DKTE Society's
TEXTILE & ENGINEERING INSTITUTE
(An Autonomous Institute)

Rajwada , Ichalkaranji 416115

DEPARTMENT: MECHANICAL ENGINEERING

CURRICULUM

Mechanical Engineering Program

Second Year

With Effect From

2017-18

Promoting Excellence in
Teaching, Learning & Research

Second Year UG Program in Mechanical Engineering
Semester III

Sr. No.	Course Code	Name of the Course	Group	Teaching Scheme				Credits
				Theory Hrs/ Week	Tutorial Hrs/ Week	Practical Hrs/ Week	Total	
1	MEL201	Engineering Mathematics III	A	3	-	-	3	3
2	MEL202	Applied Thermodynamics	D	3	-	-	3	3
3	MEL203	Machine Tool and processes	D	4	-	-	4	4
4	MEL204	Fluid Mechanics	D	3	-	-	3	3
5	MEL205	Machine Drawing	D	2	-	-	2	2
6	MEP206	Applied Thermodynamics Lab	D	-	-	2	2	2
7	MEP207	Computer Programming using C++ Lab	D	1	-	2	3	2
8	MEP208	Fluid Mechanics Lab	D	-	-	2	2	2
9	MEP209	Machine Drawing Lab	D	-	-	2	2	1
10	MEP210	Computer Aided Drafting (CAD-I) Lab	D	-	-	2	2	1
11	MEP211	Workshop Practice II	D	-	-	2	2	1
12	MEL212	Environmental Studies (Mandatory Course)	C	2	-	-	2	2 units
	Total			**18**	**-**	**12**	**30**	**23**

* Field Work/ Project.

Group Details

A: Basic Sciences
B: Engineering Sciences
C: Humanities Social Sciences & Management
D: Professional Subjects - Core & Electives
E: Open Elective
F: Project/Seminar/Training

Second Year UG Program in Mechanical Engineering
Semester IV

Sr. No.	Course Code	Name of the Course	Group	Teaching Scheme				Credits
				Theory Hrs/ Week	Tutorial Hrs/ Week	Practical Hrs/ Week	Total	
1	MEL213	Programming & Computational Methods	D	3	-	-	3	3
2	MEL214	Metallurgy	D	3	-	-	3	3
3	MEL215	Strength of Mechanical Elements	D	3	-	-	3	3
4	MEL216	Theory of Machines – I	D	3	-	-	3	3
5	MEL217	Fluid & Turbo Machinery	D	3	-	-	3	3
6	MEP218	Programming & Computational Methods Lab	D	-	-	2	2	1
7	MEP219	Metallurgy Lab	D	-	-	2	2	2
8	MEP220	Strength of Mechanical Elements Lab	D	-	-	2	2	2
9	MEP221	Theory of Machines – I Lab	D	-	-	2	2	1
10	MEP222	Fluid & Turbo Machinery Lab	D	-	-	2	2	1
11	MEP223	Computer Aided Drawing (CAD II) Lab	D	-	-	2	2	1
12	MEP224	Machine Shop Practice-I	D	-	-	2	2	1
13	MEL212	Environmental Studies	C	2	-	-	2	2 units
	Total			**17**	**0**	**14**	**31**	**24**

Group Details

A: Basic Sciences
B: Engineering Sciences
C: Humanities Social Sciences & Management
D: Professional Subjects - Core & Electives
E: Open Elective
F: Project/Seminar/Training

Second Year B. Tech. Mechanical Engineering Semester III
MEL201: ENGINEERING MATHEMATICS-III

Teaching Scheme	
Lectures	3 Hr./Week
Total Credits	3

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Pre-requisites: Engineering Mathematics-I and Engineering Mathematics-II

Course Objectives:
1. To introduce students about Linear Differential Equations and its Applications.
2. To study basic concept of Vector Differential Calculus.
3. To study properties of Laplace Transform and Transform of Derivative & Integral.
4. To study need of Fourier series.
5. To study applications of Partial Differential Equations and method to solve them.

Course Outcomes: At the end of this course, students will able to
1. Understand basic concept of Linear Differential Equations and its application for solving Problems of Mechanical Engg. fields.
2. Understand Divergence, Curl, Solenoidal and Irrotational vector fields
3. Understand how to find Laplace Transforms and its use in engineering field.
4. Apply Fourier Series to solve problems related in different engineering field.
5. Solve Partial Differential Equations related to Mechanical Engg. field.
6. Use knowledge of Probability Distribution namely Poisson, Binomial & Normal distribution in engg. Problems wherever required.

Course Contents

Unit 1	**Linear Differential Equations and its Applications:** Linear Differential Equations with constant coefficient Definition, Complementary function and Particular Integral (without method of variation of parameter), Applications of LDEs related to Mechanical Engg. Fields (Spring mass oscillator-Free oscillations, & Whirling of Shaft).	**8 Hrs.**
Unit 2	**Vector Differential Calculus:** Differentiation of vectors, Gradient of scalar point function and Directional Derivative, Divergence of Vector point function & Solenoidal vector fields, Curl of a vector point function and Irrotational.	**5 Hrs.**
Unit 3	**Laplace Transform:** Definition, Transform of elementary functions, Properties of Laplace Transform, Transform of derivative and integral, Inverse Laplace transform formulae, Inverse Laplace transform by using partial fraction and Convolution theorem.	**7 Hrs.**
		6

Unit 4	**Fourier Series:** Definition, Euler's Formulae, Dirchilt's Condition, Function having points of discontinuity, Change of interval, Expansion of odd and even periodic functions, Half range series.	**Hrs.**
Unit 5	**Applications of Partial Differential equations:** The Wave equation, The method of separation of variables, Fourier series solution of Wave equation, One dimensional heat flow equation, The method of separation of variables, Fourier series solution of heat equation	**7 Hrs.**
Unit 6	**Probability and Prob. distributions:** Definition of Probability, Random variables, Binomial, Poisson and Normal Distributions.	**6 Hrs.**

Submission: Assignment has to submit on basis of above units.

Text Books:

1. A textbook of applied mathematics by J.N.Wartikar and P.N.Wartikar, Pune Vidhyabharati.
2. Higher engineering mathematics by Dr.B.S.Grewal ,Khanna publisher Delhi.
3. Adavanced engineering mathematics by H.K.Dass,S.Chand publication New Delhi

Reference Books:

1. Higher engineering mathematics by B.V.Ramanna,Tata Mc-Graw Hill publication.
2. A textbook of engineering mathematics by N.P.Bali,Iyengar,Laxmi publication new Delhi .
3. Advanced Engg. Mathematics by Erwin Kreyszing – John Wiley & Sons.
4. Advanced Engg.Mathematics by R.K. Jain and S.R.K. Iyengar – Narosa Publishing House.

Second Year B. Tech. Mechanical Engineering Semester III
MEL202: APPLIED THERMODYNAMICS

Teaching Scheme	
Lectures	3 Hrs. /Week
Total Credits	3

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Prerequisites -Basic Mechanical Engineering, Applied Physics, Applied Chemistry

Course Objective:

1 To introduce student about basic physics and chemistry behind thermodynamics.
2 To study basic concepts of thermodynamics and its applications.
3 To study physical significance of entropy term and its application.
4 To study application of first and second law of thermodynamics to various thermodynamic devices like Steam generator, Condenser, Nozzles and Turbines.
5 To study different types of turbines and corresponding velocity diagrams.

Course Outcomes:

1 Define and discuss various laws of Thermodynamics and its corollaries, properties of steam.
2 Formulate and solve problems on rankine cycle, steam nozzle, steam turbine and steam condenser.
3 Design the steam nozzle and turbine.
4 Analyze experimental data for properties of lubrication.

