] Jigs & Fixture Design, Edwrd G Hoffman, Cengae Learning.

7th Semester	RME7D003	Design of Machine Components	L-T-P 3-0-0	3 Credits

Module-I: **(10 hours)**

Design of Pressure vessels: Thin pressure vessels: cylindrical and spherical vessels,Design of end Closures, Thick cylindrical shells.

Design of Lever: Classification, Design of levers, Cranked lever, Lever of safety - valve.

Module-II: **(10 hours)**

Design of belt drive and power screw: Design of belt drive and pulley, Power screwdesign with square thread such as screw jack.

Design of clutch and brake: Friction clutch, Cone clutch and Centrifugal clutch, Blockbrake, Band brake, Internal expanding shoe brake.

Module-III: **(10 hours)**

Gears: Design of Spur, Helical, bevel and worm gears. **Flywheel:** Design of Flywheel.

Module-IV: **(12 hours)**

Design of I.C. Engine components: Design of Cylinder, Piston, Connecting Rod, CrankShaft.

Introduction to Finite Element Method: FEM fundamental concepts, Procedure of FEM,Finite Element Modeling of one-dimensional problems. Finite Element Analysis of 2-Dproblems: Shape function, Strain Displacement Relation, Element Characteristics Matrix.

Books:

[1] Design of Machine Elements, V.B. Bhandari, Tata McGraw Hill
[2] Design of Machine Elements by C. S. Sharma and K. Purohit, PHI
[3] Mechanical Engineering Design, J.E.Shigley, C.R.Mischke, R.G.Budynas and K.J.Nisbett, TMH
[4] Machine Design, P.Kanaiah, Scietech Publications
[5] Fundamentals of Machine Component Design by R.C.Juvinall and K.M.Marshek, John Wiley & Sons
[6] Machine Drawing by N.Sidheswar, McGraw-Hill
[7] Machine Design, P.C.Sharma and D.K.Agrawal, S.K.Kataria& Sons
[8] Machine Design, Pandya and Shah, Charotar Book Stall
[9] Machine Design, Robert L. Norton, Pearson Education Asia.

7th Semester	RME7D004	Mechanical Vibration	L-T-P 3-0-0	3 Credits

Design Hand Book:

1. P.S.G. Design Data Hand Book, PSG College of Tech Coimbature
2. Design Data Hand Book, K. Lingaiah, McGraw Hill, 2nd Ed. 2003.
3. Design Hand Book by S.M.Jalaluddin ; Anuradha Agencies Publications
4. Design Data Hand Book by K.Mahadevan and B.Reddy,CBS Publishers

Module I: **(12 Hours)**

INTRODUCTION & IMPORTANCE OF MECHANICAL VIBRATION:
Brief history of Mechanical Vibration, Types of Vibration, Simple Harmonic Motion (S.H.M.),Principle of superposition applied to S.H.M., Beats, Fourier Analysis, Concept of degree of freedomfor different vibrating systems.
UNDAMPED FREE VIBRATION OF SINGLE DEGREE FREEDOM SYSTEMS: Modeling of VibratingSystems, Evaluation of natural frequency – differential equation, Energy & Rayleigh's methods,Equivalent systems.
DAMPED FREE VIBRATION OF SINGLE DEGREE FREEDOM SYSTEMS: Different types of damping,Equivalent viscous damping, structural damping, Evaluation of damping using free and forcedVibration technique, Concept of critical damping and its importance, study of vibration response ofviscous damped systems for cases of under damping, critical damping and over damping,Logarithmic decrement.

Module II: **(12 Hours)**

FORCED VIBRATION OF SINGLE DEGREE FREEDOM SYSTEMS: Steady state solution with viscousdamping due to harmonic force, reciprocating and rotating unbalance mass, vibration isolation andtransmissibility due to harmonic force excitation and support motion. Vibration measuringinstruments – vibrometer and accelerometer. Whirling of shaft with single disc and without damping, Concept of critical speed and its effect on the rotating shaft.

UNDAMPED VIBRATION OF TWO DEGREE FREEDOM SYSTEMS: Free vibration of spring coupledand mass coupled systems, Longitudial, Torsional and transverse vibration of two degree freedomsystems, influence coefficient technique, Un-damped vibration Absorber.

Module III:

(12 Hours)

INTRODUCTION TO MULTI-DEGREE FREEDOM SYSTEMS: Normal mode vibration, Co-ordinate coupling-close coupled and far coupled systems, Orthogonality of mode shapes, Methods of matrix iteration, Holzer's method and Stodola method. Torsinal vibration of two, three and multi-rotor systems. Dunkerley's lower bound approximate method.

CONTINOUS SYSTEMS: Vibration of strings, longitudinal vibration of rods, torsional vibration of rods, transverse vibration of Euler-beams.

Books:

[1] Theory of vibration with Applications: W.T. Thomson and Marie Dillon Dahleh,

7th Semester	RME7D005	Refrigeration and Air conditioning	L-T-P 3-0-0	3 Credits

Pearson
Education 5th ed. 2007.
[2] Introductory Course on theory and Practice of Mechanical Vibrations. J.S. Rao & K. Gupta,
New Age International Publication, New Delhi, 2007.
[3] Mechanical Vibrations: S.S. Rao, Prarson Education Inc, 4th ed. 2003.

[4] Mechanical Vibrations: S. Graham Kelly, Schaum's outline series, Tata McGraw Hill, Special Indian ed., 2007
[5] Mechanical Vibrations: V.P. Singh, Dhanpat Rai & company Pvt. Ltd. 3rd ed., 2006
[6] Elements of vibration Analysis: Leonard Meirovitch, Tata McGraw Hill, Special Indian ed.,2007

Module-I: **(12 Hours)**

Air Refrigeration System : Introduction, Unit of refrigeration, Coefficient of performance,Reversed Carnot Cycle, Temperature limitations, maximum COP, Bell Coleman air cycle,Simple Air Cycle System for Air-craft with problems.
Vapour Compression System : Analysis of theoretical vapour compression cycle,Representation of cycle on T - S and p - h diagram, Simple saturation cycle, sub-cooled cycleand super-heated cycle, Effect of suction and discharge pressure on performance, Actualvapour compression cycle. Problem illustration and solution.
Multi-stage compression and Multi-evaporator systems : Different arrangements ofcompressors and inter-cooling, Multistage compression with inter-cooling, Multievaporatorsystem, Dual compression system. Simple problems

Module-II: **(12 Hours)**

Vapour Absorption System : Simple Ammonia - absorption system, Improved absorptionsystem, Analysis of vapour absorption system (Specifically of analyzing coloumn andrectifier), Electrolux / Three fluid system, Lithium-bromide-water vapour absorptionsystem, comparison of absorption system with vapour compression system. SimpleProblems and solution.

Thermoelectric Refrigeration: Basics and Principle. Defining the figure of Merit. (NoProblem)**Refrigerants:** Classification of refrigerants and its designations- Halocarbon (compounds,Hydrocarbons, Inorganic compounds, Azeotropes, Properties of refrigerants, comparison ofcommon refrigerants, uses of important refrigerants, Brines. Alternative refrigerants(Organic and inorganic compounds).

Module-III: **(12 Hours)**

Psychrometrics : Properties of air-vapour mixture, Law of water vapour-air mixture,Enthalpy of moisture, Psychrometric chart, simple heating and cooling, Humidification, Dehumidification,Mixture of air streams. Review question and discussions
Requirements of comfort air conditioning: Oxygen supply, Heat removal, moisture removal,air motion, purity of air, Thermodynamics of human body, comfort and comfort chart,effective temperature, factors governing optimum effective temperature
Air Conditioning System: Process in air conditioning : Summer air conditioning, Winter airconditioning and year round air conditioning, Cooling load calculations. Review questionand discussions.

7th Semester	RME7D006	Micro and Nano Machining	L-T-P 3-0-0	3 Credits

Books:

[1] Refrigeration and Air Conditioning by R.C. Arora , PHI Publication
[2] Refrigeration and Air conditioning by C.P. Arora, Tata McGraw Hill.
[3] Refrigeration and Air Conditioning by S.C. Arora and S. Domkundwar, Dhanpat Rai & Sons. (Chapters; 3,4,5,6,7,11,16,17,19,20)
[4] Refrigeration and Airconditioning Data book by Manohar Prasad
[5] Refrigeration and Air conditioning by P.L. Ballney, Khanna Publishers.
[6] Refrigeration and Air conditioning by Manohar Prasad, New Age international publishers

Module-I: **(12 hours)**

Introduction

Introduction, Basic elements of molecular dynamics modelling, Design and requirements forstate-of-the-art MD cutting process simulations, Capabilities of MD for nanoscale materialremoval process analysis, Advances and recent developments in material removal processsimulation, Summary.

Ductile Mode Cutting of Brittle Materials

The mechanism of ductile mode cutting of brittle materials, The chip formation in cutting ofbrittle materials, Machined surfaces in relation to chip formation mode

Diamond Tools in Micromachining

Diamond technology, Preparation of substrate, Modified HFCVD process, Nucleation and diamond growth, Deposition on complex substrates, Diamond micromachining.