Course Content

Unit 1 **Review of Laws of Thermodynamics:** **6 Hrs.**
Zeroth law, first law and Second law of thermodynamics, Statement of third law of thermodynamics. Equivalence and Corrollories of Second Law, Numerical treatment on second law,
Entropy: Inequality of Clausius, Entropy change in reversible process and irreversible process, Principle of increase of entropy, Applications, Entropy change of an ideal gas.

Unit 2 **Properties of Pure Substances and Vapour Power Cycles:** **6 Hrs.**
Properties of steam, Use of steam table and Mollier chart, Carnot cycle using steam, Limitations of Carnot cycle Rankine cycle, Representation on T-s and h-s planes, Thermal efficiency, Specific steam consumption. Work ratio, Effect of steam supply pressure and temperature, Condenser pressure on the performance. (Numerical Treatment)

Unit 3 **Steam Condensers** Functions, Elements of condensing plant, Types of steam condensers, surface and jet condensers, Comparison, Vacuum efficiency, Condenser efficiency, Loss of vacuum, Sources of air leakages, Methods of leak **5 Hrs.**

	detection, Air extraction methods, Estimation of cooling water required, Capacity of air extraction pump, Air ejectors.	
Unit 4	**Steam Nozzles** : Functions, Shapes, Critical pressure ratio, Maximum discharge condition, Effect of faction, Design of throat and exit areas, Nozzle efficiency, Velocity coefficient, Coefficient of discharge, Supersaturated flow, Degree of under-cooling and degree of super saturation, Effects of super saturation.	**5 Hrs.**
Unit 5	**Impulse Turbines** : Principles of operation, Classification, Impulse and reaction steam turbine, compounding of steam turbines. Flow through impulse turbine blades, Velocity diagrams, Work done, Efficiencies, End thrust, Blade friction, Influence of ratio of blade speed to steam speed on efficiency of single stage turbines and its condition curve and reheat factors, Introduction to multistage turbine.	**8 Hrs.**
Unit 6	**Reaction Turbines:** Flow through impulse reaction blades, Velocity diagram, and degree of reaction, Parson's reaction turbine, Back pressure and pass out turbine. Governing of steam turbines. Losses in steam turbines, Performance of steam turbines. Function of diaphragm, Glands, Turbine troubles like Erosion, Corrosion, Vibration, Fouling etc.	**9 Hrs.**

Text Books:

1. "Thermal Engineering", Mathur and Mehta, Jain Bros. Publishers, Delhi,3rd Ed.
2. "Thermal Engineering", Ballaney P.L, Khanna Publishers, New Delhi, 27th Ed.
3. "Thermal Engineering",R. K. Rajput, Laxmi Publications, 3rd Edition

Reference Books:

1. "Engineering Thermodynamics", P.K. Nag., Tata McGraw Hill, New Delhi, 4th Ed.
2. "Fundamentals of Thermodynamics", Claus Borgnakke, Sonntag R. E., John Wiley and Sons.
3. "Principles of Engineering Thermodynamics", Moran, Shapiro, Boetnner, Wiley, 8th Edition
4. "Applied Thermodynamics", Estop Mcconkey ,Pearson Education, 5th Edition
5. Engineering Thermodynamics" G. Rogers Yon Mayhew, Pearson Education, 4th Edition
6. "Thermal Engineering", Kumar and Vasandani, D. S . Publisher Metropolitan Book Co, Delhi, 3rd Ed.
7. "Thermodynamics: an Engineering Approach", Cengel and Boles, Tata McGraw-Hill, New Delhi, 3rd Edition.
8. "Engineering Thermodynamics", D.P. Mishra, Cengage learning, 1st Edition
9. "Principles of Engineering Thermodynamics", Moran, Shapiro, Boetnner, Wiley, 8th Ed.
10. "Engineering Thermodynamics", Gupta and Prakash, Nemchand and Sons, 2nd edition
11. "Steam and Gas Turbines", R. Yadav, CPH Allahabad, 2nd Edition , 2005.
12. "Thermal Engineering", M.M Rathod, Tata McGraw Hill, 1st Edition , 2010

Second Year B. Tech. Mechanical Engineering Semester III
MEL203: MACHINE TOOL AND PROCESSES

Teaching Scheme	
Lectures	4 Hrs. /Week
Total Credits	4

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Course Objective:
1. To introduce different methods of Molding and Casting
2. To introduce forming and Plastic Shaping processes.
3. To study various Metal Removal Processes and Machine tools.
4. To study Nonconventional Machining

Course Outcomes:
1. Describe Importance of casting as manufacturing Process.
2. Explain different types of forming and Plastic Shaping processes.
3. Categorize Machine tools and discuss their Basic working principle, Configuration and Specification.
4. Enumerate working principle and applications of non-traditional machining.

Course Content

Unit 1 Machine Tools, Lathe, Drilling Machine, Boring Machine: **9 Hrs.**

Machine tool - definition and purpose, characteristics, classification, elements, Lathe, Working principles, type's specifications, principal parts, accessories and attachments, various lathe operations. Shop floor explanation
Capstan and Turret Lathes Principle parts, working, comparison with centre lathe, turret indexing mechanism, bar Feeding mechanism, turret tool holders, Introduction to automats (theoretical treatment only).Classification of drilling machines, construction and working of radial drilling machine, various accessories, various operations. Horizontal and vertical boring machine, construction and operation, boring tools and bars. Introduction to Jig boring-machine.

Unit 2 Shaping Machine, Planning Machine, Milling Machine: **9 Hrs.**

Types-crank shaper, Crank and slotted link quick return mechanism. Table feed mechanism, various operations, Shop floor explanation. Types-standard double housing planer, principle parts, table drive and feed mechanism, various operations. Classification of milling machines, construction and working of column and knee type of milling machines, milling operations, study of standard accessories- dividing head, rotary table, vertical milling attachment for horizontal milling machine. Shop floor explanation. Shop floor explanation

Unit 3 Gear Manufacturing, Nonconventional Machining: **8 Hrs.**

Gear cutting on milling machine, Change gear calculations, vertical milling attachment for horizontal milling machine Gear Manufacturing Processes - Study of various processes like gear shaping, Gear hobbing. Gear finishing

processes –Gear shaving, Gear burnishing and gear rolling. Abrasive Jet Machining, Electrical Discharge machining, Electro- Chemical machining, Laser beam machining, Ultrasonic machining, Water jet machining.

Unit 4 Casting Processes: **9 Hrs.**

Importance of casting as manufacturing Process, advantages and disadvantages of casting processes, foundry layouts. General introduction to patterns, core boxes and gating systems. Types of patterns and cores and core boxes, materials used and selection criteria for pattern making, pattern allowances. Components of gating system, functions and importance of runners and risers, solidification control devices: chills, ceramics bricks, directional solidification**,** Numerical on riser and gating design.

Unit 5 Moulding, Melting And Pouring: **9 Hrs.**

Types of moulding and core making sands and their properties, Green sand Moulding, shell Moulding, CO2 Moulding, Investment casting. Moulding machines and core making machines. Types of fuel fired melting Furnaces-Cupola furnace, oil/gas fired furnaces, crucible furnaces, Electrical furnaces, Metallurgical control in furnaces, Metal pouring equipment's, Cleaning-fettling and inspection of casting, Automation in foundries. Introduction to permanent mould casting Process-Gravity and pressure die-casting, squeeze casting Centrifugal casting, Continuous casting. Pollution Control in foundries. Casting defects and remedies**.**

Unit 6 Rolling, Forming and Forging: **8 Hrs.**

Metal Forming Processes: Nature of plastic deformation, hot working and cold working. Principles of rolling roll passes, roll pass sequences. Forging: Forging operations, smith forging, drop forging, press forging, forging defects. Extrusion and Sheet metal operations: Extrusion principle, hot extrusion, cold extrusion, wire drawing, swaging, tube making. Sheet metal operations: Press tools operations, shearing action, drawing dies, spinning, bending, stretch forming, embossing and coining. Numerical on forging process.