Module-II: (8 hours)

Conventional Processes: Micro-turning, Micro-drilling and Micro-milling

Introduction, Micro-turning, Micro-drilling, Micro-milling, Product quality in micromachining

Micro-grinding and Ultra-precision Processes

Introduction, Micro and nanogrinding, Nanogrinding tools

Module-III: **(8 hours)**

Non-Conventional Processes: Laser Micromachining

Introduction, Fundamentals of lasers, Laser microfabrication, Laser nanofabrication.

Evaluation of Subsurface Damage in Nano and Micromachining

Destructive evaluation technologies, Non-destructive evaluation technologies

Module-IV: **(10 hours)**

Micro and Nano Finishing Processes

Need for Nano finishing, Magnetic abrasive Finishing, Magnetorheological Finish, ElasticEmission Finishing, Magnetic Float Polishing, Ion Beam finishing.

Micro Joining

6th Semester	REI6D001	Micro Electronics Mechanical Systems	L-T-P 3-0-0	3 Credits

Challenges, Micro Resistance welding, Ultrasonic welding, Micro TIG, Applications.

Applications of Nano and Micromachining in Industry

Typical machining methods, Applications in optical manufacturing, Semiconductor andelectronics related applications.

Books:

[1] J. Paulo Davim, Mark J. JacksonNano and Micromachining,John Wiley & Sons, 2013
[2] Mark. J. Jackson, Micro and Nano-manufacturing, Springer, 2006.
[3] Mark. J. Jackson, Micro-fabrication and Nano-manufacturing - Pulsed water drop micromachining CRC Press 2006.
[4] NitaigourPremchandMahalik, Micro-manufacturing and Nanotechnology, 2006.
[5] V.K.Jain, Micro-manufacturing Processes, CRC Press, 2012.
[6] Yi Qin, Micro-manufacturing Engineering and Technology, William Andrew, 2015

Module-I: **(12 hours)**

Introduction and Emergence of MEMS, Scaling issues, materials for MEMS, Thin film deposition, Photolithography, doping, wet and dry etching

Micromachining Techniques: Surface and Bulk micro machining, wafer bonding, surface micro machining and LIGA process, Silicon as material for micromachining, (Chapter 3 and Section 8.2 of Book 1, Chapter 2 of Book 2)

Module-II: **(12 hours)**

MEMS devices, Engineering Mechanics for Micro System Modeling and Design – static bending of thin plates, Mechanical vibrational analysis, Thermo mechanical analysis,fracture mechanics analysis, thin film mechanics, Mechanics of deformable bodies, Energy method, Estimation of stiffness and damping for different micro-structures, Modeling of electromechanical systems, Pull-in voltage, Theory and design: Micro Pressure Sensor, micro accelerometer – capacitive and piezoresistive, micro actuator.(Section 4.1 to 4.3 and 6.2.2 of Book 1, Section 3.4 of Book 2)

Module-III: **(12 hours)**

MEMS Applications: Mechanical sensors and actuators: Piezoresistive pressure sensors, MEMS capacitive accelerometer, OpticalGyroscopes: Micro-lens, Micro-mirror, Optical Switch Radiofrequency MEMS:Inductor, Varactor, Filter, Resonator.

Microfluidics: Capillary action, Micro pumping, Electro wetting, Lab-on-a-chip.

Electronic interfaces, design, simulation and layout of MEMS devices using CAD tools.(Section 10.1to 10.8 of Book 2)

Books:

[1] G.K. Ananthsuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat and V.K. Atre: Micro and Smart Systems, Wiley India, New Delhi, 2010.
[2] N.P. Mahalik: MEMS, Tata McGraw-Hill, New Delhi, 2007.
[3] T. Hsu: MEMS and Microsystems: Design and Manufacture, Tata McGraw-Hill, New Delhi, 2002.

7th Semester	REC5D006	Digital VLSI Design	L-T-P 3-0-0	3 Credits

[4] Gabriel M. Rebeiz: RF MEMS Theory, design &Technology, Wiley India Education,2010.

Digital Learning Resources:

Course Name: MEMS and Microsystems
Course Link: https://nptel.ac.in/courses/117/105/117105082/

MODULE-I **(08Hours)**

Introduction: Historical Perspective, VLSI Design Methodologies, VLSI Design Flow, Design Hierarchy, Concept of Regularity, Modularity and Locality, VLSI Design Styles, Computer-Aided Design Technology.
Fabrication of MOSFETs: Introduction, Fabrication Processes Flow – Basic Concepts, The CMOS n-Well Process, Layout Design Rules, Stick Diagrams, Full Customs Mask Layout Design.
MOS Transistor: The Metal Oxide Semiconductor (MOS) Structure, The MOS System under External Bias, Structure and Operation of MOS Transistor (MOSFET), MOSFET Current-Voltage Characteristics, MOSFET Scaling and Small-Geometry Effects, MOSFET Capacitance.

MODULE-II
MOS Inverters – Static Characteristics: Introduction, Resistive-Load Inverters, Inverters with n-Type MOSFET Load, CMOS Inverter.
MOS Inverters – Switching Characteristics and Interconnect Effects: Introduction, Delay-Time Definitions, Calculation of Delay-Times, Inverter Design with Delay Constraints, Estimation of Interconnect Parasitics, Calculation of Interconnect Delay, Switching Power Dissipation of CMOSInverters.
Combinational MOS Logic Circuits: Introduction, MOS Logic Circuits with Depletion NMOS Loads, CMOS Logic Circuits, Complex Logic Circuits, CMOS Transmission Gates (Pass Gates).

MODULE-III
Sequential MOS Logic Circuits: Introduction, Behaviour of Bistable Elements, SR Latch Circuits, Clocked Latch and Flip-Flop Circuits, CMOS D-Latch and Edge Triggered Flip Flop.
Dynamic Logic Circuits: Introduction, Basic Principles of Pass Transistor Circuits, Voltage

Bootstrapping, Synchronous Dynamic Circuit Techniques, Dynamic CMOS Circuit Techniques, High Performance Dynamic CMOS Circuits.

MODULE-IV

Design for Testability: Introduction, Fault Types and Models, Ad Hoc Testable Design Techniques, Scan-Based Techniques, Built-In Self-Test (BIST) Techniques, Current Monitoring IDDQ Test.

MODULE-V

Semiconductor Memories: Introduction, Dynamic Random Access Memory (DRAM), Static Random Access Memory (SRAM), Non-volatile Memory, FlashMemory.

Books:

[1] *CMOS Digital Integrated Circuits: Analysis and Design*, Sung-Mo Kang and Yusuf Leblebici, Tata McGraw-Hill Publishing Company Limited, 3rdEdn, 2003.

[2] Principles of CMOS VLSI Design – a Systems Perspective, K. Eshraghian and N.H.E. Weste, Addison Wesley,2nd Edition, 1993.

[3] Digital Integrated Circuits– *A Design Perspective***,** Jan M. Rabaey,Anantha Chandrakasan, Borivoje Nikolic, PHI, 2nd Edn.

[4] Modern VLSI Design System – *on – Chip Design*, Wayne Wolf, PHI, 3rd Edn.
[5] VLSI Design, Debaprasad Das, Oxford University Press, New Delhi, 2010.
[6] CMOS Logic Circuit Design, John P. Uyemura, Springer, 2001.
[7] Digital Integrated Circuit Design, Ken Martin, Oxford University Press, 2000.
[8] VLSI Design Technique forAnalog and Digital Circuits, R L Geiger, TMH.

Digital Learning Resources:

Course Name:	VLSI Design
Course Link:	https://nptel.ac.in/courses/117/101/117101058/
Course Instructor:	Prof. A.N. Chandorkar, IIT Bombay

Course Name:	Digital VLSI Testing
Course Link:	https://nptel.ac.in/courses/117/105/117105137/
Course Instructor:	Prof. S, Chattopadhyay, IIT Kharagpur

Course Name:	VLSI Technology
Course Link:	https://nptel.ac.in/courses/117/106/117106093/
Course Instructor:	Dr. Nandita Dasgupta, IIT Madras

7th Semester	REC7D002	Embedded Systems	L-T-P 3-0-0	3 CREDITS

Module-I **(12 hrs)**

Hardware Concepts Embedded System: Application and characteristics of embedded systems, Overview of Processors and hardware units in embedded system, embedded software in a system, Examples of Embedded system.

ARM:ARM pipeline, Instruction Set Architecture ISA: Registers, Data Processing Instructions, Data Transfer Instructions, Multiplication's instructions, Software interrupt, Conditional execution, branch instruction, Swap instruction, THUMB instructions.

Module-II **(8hrs)**

Devices and device drivers: I/O devices, Serial peripheral interfaces,IIC, RS232C, RS422, RS485, Universal serial bus, USB Interface, USB Connector IrDA, CAN, Bluetooth, ISA, PCI, PCI -X and advance busses, Device drivers.