Text Books:

1. Manufacturing Science - Ghosh A; Mallik A.K. Affiliated East-West Press Pvt. Ltd., New Delhi.
2. M.P. Groover, Principles of Modern Manufacturing, Wiley Indiapvt. ltd., New Delhi
3. P. C. Sharma., Production technology, S. Chand and Company Ltd., New Delhi.

Reference Books:

1. Machine Tools and Mfg. Technology, Steve F. Krar, Mario Rapisarda, Albert F. Check
2. O. P. Khanna, Foundry technology, Khanna Publishers, New Delhi.
3. P L Jain, Principles of foundry technology, Tata McGraw-Hill, New Delhi.
4. O. P. Khanna. Welding technology, Khanna Publishers, New Delhi.
5. HajraChowdhary, Elements of Workshop Technology, Vol. I, Media Promoters & Publications, Bombay
6. B.S. Raghuvanshi, Workshop Technology, Vol. II, DhanapatRai Publications, New Delhi, 10th Edition, 2000

7. W.A.J. Chapman, Workshop Technology, Vol. II, Viva Books, New Delhi,
8. HajraChoudhury and A.K. HajraChoudhury, Elements of Workshop Technology, Vol. II, S.K. Media Promoters and Publishers, New Delhi, 13th Edition, 2012.
9. Production Technology, R. K. Jain, Khanna Publishers, Delhi, 15th Edition, 2000.
10. Workshop Technology, W.A.J. Chapman, CBS Publishing and Distributors, N. Delhi Vol.I, 2001, Vol.I 2007 and Vol.III, 1995

Second Year B. Tech. Mechanical Engineering Semester III
MEL204: FLUID MECHANICS

Teaching Scheme	
Lectures	3 Hrs. /Week
Total Credits	3

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Prerequisites-Applied Physics**,** Applied Chemistry

Course Objectives

1. To identify various properties of fluids and their SI units.
2. To state and illustrate fundamentals of Fluid Statics, Kinematics and Dynamics
3. To identify and explain the fluid properties and concepts of Boundary layer, Drag and Lift force
4. To study the use of Bernoulli's Equation for various applications
5. To understand the physics of fluid flow and its applications
6. To get conversant with Internal, External flows and it's applications

Course Outcomes

At the end of the course students will be able to

1. Define /describe various characteristics of fluid mechanics such as fluid properties, flow types, boundary layers, lift and drag etc.
2. Formulate and solve variety of simplified problems in fluid mechanics such as venturimeter, boundary layer theory ,laminar flow , compressible flow etc.
3. Apply concepts of mass, momentum and energy conservations to design various systems in fluid mechanics such as pipe systems, aerofoil sections.
4. Perform experiments individually& / or in team to find various parameters such as coefficient of discharge of various flow measuring devices, friction factor, flow visualisation, Bernoulli's experiment etc.

Course Contents

Unit 1 Fluid Properties And Fluid Statics: **7 Hrs.**

Fluid Properties: Definition of fluid, Fluid as a continuum, Properties of fluid, Viscosity, Types of fluid, Compressibility, Surface tension, Capillarity and vapor pressure.

Fluid Statics: Pascal‟s law, Hydrostatic law of pressure, Total Pressure, Centre of Pressure, Buoyancy, Meta centre, Condition of Equilibrium of floating and submerged bodies (No Numerical Treatment on fluid Statics)

Unit 2 Fluid Kinematics: **7 Hrs.**

Eulerian and Langragian approach of fluid flow, Flow visualization, Total or material derivative for velocity field, Types of flow, Streamline, Path line, streak line, Stream tube, Continuity equation in Cartesian coordinates in three

dimensional form. Velocity and Acceleration of fluid particles, Stream function and velocity potential function.

Unit 3 Fluid Dynamics: **7 Hrs.**

Equation of motion. Integration of Euler's equation as energy equation. Energy correction factor, concept of HGL and THL or TEL, Steady flow through orifice. Orifice meter, Venturimeter, Flow over triangular and rectangular notches, Pitot tube. Derivation of momentum equation, momentum correction factor. Applications of momentum equation.

Unit 4 Laminar Flow And Pipe Flow: **6 Hrs.**

Laminar Flow: Laminar flow through circular pipes. Laminar flow through parallel plates, Introduction to Navier Stokes equation and its applications
Pipe Flow: Energy losses in transition, expansion and contraction (Darcy's and Chezy's equation), Parallel pipe, Siphon pipes, Branching pipes and equivalent pipes, Moody's Diagram.

Unit 5 Boundary Layer Theory And Dimensional Analysis, Similitude: **6 Hrs.**

Boundary Layer Theory: Boundary layer thickness, its characteristics, laminar and turbulent boundary layers, separation, boundary layer control
Dimensional Analysis, Similitude: Dimensionally homogeneous equations, Buckingham's Pi-theorem, Calculation of dimensionless parameters. Similitude, complete similarity, Model Scales.

Unit 6 Forces On Immersed Bodies And Compressible Flow: **6 Hrs.**

Forces on Immersed Bodies: Lift and Drag, Drag on a flat plate and on aerofoil. Types of drags, Development of lift. (Magnus effect) stalling condition of aerofoil.
Compressible Flow: Propagation of elastic waves, Mach Cone and Mach number. Energy equation of compressible flows. Stagnation pressure, Temperature and density.

Text Books:

1. Fluid Mechanics, R. K. Bansal, Laxmi publications. New Delhi, 1998.
2. Fluid Mechanics and Hydraulic Machines, Ramamrutham,
3. Fluid mechanics and Hydraulic Machinery, R. K Rajput, Laxmi Publishers

Reference Books:

1. Fluid Mechanics, V. L. Streeter & E. B. Wylie, Tata McGraw Hill New Delhi , 2nd Ed.,1997
2. Introduction to Fluid Mechanics, Edward J. Shaughnessy, Oxford University press
3. Mechanics of Fluid, Merle C. Potter, Prentis Hall of India,New Delhi ,2ndEdtion
4. Fluid Mechanics, Fox and McDonald, John Wiley and Sons, New York, 8th Edition.
5. Fluid Mechanics, Fraizini, Tata McGraw-Hill, New Delhi, 4thEdition.
6. Fluid Mechanics, White, Tata McGraw-Hill, New Delhi., 4thEdition
7. Fluid Mechanics, K. L. Kumar, S. Chand Publication. New Delhi,2nd Edition , 2000
8. Fluid mechanics and Hydraulic Machines, Modi and Seth.
9. Theory and Applications of machines, K. Subramanya, , Tata McGraw Hill,1993

Second Year B. Tech. Mechanical Engineering Semester III
MEL205: MACHINE DRAWING

Teaching Scheme	
Lectures	2 Hrs. /Week
Total Credits	2

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Pre-requisites: Engineering Graphics.