Module –III **(9 hrs)**

Real Time Operating System (RTOS): Real-Time Task Scheduling: Some important concepts, Types of real-time tasks and their characteristics, Task scheduling, Clock-Driven scheduling, Hybrid schedulers, Event-Driven scheduling, Earliest Deadline First (EDF) scheduling, Rate monotonic algorithm (RMA)

Module –IV **(8 hrs)**

Modelling Techniques: Software and programming concept: Processor selection for an embedded system, State chart, SDL, Petri-Nets, Unified Modeling Language (UML). Hardware software codesign. Hardware and software partitioning: K-L partitioning, Partitioning using genetic algorithm,

Module –V **(8 hrs)**

Low power embedded system design: Dynamic power dissipation, Static power dissipation, Power reduction techniques, system level power management. Software design for low power devices.

Books:

[1] "Embedded system architecture, programming and design" By Raj Kamal, TMH.

[2] "Embedded System Design" by SantanuChattopadhay, PHI

[3] Frank Vahid and Tony Givargis, Embedded Systems Design – A unified Hardware /Software Introduction, John Wiley, 2002.

[4] "Hardware software co-design of Embedded systems" By Ralf Niemann, Kulwer Academic.

[5] "Embedded real time system programming" By Sriram V Iyer, Pankaj Gupta, TMH.

Digital Learning Resources:

Course Name:	Embedded Systems
Course Link:	https://nptel.ac.in/courses/108/102/108102045/
Course Instructor:	Prof. Santanu Chaudhary, IIT Delhi

Course Name:	Embedded Systems
Course Link:	https://nptel.ac.in/courses/108/105/108105057/
Course Instructor:	Prof. Amit Patra et al, IIT Kharagpur

Course Name:	Embedded Systems Design
Course Link:	https://nptel.ac.in/courses/106/105/106105159/
Course Instructor:	Prof. Anupam Basu, IIT Kharagpur

7th Semester	REV5D004	Disaster Management	L-T-P 3-0-0	3 CREDITS

Module I (12 hr)

Understanding Disaster: Concept of Disaster - Different approaches- Concept of Risk - Levels of Disasters - Disaster Phenomena and Events (Global, national and regional) Hazards and Vulnerabilities: Natural and man-made hazards; response time, frequency and forewarning levels of different hazards - Characteristics and damage potential or natural hazards; hazard assessment - Dimensions of vulnerability factors; vulnerability assessment - Vulnerability and disaster risk - Vulnerabilities to flood and earthquake hazards

Module II (6 hr)

Disaster Management Mechanism: Concepts of risk management and crisis managements - Disaster Management Cycle - Response and Recovery - Development, Prevention, Mitigation and Preparedness - Planning for Relief

Module III (6 hr)

Capacity Building: Capacity Building: Concept - Structural and Nonstructural Measures Capacity Assessment; Strengthening Capacity for Reducing Risk - Counter-Disaster Resources and their utility in Disaster Management - Legislative Support at the state and national levels

Module IV (12 hr)

Coping with Disaster: Coping Strategies; alternative adjustment processes - Changing Concepts of disaster management - Industrial Safety Plan; Safety norms and survival kits - Mass media and disaster management

Planning for disaster management: Strategies for disaster management planning - Steps for formulating a disaster risk reduction plan - Disaster management Act and Policy in India - Organizational structure for disaster management in India - Preparation of state and district disaster management plans

Books

1. Manual on Disaster Management, National Disaster Management, Agency Govt of India.
2. Disaster Management by Mrinalini Pandey Wiley 2014.

3. Disaster Science and Management by T. Bhattacharya, McGraw Hill Education (India) Pvt Ltd Wiley 2015

1. Earth and Atmospheric Disasters Management, N. Pandharinath, CK Rajan, BS Publications 2009.

2. National Disaster Management Plan, Ministry of Home affairs, Government of India

http://www.ndma.gov.in/images/policyplan/dmplan/draftndmp.pdf

7th Semester	RIP7E002	Intellectual Property Right	L-T-P 3-0-0	3 CREDITS

MODULE-I **(12 Hours)**

Introduction: Intellectual property: meaning, nature and significance, need for intellectual property Right (IPR), IPR in India – Genesis and development, IPR in abroad, Examples: - Biotechnology Research and Intellectual Property Rights Management. What is a patent, what can be protected by a patent, why should I apply for a patent? Patent Law, Patentability requirements, non-Patentable subject matters, Layout of the Patents. Procedure for domestic and international filing of applications, Restoration, Surrender and Revocations of Patents, Rights of Patentee and Working of Patent, Licensing and Enforcing Intellectual Property.

MODULE-II **(10 Hours)**

Copyrights: Copyright: meaning, scope; What is covered by copyright? How long does copyright last? Why protects copyright? Related rights, Rights covered by copyright. Ownership: Duration, Division, Transfer and Termination of Transfers.

MODULE-III **(10 Hours)**

Infringement and Remedies: Literal and non-literal infringement, Role of claims, Doctrines on infringement: Equivalent doctrine, Pith and Marrow doctrine, Comparative test. Defences: Gillette Defence, General grounds, Patents granted with conditions, Parallel import. Remedies: Civil, Administrative.

MODULE-IV **(08 Hours)**

State Law: Trade Secret, Contract, Misappropriation, Right of Publicity Trademarks, Trade Secret - Overview, Requirements, Misappropriation of Trade Secret, Departing Employees, Remedies, Criminal Liability, Misappropriation, Clickwrap Agreements, Idea Submissions; Right of Publicity, Federal Pre-emption, Review.

Books:

[1] W. R. Cornish and D. Llewellyn, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Rights, Sweet & Maxwell.
[2] Lionel Bently and Brad Sherman, Intellectual Property Law, Oxford University Press.
[3] P. Narayanan, Intellectual Property Law, Eastern Law House
[4] B. L. Wadehra, Law Relating to Intellectual Property, Universal Law Publishing Co.
[5] V. K. Ahuja, Law Relating to Intellectual Property Rights, LexisNexis
[6] AjitParulekar and Sarita D'Souza, Indian Patents Law – Legal & Business Implications;Macmillan India ltd, 2006
[7] P. Narayanan; Law of Copyright and Industrial Designs; Eastern law House, Delhi, 2010.

Reference:

[1] The Copyright Act, 1957
[2] The Patent Act, 1970
[3] The Trade Marks Act, 1999
[4] The Designs Act, 2000
[5] The Geographical Indication of Goods Act, 1999
[6] The Protection of Plant Varieties and Farmers' Rights Act, 2001
[7] The Semiconductor Integrated Circuits Layout Design Act, 2000

Digital Learning Resources:

Course Name:	Intellectual Property
Course Link:	https://nptel.ac.in/courses/109/106/109106137/
Course Instructor:	Prof. Feroze Ali, IIT Madras

7th Semester	RGT6A003	Green Technology	L-T-P 3-0-0	3 CREDITS

Module I: (12 Hrs)

Global Warming and its effect:- Introduction and physical definition of global warming, the New Carbon Problem: Accumulation, Long Half-Life, Heating Potential, Carbon Emission Factors, Carbon Absorption in Nature, The Global Emission Situation and its effect in India, The Kyoto and Other Protocols and its view in India, Effect of climate change and its impact. Planning for the Future to reduce global warming:- Steps taken to Control Carbon Emissions universally, Use of Promotional and Punitive Mechanisms for Reducing Carbon in Atmosphere, The General Approach in Planning for the Future, Developing Countrywide Adaptive Measures for Safety of Local People, Developing Mitigative Measures for Global Reduction of Carbon, India's National Action Plan on Climate Change (NAPCC) till date, National Mission for a Green India, The MRV Debate.

Module II: (8 Hrs)

Opportunities in Control of Carbon Emissions and Accumulation:- Essential Steps for Control of Carbon Emissions and Accumulation, Procedure to develop own Priorities and Business Opportunities in India for control of carbon emissions and accumulation, Needs a Mix of Green and Traditional Power Sources in India, A Logical Approach for Carbon Reduction, Need in India —More Forests, Less Deforestation and payment rates procedure for controlling carbon emissions and its Promotional Mechanisms at India. Green Technologies for Energy Production: - Various Technologies Available for Energy Production, Cost Comparison of a Few Typical Systems for Power Generation, Sources of Energy Production Already in Use, Alternative Methods Ready for Use, Green Technologies Needing some Prior R&D Work.

Module III: (10 Hrs)

Green Technologies for Personal and Citywide Application: - Measures to be taken for Green city, Carbon Emission Reduction at Personal Level, Carbon Emission Reduction at Local Authority and Citywide Level, Carbon Emissions from Imports. Green Technologies for Specific Applications:- Promotion of 'Green' Buildings, Guidelines, The Energy Conservation Building Code (ECBC), Green Hotels and Hospitals, Green Technologies for Transport, Green Roads, Ports and Harbours, Industries, Carbon, Carbon Emissions from a Few Selected Industries in India, The Changing Scenario in Cities, Need for Wider Application to Town Planning and Area Re-Development Projects, 'Green' Infrastructure for Municipal Services, Bringing up Indian Villages, Green Services for Crematoria, Spreading Message to all Stakeholders.