Course Objectives:
1. To study BIS conventions used in machine drawing
2. To find the line/curve of intersection between two solids
3. To study the function of various machine components
4. To study the use of production drawings
5. To study assembly and detail drawings

Course Outcomes: At the end of this course, student will be able to
1. Apply knowledge of BIS conventions, linear and auxiliary projection in drawings
2. Identify and draw different machine components
3. Construct assembly, details with limits, fits, and tolerances

Course Contents

Unit 1 Significance and importance of BIS Conventions, Drawings sheet sizes and layout recommended by BIS. Conventional representation of engineering materials, BIS conventions for sectioning, Types of threads profiles, Internal and external threads, Types of springs, Types gears and gearings, Conventional representation of common features (Splined shaft, Serrated shaft, Knurling, Bearings etc.). BIS methods of Linear- and angular dimensioning. Symbolic representation of welds as per BIS for representation of above conventions. **4 Hrs.**

Unit 2 Introduction, interpenetration of Prism with Prism, Prism with cylinder, Prism with cone, prism with pyramid. (Prisms and Pyramids limited upto Rectangular base), Cylinder with Cylinder, Cone with Cylinder. **4 Hrs.**

Unit 3 Importance of sketching and entering proportionate dimensions on sketches. Sketches of nut, Bolts square and Hexagonal Flanged nuts, Lock nuts, Dome nut, Capstan nut, Wing nut, Castle nut, Split pin, Square headed bolt, Cup headed bolt, T-headed bolt, Types of foundation bolts, Stud, Washer, Set screws, Cap screws. Various types of rivets and riveted joints, Various types of keys, Socket and spigot (Cotter joint) , Knuckle (pin) joint, Muff coupling, Protected and unprotected Flanged, Coupling, Universal coupling, solid and bush bearing. Plummer block (pedestal bearing), Foot step bearing. Flat and V-belt pulleys, Fast and loose pulleys, speed cone pulleys, Pipe joint for C.I. **4 Hrs.**

	Flanged, socket and spigot type pipe joint. Union pipe joint and standard pipe-fittings. Students should know the applications of above machine components	
Unit 4	Projection on auxiliary vertical and horizontal plane, Auxiliary projection of simple machine components	**4 Hrs.**
Unit 5	Significance of system of limits and fits. Definitions, Types, Recommendations and selections, Tolerances of form and position, surface finish symbols as per BIS, Selection and entering of all these symbols with reference to details and assembly drawings, Tolerancing an individual dimensions of details drawing	**4 Hrs.**
Unit 6	**Details and Assembly Drawing:** To prepare detail drawings from given assembly drawing. To prepare assembly drawing from given drawing of details. The number of parts is limited to ten to twelve. Preparation of detail and assembly drawing from the following details such as: - Machine tool parts: Tool post, Tailstock, Machine vice, Chucks etc. - Engine parts: Stuffing box, Crosshead assembly, Piston & connecting rod etc. - Miscellaneous parts: Valve assembly, Screw jack, Jigs & fixture, Pipe vice etc Assembly selected should include different types of sections	**4 Hrs.**

Text Books:

1) P.S. Gill, Machine Drawing., S.K. Kataria and Sons, Delhi.
2) N. D. Bhatt, Machine Drawing. Charotor Publication House, Bombay.
3) R.K. Dhavan, Machine Drawing., S. Chand and Company.

Reference Books:

1) IS: SP46- Engineering Drawing Practice for Schools and Colleges, B.I.S. Publications.
2) IS: 696- Code of Practice for General Engineering Drawings B.I.S. Publications.
3) IS: 2709-Guide for Selection of Fits, B.I.S. Publications.
4) IS:919- Recommendation for Limits and Fits for Engineering, B.I.S. Publications.
5) IS: 8000 Part I, II. III. TV, Geometrical Tolerencing of Technical Drawings - B.I.S. Pub.
6) Dhananjay A. Jolhe Engineering Drawing, with an Introduction to AutoCAD, Tata McGraw Hill.
7) N. Sidheshwsr. P. Kannaiah & V.V. S. Sastry. Machine Drawing, Tata McGraw Hill, New Delhi.
8) Narayana, Kannaiah and Venkatareddv, Production Drawing, New Age International.
9) N.D. Junnarkar Machine Drawing 1st print Pearson Education.

Second Year B. Tech. Mechanical Engineering Semester III
MEP 206: APPLIED THERMODYNAMICS LAB

Teaching Scheme	
Practical	2 Hrs./Week
Total Credits	2

Evaluation Scheme	
CIE	50
SEE	50
Total	**100**

List of Experiments

1 Significance & Relevance of Lubrication Properties and Systems

2 Study of types of boiler and demonstration of Water Tube and Fire Tube Boiler

3 Demonstration of Boiler Mountings and Accessories

4 Test on Grease Penetrometer and Dropping Point Apparatus

5 Test on Carbon residue, Cloud and Pour Point Apparatus

6 Test on Redwood Viscometer

7 Test on Aniline Point Apparatus

8 Study of Steam Calorimeter

9 Study/Trial on Steam Generator

10 Report on Industrial Visit to a steam power plant

Minimum 8 experiments to be conducted from above list.

Submission: Completed Journal.

SEE: Based on experiments conducted and Practical/Oral Examination at the end of semester

Second Year B. Tech. Mechanical Engineering Semester III
MEP207: COMPUTER PROGRAMMING USING C++ LAB

Teaching Scheme	
Lectures	1 Hrs/Week
Practical	2 Hrs/Week
Total Credits	2

Evaluation Scheme	
CIE	50
Total	**50**

Course Objectives:

1. Do develop and enhance the programming skills amongst the students in general as well as Application of it in the field of mechanical engineering.
2. To introduce an object oriented programming language.

Course Outcomes:

1. Enumerate the tokens and expressions of C++ language.
2. Explain the features of C++.
3. Develop algorithms for solving the problems using object oriented language.
4. Apply their knowledge and programming skills to solve various computing problems in the field of mechanical engineering.

Course Contents

Unit 1	**Introduction to 'C++' programming**: Structure of a C++ program, Creating source file, Compilation and linking processes. **Tokens, Expressions:** Basic Data types, Identifier, Variables, Constants, Operators, Formatted and console I/O, cin(), cout(). **Functions in C++:** Introduction, main function, f unction prototyping, call by reference and return by reference.	**4 Hrs.**
Unit 2	**Object-Oriented programming:** Introduction, Basic concepts, Benefits, object oriented Languages, Applications.	**1 Hrs.**
Unit 3	**Classes & Objects:** Introduction, structures & classes, Declaration of class, Member functions; defining the object of a class; accessing a member of a class, Array of class objects.	**3 Hrs.**
Unit 4	**Inheritance:** Introduction, single inheritance; Types of base classes: Direct, Indirect; Types of derivation: Public, Private, Protected.	**2 Hrs.**
Unit 5	**Overloading:** Function overloading with various data types, arguments; operator, overloading, assignment operator, arithmetic & comparison operators.	**2 Hrs.**
Unit 6	**Polymorphism:** Polymorphism –early binding –late binding–virtual functions.	**2 Hrs.**

Text Books:

1. Object Oriented Programming , E. Balguruswami. (Tata McGraw Hill Publication)
2. Let us C++, Yashwant Kanitkar (BPB Publication)
3. C++ Programming 7th Edition Alstevanswiely India.

Reference Books:

1. Professional C++ Solter, Wiely India
2. Object oriented Programming with C++ , SouravSahay (Oxford University Press)

3. Object-Oriented Programming in C++, Rajesh K Shukla(Wiley India)

List of Experiments:

1. Minimum 2 program on Input / Output and arithmetic expressions, Hierarchy of Operators, branching and loop control statements.

2. Minimum 2 program on Classes and Objects.

3. Minimum 1 program on pointers with Arrays and Function.

4. Minimum 2 program on Inheritance.

5. Minimum 2 program Overloading.

6. Minimum 2 program Polymorphism.

All experiments to be conducted.

Submission:
Completed journal with C++ programs.

Second Year B. Tech. Mechanical Engineering Semester III
MEP208: FLUID MECHANICS LAB

Teaching Scheme	
Practical	2 Hrs. /Week
Total Credits	2

Evaluation Scheme	
CIE	50
SEE	50
Total	**100**

List of Experiments :

1. Study and demonstration of Pressure Measuring Devices.
2. Flow visualization by plotting of streamlines (Heleshaw's apparatus).
3. Calibration of Venturimeter.
4. Calibration Of Orifice meter.
5. Calibration Of V Notch
6. Verification Of Bernoulli's Theorem.
7. Study And Determination Of Reynolds's Number
8. Determination of minor losses in pips-fittings
9. Determination of coefficient of friction In G. I. Pipe
10. Determination of coefficient of friction In P.V.C. Pipe.
11. Determination of loss of friction in series/parallel pipes.
12. Study of CFD Tools.

Minimum 8 experiments to be conducted from above list.

Submission:

Completed Journal.

SEE: Based on experiments conducted and Practical/Oral Examination at the end of semester

Second Year B. Tech. Mechanical Engineering Semester III
MEP209: MACHINE DRAWING LAB

Teaching Scheme	
Practical	2 Hrs. /Week
Total Credits	1

Evaluation Scheme	
CIE	50
Total	**50**

List of Experiments:

1. To draw BIS conventions.
2. Sketching (Free hand drawing) of various machine components.
3. To provide Limits, Fits and tolerances on Production Drawing.
4. To draw details drawing from given assembly.
5. To draw details and assembly drawing by taking actual measurements and entering Limits; Fits, Tolerances, Surface Finish symbols & Geometrical requirements etc.
6. To draw Auxiliary projection.
7. To draw Interpenetration of solids.

All experiments (sheets) to be conducted.

Submission:
1. Completed all Experiment on drawing sheet as mentioned by faculty.

Second Year B. Tech. Mechanical Engineering Semester III
MEP210: COMPUTER AIDED DRAFTING (CAD) - I LAB

Teaching Scheme	
Practical	2 Hrs. /Week
Total Credits	1

Evaluation Scheme	
CIE	50
Total	**50**

Prerequisites: Engineering Graphics.

Course Objective:
1. To understand: Importance of CAD tool.
2. To develop ability to: Create 2-D drawings.
3. Create assembly of simple machine components.

Course Outcomes: At the end of the course students will be able to,
1. Analyze and interpret design data.
2. Draw 2D drawings.
3. Use modern engineering techniques, tools and skills for engineering practice

Course Content

Unit 1 Basic Commands to Draw 2D Objects
Units, Limits, Point, Line, Circle, Arc, Ellipse, Polygon, Polyline, Spline etc.

Unit 2 Edit/Modify Commands
Erase, Trim, Extend, Scale, Break, Fillet, Chamfer, Offset, Copy, Move, Mirror, Array, Hatch etc.

Unit 3 Viewing Commands
Zoom, Pan, Rotate etc.
Other Commands: Line type, Text, Text style, Dimensioning, Dimension style, Leader, Layers etc.

Unit 4 Assembly of 2D Components
Block, Insert etc.

Unit 5 Geometric Dimensions and Tolerances for 2-D Objects
Straightness, Flatness, Perpendicularity, Angularity, Roundness, Concentricity, Cylindricity , Run out, Profile, Parallelism etc. Machining Symbols.

List of Experiments/Assignments:

1. **CAD Sketcher (4 Assignments):** Creating Sketches of Simple Machine Parts and components.
2. **Assembly Modelling (1 Assignment):** Creating Mechanical Assemblies of Parts.

3. **Production Drawing (2 Assignments):** Production drawing of two machine components with G.D. and T's and machining symbols**.**
4. **3-D Drawing (1 Assignment)**

All assignments to be conducted.

Submission:

Completed all assignment by using latest drafting software like AutoCAD and 3D software CATIA and take print out of the same on A4 size sheet.

Text Books:

1. "Machine Drawing", N.D. Bhatt and V.M. Panchal, Charotar Publication House, Anand, 42nd Edition, 2007.
2. "Machine drawing", Basudeb Bhattacharyya, Oxford University Press.

Reference Books:

1. "Auto cad 2014 for Engineers and Designers", Sham Tickoo, Dreamtech press, New Delhi, 2014.
2. "Auto Cad 2014", Ellen Finkelsten, Wiley India
3. "Help Manuals and Tutorials of referred software"

Second Year B. Tech. Mechanical Engineering Semester III
MEP211: WORKSHOP PRACTICE II

Teaching Scheme	
Practical	2 Hrs. /Week
Total Credits	1

Evaluation Scheme	
CIE	50
Total	**50**

List of Experiments

1. To find Size analysis and Grain fineness Number of moulding sand.
2. To calculate Hardness (mould/core) and Green Compressive strength of moulding sand
3. To find Permeability, Moisture percentage and Clay content of given sand
4. To Study types of patterns and core boxes
5. To Study casting defects, causes and remedies
6. Study and demonstration of Lathe Capstan Lathe machine.
7. Study and demonstration of Drilling and milling machine.
8. Numerical on thread cutting and gear cutting.
9. Numerical on Riser and Gating design.
10. Numerical on forging process.
11. Industrial visit report.

Any eight experiments to be conducted excluding industrial visit.

Submission:
Completed journal on above any eight experiments along with Industrial visit is compulsory.

Text Books:

1. Manufacturing Science - Ghosh A; Mallik A.K. Affiliated East-West Press Pvt. Ltd., New Delhi.
2. M.P. Groover, Principles of Modern Manufacturing, Wiley Indiapvt. ltd., New Delhi
3. P. C. Sharma., Production technology, S. Chand and Company Ltd., New Delhi.

Reference Books:

1. O. P. Khanna, Foundry technology, Khanna Publishers, New Delhi.
2. HajraChowdhary, Elements of Workshop Technology, Vol. I, Media Promoters & Publications, Bombay
3. B.S. Raghuvanshi, Workshop Technology, Vol. II, DhanapatRai Publications, New Delhi, 10th Edition, 2000

Second Year B. Tech. Mechanical Engineering Semester III
MEL212: ENVIRONMENTAL STUDIES (Mandatory Course)

Teaching Scheme	
Lectures	2 Hrs. /Week
Total Credits	2

Evaluation Scheme (Annual Evaluation in Sem IV)	
SEE	70
Project	30
Total	**100**

- **Evaluation of the course will be in sem IV based on syllabus of semester III and Sem IV.**

Prerequisites –

Concern about nature, resource conservation awareness, curious about new innovations in ecofriendly technology, individual role in ensuring sustainable development.

Course Objectives:

1 Introduce students to multi disciplinary nature of Environment sciences and its importance
2 To create awareness about present Environmental problems and their root causes
3 Understand action needed for environment conservation for present and future
4 Introduction to sustainability and resource conservation

Course Outcomes:

1 Discuss various concepts in Environmental sciences
2 Awareness about collective responsibility towards conservatory approach
3 Suggest importance of mass awareness and individual role in pollution prevention
4 Sustainability and future of humanity in terms resource conservation

Course Contents

Unit 1 **Nature of Environmental Studies:** **2 Hrs.**

Definition, scope and importance.
Multidisciplinary nature of environmental studies.
Need for public awareness.