Module IV: (10 Hrs)

Some High-tech Measures for Reducing Carbon Emissions: - Use of Solar Power with Satellite-Based Systems, Use of Carbon Capture and Storage (Sequestration), Microorganisms, A Quick SWOT Analysis.Recommended Plan of Action: - India's National Action Plan Take Us to a Low-Carbon Path, The Missions Help Develop Awareness, few case studies on Projects undertakenby Various Countries, Adaptive Measures Essential for Indian People to Cope with Climate Change

Books

[1] Green Technologies, Soli J. Arceivala, McGraw Hill Education
[2] Green Technologies and Environmental Sustainability edited by Ritu Singh, Sanjeev

Kumar

Digital Learning Resources:

Course Name: Sustainable Materials and Green Buildings
Course Link:https://nptel.ac.in/courses/105/102/105102195/
Course Instructor:Dr. B. Bhattacharjee, IIT Delhi

7th Semester	RIT7D001	Internet of Things	L-T-P 3-0-0	3 CREDITS

Module-1

Introduction-Definition & Characteristics of IoT, Physical Design of IoT- Things in IoT, IoT Protocols, Logical Design of IoT- IoT Functional Blocks, IoT Communication Models, IoT Communication APIs , IoT Enabling Technologies- Wireless Sensor Networks , Cloud Computing, Big Data Analytics , Communication Protocols , Embedded Systems, IoT Levels & Deployment Templates.

Module-2

Domain Specific IoTs

Home Automation: Smart Lighting, Smart Appliances, Intrusion Detection, Smoke/Gas Detectors, Cities-Smart Parking, Smart Lighting, Smart Roads, Structural Health Monitoring, Surveillance, Emergency Response,

Environment-Weather Monitoring, Air Pollution Monitoring, Noise Pollution Monitoring, Forest Fire Detection , River Floods Detection , **Energy**- Smart Grids , Renewable Energy Systems , Prognostics , Retail-Inventory Management , Smart Payments , Smart Vending Machines , **Logistics**-Route Generation & Scheduling , Fleet Tracking , Shipment Monitoring , Remote Vehicle Diagnostics, **Agriculture**-Smart Irrigation ,Green House Control ,**Industry** -Machine Diagnosis & Prognosis Indoor Air Quality Monitoring ,Health & Lifestyle -Health & Fitness Monitoring, Wearable Electronics

IoT and M2M Introduction, M2M-Difference between IoT and M2M, SDN and NFV for IoT-Software Defined Networking , Network Function Virtualization

Module-3

IoT Platforms Design Methodology

IoT Design Methodology-Purpose & Requirements Specification, Process Specification, Domain Model Specification, Information Model Specification , Service Specifications , IoT Level Specification, Functional View Specification , Operational View Specification , Device & Component Integration , Application Development, Case Study on IoT System for Weather Monitoring, Motivation for Using Python

IoT Physical Devices & Endpoints

What is an IoT Device-Basic building blocks of an IoT Device, Exemplary Device: Raspberry Pi, About the Board, Linux on Raspberry Pi , Raspberry Pi Interfaces – Serial, SPI , I2C , Programming Raspberry Pi with Python-Controlling LED with Raspberry Pi , Interfacing an LED and Switch with Raspberry Pi ,Interfacing a Light Sensor (LDR) with Raspberry Pi , Other IoT Devices- pcDuino, Beagle Bone Black , Cubieboard

Module-3

IoT &Beyond : Use of Big Data and Visualization in IoT, Industry 4.0 Concepts. Overview of RFID, Low-power design (Bluetooth Low Energy), range extension techniques (data mining and mesh networking), and dataintensive IoT for continuous recognition applications. Overview of Android / IOS App Development tools & Internet Of Everything

Books:

1. Internet of Things, A Hands on Approach, by ArshdeepBahga& Vijay audisetti, University Press.
2. The Internet of Things, by Michael Millen, Pearson

7th Semester	RIS7B001	Industrial Safety Engineering	L-T-P 3-0-0	3 CREDITS

Module-I: **(7 hours)**

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment
and methods.

Module-II **(7 hours)**

Fundamentals of maintenance engineering: Definition and aim of maintenanceengineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Module-III:(7 hours)

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

Module-IV: **(7 hours)**

Fault tracing: Fault tracing-concept and importance, decision treeconcept, need and applications, sequence of faultfinding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic,automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

Module-V: **(8 hours)**

Periodic and preventive maintenance: Periodic inspection-concept and need,degreasing, cleaning and repairing schemes, overhauling of mechanical components,overhauling of electrical motor, common troubles and remedies of electric motor, repaircomplexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Books:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, McGraw Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

7th Semester	RCS7D007	Soft Computing	L-T-P 3-0-0	3 CREDITS

Module I: **(14 Hrs)**

Basic tools of soft Computing: Fuzzy logic, Neural Networks and Evolutionary Computing, Approximations of Multivariate functions, Non - linear Error surface and optimization

Fuzzy Logic Systems: Basics of fuzzy logic theory, Crisp and fuzzy sets; Basic set operations; Fuzzy relations, Composition of Fuzzy relations, Fuzzy inference, Zadeh's compositional rule of inference; Defuzzification; Fuzzy logic control; Mamdani and Takagi and Sugeno architectures. Applications to pattern recognition.

Module II: **(14 Hrs)**

Neural networks: Single layer networks, Perceptron; Activation functions; Adaline- its training and capabilities, weights learning, Multilayer perceptrons; error back propagation, generalized delta rule; Radial basis function networks and least square training algorithm, Kohenen self - organizing map and learning vector quantization networks; Recurrent neural networks, Simulated annealing neural networks; Adaptive neuro-fuzzy information; systems (ANFIS).

Module III: **(8 Hrs)**

Evolutionary Computing: Genetic algorithms: Basic concepts, encoding, fitness function, reproduction. Differences of GA and traditional optimization methods. Basic genetic, basic evolutionary programming concepts Applications, hybrid evolutionary algorithms.

Books:

1. F. O. Karry and C. de Silva, "Soft Computing and Intelligent Systems Design - Theory, Tools and Applications". Pearson Education.(Printed in India).
2. J. S. R. Jang. C. T. Sun and E. Mizutani, "Neuro-fuzzy and soft-computing". PHI Pvt. Ltd., New Delhi.
3. Fredric M. Ham and Ivica Kostanic, "Principle of Neuro Computing for Science and Engineering", Tata McGraw Hill.
4. S. Haykins, "Neural networks: a comprehensive foundation". Pearson Education, India. 4) V. Keeman,"Learning and Soft computing", Pearson Education, India.
5. R. C. Eberhart and Y. Shi, "Computational Intelligence Concepts to Implementation". Morgan Kaufmann Publishers (Indian Reprint).

7th Semester		Essence of Indian Knowledge Tradition - II	L-T-P 3-0-0	3 CREDITS

Course Objectives:

1. To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.
2. To make the students understand the traditional knowledge and analyse it and apply it to their day to day life

Course Outcomes :

At the end of the Course, Student will be able to:

1. Identify the concept of Traditional knowledge and its importance.
2. Explain the need and importance of protecting traditional knowledge.
3. IIllustrate the various enactments related to the protection of traditional knowledge.
4. Interpret the concepts of Intellectual property to protect the traditional knowledge.
5. Explain the importance of Traditional knowledge in Agriculture and Medicine.

Module-1:

Introduction to traditional knowledge: Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge (IK), characteristics, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge

Module-2:

Protection of traditional knowledge:The need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

Module-3:

Legal framework and TK: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016.

Module-4:

Traditional knowledge and intellectual property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge

Module-5:

Traditional Knowledge in Different Sectors: Traditional knowledge and engineering, Traditional medicine system, TK in agriculture, Traditional societies depend on it for their

food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK

Books:

1. Traditional Knowledge System in India, by Amit Jha, 2009.

2. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.

3. "Knowledge Traditions and Practices of India" Kapil Kapoor, Michel Danino.

Digital Learning Resources:

Course Name:	Ayurvedic Inheritance of India
Course Link:	https://nptel.ac.in/courses/121/106/121106003/
Course Instructor:	Dr M. S. Valiathan, IIT, Madras

https://www.youtube.com/watch?v=LZP1StpYEPM

EIGHTH SEMESTER(COMMON TO ALL BRANCHES OF B.Tech)							
Theory							
Sl No	**Category**	**Course Code**	**Course Title**	**L-T-P**	**Credit**	**University Marks**	**Internal Evaluation**
-	-	-	-		0		
				Total Credit (Theory)	**0**		
				Total Marks			
				Practical			
1	PSI	RMP8H201	Major Project / Internship	0-0-12	6		400
				Total Credit (Practical)	**6**		
				Total Semester Credit	**6**		
				Total Marks			**400**