Unit 2. **Natural Resources and Associated Problems:** **10 Hrs.**

Forest resources: Use and over-exploitation, deforestation. Timber extraction, mining, dams and their effects on forests and tribal people.

Mineral resources: Usage and exploitation, environmental effects of extracting and using mineral resources.

Food resources: World food problem, changes caused by agriculture effects of modern agriculture, fertilizer-pesticide problems.

Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources.

Land resources: Land as a resource, land degradation, man induced landslides soil erosion and desertification. Role of an individual in conservation of natural resources.

Water resources: Global distribution, Use and over utilization of source and ground water, drought and flood, Dam benefits and problems.

Unit 3. **Ecosystems:** **10 Hrs.**

Concept of an ecosystem, Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem, Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristics features, structure and function of the following ecosystem - Forest ecosystem. Grassland ecosystem.
Desert ecosystem. Aquatic ecosystems (Ponds, Lakes). Aquatic ecosystems (Lakes, Rivers). Aquatic ecosystems (Streams, Oceans, Estuaries).

Text Books :

1. Environmental studies for Undergraduates publisher shivaji university Kolhapur
2. Environmental studies by Erach Bharucha, publisher University press
3. Envrionmental Studies by Tiwari and khulbe publisher IKInternationa Kanpur

References :

1) Agarwal, K.C.2001, Environmental Biology, Nidi Pub. Ltd., Bikaner.

2) Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad 380013, India, Email:mapin@icenet.net (R)
3) Brunner R.C.,1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
4) Clank R.S. Marine Pollution, Clanderson Press Oxford (TB)

5) Cunningham, W.P. Cooper, T.H. Gorhani, E. & Hepworth, M.T.2001, Environmental Encyclopaedia, Jaico Pub. Mumbai, 1196p
6) De A.K., Environmental Chemistry, Wiley Western Ltd.
7) Down to Earth , Centre for Science and Environment , New Delhi.(R)

8) Gleick, H.,1993, Water in crisis, Pacific Institute for studies in Dev., Environment & Security. Stockholm Env. Institute. Oxford Univ. Press 473p

9) Hawkins R.E., Encyclopaedia of Indian Natural History, Bombay Natural History Society, Bombay (R)

10) Heywood, V.H.& Watson, R.T.1995, Global Biodiversity Assessment, Cambridge Univ. Press 1140p.

Second Year B. Tech. Mechanical Engineering Semester IV

MEL213: PROGRAMMING AND COMPUTATIONAL METHODS.

Teaching Scheme	
Lectures	3 Hrs/Week
Total Credits	3

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Prerequisites-
Engineering Mathematics-I, Engineering Mathematics-II, and Engineering Mathematics-III.

Course Objectives

1. To introduce numerical methods for solving linear and non-linear equations.
2. To apply the knowledge of these methods to solve practical problems with suitable software.
3. To introduce numerical methods for evaluating definite integrals.
4. To describe best fit curve for equations.
5. The students gain the Knowledge about ordinary differential.

Course Outcomes
At the end of the course students will be able to
1. Define the basic mathematical techniques, errors and approximations.
2. Study the mathematical problem and select appropriate numerical method to solve the problem.
5. Use modern tool such as Scilab, C, and C++ to solve numerical problems.
6. Study the importance of Numerical methods for Lifelong use.

Course Contents

Unit 1.	**Errors:** Introduction, Types of errors, Rules for estimate errors, Error propagation, Error in the approximation of function **Roots of Equation:** a. Bracketing Method: Bisection Method, False position method b. Open method: Newton Raphson's, Multiple Roots, Iteration system of non-linear Equations. C. Roots of polynomial: Muller's Method. Problems based on engineering application.	**7 Hrs.**
Unit 2.	**Linear Algebraic Equation:** 1. Gauss Elimination Method- Naïve Gauss Elimination, Pitfalls of Elimination, Techniques of improving solutions, Gauss- Jordan method. 2. Matrix Invention- LU decomposition, Gauss Seidal, Jacobi Iteration method. Problems based on engineering application.	**5 Hrs.**

Unit 3.	**A. Curve fitting:** i. Least Square Regression – Linear regression, Polynomial Regression ii. Interpolation – Newton's divided difference, Interpolating polynomial, Languages interpolating polynomial, with considering mechanical engineering application. **B. Statistics:** Mean and standard deviation, Addition and multiplication laws probabilities, Binomial, Poisson and normal distribution.	**8 Hrs.**
Unit 4.	**Numerical Differentiation and Integration** a. Newton's cote's Integration of equation: Trapezoidal rule, Simpson's rules, Integration unequal segments. b. Integration of Equation: Romberg's Integration and Gauss Quadrature. c. Numerical differentiation, Differentiation formulae, Richardson extrapolation, Derivation of unequally spaced data, Forward difference, Central difference, backward difference, backward difference. Problems based on engineering application.	**7 Hrs.**
Unit 5.	**Ordinary Differential Equation:** a. Taylor's series method, Picard's Method, Runge-Kutta method, Euler's Method, Improved polygon method, System of equation b. Boundary value and Eigen value problem, Shooting Method, Finite Difference Method, Eigen value problem based on polynomial method, Power method. Problems based on engineering application.	**6 Hrs.**
Unit 6.	**Partial Differential Equation:** a. Finite Difference – Elliptical equation, Laplace's equation, Liebmen's Method, Secondary variables, Boundary condition. b. Finite Difference- Parabolic Equation , Explicit Method- Bender- Schmidt method, Implicit method- Crank Nicolson Method. Problems based on engineering application.	**6 Hrs**

Text Books:

1. Numerical Methods by Dr. B.S.Grewal.
2. Numerical Methods by Dr. Kandasamy.
3. Numerical Methods for Engineers by S.C.Chapra

Reference Books:

1. Higher Engineering Mathematics by Dr.B.S.Grewal, Khanna Publication.
2. Numerical Methods by E Balguruswamy Tata McgrawHill Publication
3. Introductory Method of Numerical Analysis by S.S.Sastry.
4. Numerical Methods by Dr. V.N.Vedamurthy. Vikas Publication.
5. Numerical Mathematics and Computing. Ward cheney, CENGAGE 7th Edition.
6. Principles Analysis and Algorithms by Shrimanta Pal, OXFORD University Press.

Second Year B. Tech. Mechanical Engineering Semester IV
MEL214: METALLURGY

Teaching Scheme	
Lectures	3 Hrs. /Week
Total Credits	3

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Course Objective:

1 To acquaint students with the basic concepts of Metal Structure
2 To impart fundamental knowledge of ferrous and non ferrous metal processing
3 To study applications of different Metals and Alloys
4 To Know Fundamentals of Metallography
5 To develop futuristic insight into Metals

Course Outcomes:

1 Identify and Interpret ferrous and non ferrous alloys.
2 Demonstrate the equilibrium diagrams and phase transformations
3 Analyze the different mechanical properties of ferrous and non ferrous alloys.
4

Course Content

Unit 1 Metals and alloy system **7 Hrs**

Introduction to Metallic and Non-metallic materials and its classification (metals/alloys, Metals, Metallic bonds, Crystal structure (SC, BCC, FCC, HCP), Imperfections in crystals,Alloy formation by crystallization, Nucleation and growth, Cooling curves, Dendritic structure and coring. Solid solutions and intermediate phases, Phases and Gibbs phase rule, Construction of equilibrium diagrams from cooling curves, Isomorphous system (Solid Solution), Eutectic, Partial solubility Peritectic and Intermetallic Compounds Lever arm principles,

Unit 2 Study of Ferrous alloys **6 Hrs**

With respect to typical compositions, Properties and Applications for the following alloys.) Fe- Fe3C equilibrium diagram - Ferrous alloys (Plain carbon steels, cast iron) Alloy steels- Free cutting steels, HSLA high carbon low alloy steels, mar aging steels. Creep resisting steels, Stainless steels- different types. Tool steels- types, Specifications based on IS, BS, SAE, AISI,

Unit 3 Study of Non Ferrous alloys and mechanical testing **6 Hrs**

Copper based alloys- brasses (Cu- Zn), Bronzes (Cu- Sn), Cu- Be, Cu-Ni. aluminium alloys Al-Cu(Duralumin) Al-Si (Modification), Pb- Sn (Solders and fusible alloys) Sn-Sb alloys (Babbits) Ti (Ti-6Al-4V) super alloy Precipitation hardening - Basic requirements, Stages, Destructive Testing methods: Tensile, Compressive, Impact, Fatigue, Creep, Hardness (Rockwell, Brinell and Vickers) Non- Destructive Testing: Visual inspection, Dye Penetrant,

Magnetic, Ultrasonic, Radiography, Eddy Current testing.

Unit 4 **Principles of heat treatment, softening process** **7 Hrs**

Transformation of Pearlite into austenite upon heating, Transformation of austenite into Pearlite, Bainite and Martensite on cooling. TTT –Diagram and CCT - Diagrams - significance, Effect of alloying elements on TTT diagram and its Significance. Heat treatment of steels, Annealing – Types-Full, Partial and Sub critical annealing (Various types) and purposes, Normalising-Purposes.

Unit 5 **Heat treatment Processes** **6 Hrs**

Hardening (Hardening types), Purposes, Austempering&Martempering, Mechanism of quenching and Quenching media, Hardenability- Grossmans critical diameter method and Jominy end quench test. Tempering Types, Structural transformations during tempering, purposes sub-zero treatment, Surface hardening - Flame and Induction, case hardening - Carburising, Nitriding, Cyniding, Carbonitriding, Heat treatment defects and remedies.

Unit 6 **Powder Metallurgy** **6 Hrs**

Advantages, Limitations and Applications of Powder Metallurgy Powder manufacturing types- Mechanical, Physical, Chemical and Electro- Chemical, Mixing/ Blending- (Double cone and Y- Cone mixers) Compaction- types- Conventional, Isostatic, HERF, Powder rolling and extrusion Sintering- Types liquid stage and solid stage sintering, Finishing operations: Sizing, Machining, Infiltration and Impregnation, Flowcharts for – Self-lubricating bearings, Electrical Contacts, Carbide Tipped Tools, Sintered aluminium products, Filters.

Text Books

1. "Material science and metallurgy for engineers", V.D. Kodgire, Everest Publishers Pune, 12th Edition.
2. "Physical metallurgy", Vijendrasingh, Standard Publishers Delhi

Reference Books

1. "Introduction to physical metallurgy", S.H.Avner, McGraw Hill Book Company Inc, Edition, 2nd , 1974.
2. "Material science and engineering" W.DCallister, Wiley India Pvt.Ltd., 5th Edition.
3. "Heat Treatment of Metals", J L Smith and SC Bhatia, CBS Publishers and distributors, New Delhi, 1st edition, 2008.
4. "Heat Treatments Principles and Practices", T.V. Rajan / C.P. Sharma, Prentice Hall of India Pvt Ltd, New Delhi,
5. "Material Science and Engineering",VRaghwan., Prentice Hall of India Pvt. Ltd., New Delhi ,3rd Edition, 1995.
6. "Engineering Metallurgy", R.A. Higgins, Viva Books Pvt. Ltd., New Delhi, 1stEd.,1998
7. "Physical Metallurgy for Engineers ", D.S.Clark, W. R. Varney, AN East West Press Pvt. Ltd. , New Delhi, 2nd Edition,1962

Second Year B. Tech. Mechanical Engineering Semester IV
MEL215: STRENGTH OF MECHANICAL ELEMENTS

Teaching Scheme	
Lectures	3 Hrs. /Week
Total Credits	3

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Course Objective:

1. To understand the basics for design of mechanical elements.
2. To gain knowledge of different types of stresses, Strains and deformation induced in Mechanical Components due to external loads.
3. To study the distribution of various stresses in Mechanical Elements due to various types of loads.

Course Outcomes:

At the end of the course students will be able to,

1. Student will be able to understand the concepts of various stresses and their significant effects in context with engineering applications.
2. Student will be able to effectively use the concepts of shear force and bending moment diagram in design of machine elements.
3. Compute and analyze bending and shear stresses induced in mechanical components.
4. Will be able to compute the principal stresses and strains by analytical and graphical methods.
5. Able to estimate the slope and deflection in determinate beam by double integration method and Macaulay's method.
6. Analyze buckling and bending phenomenon in columns and beams.

Course Contents

Unit 1 **Stresses and Strains:** Concept of Stress and Strain, (Linear, Lateral, Shear and Volumetric), Hooke's Law, Poisson's ratio, Modulus of Elasticity, Modulus of Rigidity, Stress-strain diagram for ductile and brittle material, Factor of safety, Working stress. Normal and shear stresses, Principal of superposition, Composite sections, Stresses of varying section in bars, Bulk Modulus, Inter-relationship between elastic constants. **7 Hrs**

Unit 2 **Torsion, Shear Force and Bending Moment** **7 Hrs**

A) Torsion: Basic assumptions, Torsion formula, Hollow and solid circular shafts, Angular deflection

B) Shear Force and Bending Moment: Concept and definition of shear force and bending moment in determinate beams due to concentrated, UDL, uniformly varying load and couples.

Unit 3 **Bending Stresses in Beams:** Symmetric pure bending of beams, Flexure formula, moment of resistance of cross-sections, Simple built-up section, Design of rectangular and circular (solid and hollow) sections; L, I and T **6 Hrs**

sections.

Unit 4	**Shear Stresses in Beams :** Distribution of shear stresses in beams of symmetrical and unsymmetrical sections such as I, T, and L.	**5 Hrs**
Unit 5	**Principal Stresses and Strains:** Normal and shear stresses on any oblique planes, Concept of Principal planes, Derivation of expression for Principal stresses and maximum shear stress, Positions of principal planes and planes of maximum shear, Graphical solutions using Mohr's circle of stresses, Combined effect of shear and bending in Beam**.**	**7 Hrs**
Unit 6	**Deflection of Beams and Columns** **A) Deflection of Beams:** Strain curvature and moment curvature relation, Solution of beam deflection problem by Double integration method, Macaulay's method. (Simply Supported Beam and Cantilever.) **B) Columns:** Derivation of Euler's formula for different end connections, its limitation Concept of equivalent length, Eccentric loading, Rankine formula.	**7 Hrs**

Text Books:

1. "Strength of Materials", S. Ramamruthum, Dhanpat Rai and Sons, New Delhi.
2. "Strength of Materials", R. K. Bansal, Laxmi Publication, 4th Edition.
3. "Strength of Materials", Khurmi Gupta, S. Chand Publication.

Reference Books:

1. "Strength of Materials", R.K. Rajput, S. Chad Publication.
2. "Mechanics of structure", S.B Junnerkar, Charotar Publication House.
3. "Strength of Materials", S. S. Bhavikatti, Vikas Publication House.
4. "Strength of Materials", Timoshenko and Young, CBS Publication.
5. "Mechanics of Materials", S. S. Ratan, Tata McGraw Hill Publication, 2009.
6. "Strength of Materials", B. K. Sarkar, McGraw Hill Publication, 2003.
7. "Strength of Materials", L. S. Negi, McGraw Hill Publication, 2008.

Second Year B. Tech. Mechanical Engineering Semester IV
MEL216: THEORY OF MACHINES-I

Teaching Scheme	
Lectures	3 Hrs. /Week
Total Credits	3

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Prerequisites- Engineering Mechanics, Applied Physics

1. To provide basic concept of kinematics and kinetics of machine elements.
2. To study basics of power transmission.

Course Outcomes

At the end of the course students will be able to

1. Understand different types of mechanisms and their applications.
2. Select different power transmitting elements according to application.
3. Select different governing mechanisms according to application.
4. Design cam with follower for different applications.

Course Contents

Unit 1.	**1 Basic Concept of Mechanisms:** Links, kinematic pair (lower and higher), Kinematic chain, Mechanism, inversion, Types of constraints, Grubbler's criterion, Inversions of slider crank chain, Double slider crank chain, Four bar, Steering gear mechanisms, Analysis of Hooke's joint.	**5 Hrs.**
Unit 2.	**Velocity and Acceleration in Mechanisms:** Graphical analysis of Velocity and acceleration for different mechanisms using relative velocity and acceleration method, Coriolis' component of acceleration, Velocity analysis by Instantaneous centre method. Introduction to Synthesis of Mechanism.	**12 Hrs.**
Unit 3.	**Friction:** Introduction of friction, Friction in pivot bearings, Inclined plane theory, Friction in screws.	**5 Hrs.**
Unit 4.	**Cams:** Types of cams and followers, Profiles of cams for specified motion of different followers, Spring load on the follower, Jumping of follower, Introduction to polynomial follower motions.	**5 Hrs.**
Unit 5.	**Belts and Dynamometers:** Types of belt drives, Calculation of power transmitted, Belt tension ratio, Actual tension in a running belt, Centrifugal and initial tension in belt, Slip and creep of belt, Classification of dynamometers, Study of rope brake absorption dynamometer and belt transmission dynamometer.	**5 Hrs.**
Unit 6.	**Governors and Flywheel:** Types of governors, Porter and Hartnell governor, Controlling force and stability of governor, Hunting, Sensitivity, Isochronism, Governor effort and power, Insensitiveness of governors. Turning moment diagrams, Fluctuation of energy, Coefficient of fluctuation of speed, Rimmed flywheel.	**7 Hrs.**

Text Books

1 "Theory of Machines", Rattan S.S, Tata McGraw Hill New Delhi, 2nd Edition.
2 "Theory of Machines", H.G. Phakatkar, Nirali Publication. Pune
3 "Theory of Machines", V.P. Singh, Dhanpat Rai and Sons.

Reference Books

1 "Theory of Machines", Thomas Bevan, CBS Publishers, New Delhi.
2 "Theory of Machines and Mechanism", Shigley, McGraw Hill, New York
3 "Theory of Machines", Dr. R.K. Bansal, Laxmi Publication.
4 "Theory of Machines and Mechanism", G.S. Rao and R.V. Dukipatti, New Age, Delhi.
5 "Theory of Machines", Shah and Jadhawani, Dhanpat Rai and Sons
6 "Theory of Machines", P.L.Ballany, Khanna Publication, New Delhi, 2nd Edition.
7 "Theory of Machines", Abdullah Shariff, McGraw Hill, New Delhi.

Second Year B. Tech. Mechanical Engineering Semester IV
MEL217: FLUID AND TURBO MACHINERY

Teaching Scheme	
Lectures	3 Hrs. /Week
Total Credits	3

Evaluation Scheme	
SE-I	25
SE-II	25
SEE	50
Total	**100**

Prerequisites: Fluid Mechanics, Applied Thermodynamics

Course Objectives:

1. To learn the working principles of Impulse and Reaction water turbines and also to study its velocity triangles .To study design parameters related to Turbines
2. To understand the concept of Centrifugal pumps and its construction. To understand MPSH and NPSH terms related to centrifugal pumps
3. To study equations for specific speed of various turbines and pumps. To understand performance characteristics of various turbines and pumps.
4. To illustrate the concept of centrifugal compressor, Axial compressors. To understand various parameters related to rotodynamic air compressors
5. To discuss the working of Gas Turbines and know its various configurations. To determine the efficiencies of gas turbines

Course Outcomes :

At the end of the course students will be able to

1. Define/Describe classification, types, working principle, efficiency, and applications etc. For fluid and turbo machines.
2. Formulate and solve variety of simplified problems in fluid and turbo machinery.
3. Apply concepts of mass, momentum and energy conservation to design various fluid and turbo machines such as impulse and reaction turbines, centrifugal pump and air compressors.
4. Perform experiments individually & / or in team to evaluate / analyse performance of fluid and turbo machines such as impulse turbine, reaction turbine, centrifugal pump, two stage reciprocating air compressor and centrifugal blower.

Course Contents

Unit 1 **IMPULSE WATER TURBINES:** **7 Hrs.**

Impact of Jet, Euler's equation for work done in Rotodynamic Machines classification of water turbines, Pelton wheel, its construction and working, velocity triangles. Types, Pelton wheel design bucket dimensions, Number of buckets, Jet diameter, Wheel diameter, Jet ratio, Speed ratio, Number of jets, Calculation of efficiency, Power, Discharge etc. Governing of Pelton wheel, Model Testing, Unit quantities, Specific speed of turbine and performance characteristics of turbine

Unit 2	**REACTION WATER TURBINES:** Principle of operation, Construction and working of Francis and Kaplan Turbine, Draft tube, Cavitation calculation of various efficiencies, Power, Discharge, Blade angles, Runner dimensions etc. Governing of Francis and Kaplan turbine. Draft tube-types and analysis. Model Testing, Specific speed of turbine and performance characteristics of turbine.	**7 Hrs.**
Unit 3	**CENTRIFUGAL PUMPS:** Working principles, Construction, Types, Various heads, Multistage pumps, Velocity triangles, Minimum starting speed, Cavitation, Maximum permissible suction head (MPSH) and Net positive suction head (NPSH). Methods of priming, calculations of efficiencies, Discharge, Blade angles, Head, Power required Impeller dimensions etc. Specific speed and performance characteristics of pumps, Pump selection.	**7 Hrs.**
Unit 4	**AIR COMPRESSORS:** Application of compressed air, classification of compressor, Reciprocating compressors, construction , Work input, Necessity of cooling , Isothermal efficiency, Heat rejected, Effect of clearance volume, Volumetric efficiency, Necessity of multi staging, construction, Optimum intermediate pressure for minimum work required, After cooler, Free air delivered, air flow measurement.	**6 Hrs.**
Unit 5	**ROTODYNAMIC AIR COMPRESSORS:** Centrifugal compressor, velocity diagram. Theory of operation, losses, Adiabatic efficiency, Effect of compressibility, Diffuser, Pre whirl, Pressure coefficient, Slip factor, performance. Axial flow compressors, Velocity diagram, Degree of reaction, Polytropic efficiency, Surging, Chocking, Stalling, Performance, Comparison with centrifugal.	**6 Hrs.**
Unit 6	**GAS TURBINES:** Working principles, Applications, Open, Closed cycle and their comparison. Cycle modified to Regeneration, Reheat, and Intercooling performance. Calculation of gas turbine work ratio, Efficiency, Types of fuels for gas Turbine, Introduction to Jet engine.	**6 Hrs.**

Text Books :

1. Thermal Engineering, R K Rajput, Laxmi Publication.
2. Fluid Mechanics and hydraulic machines, R. K. Rajput , S. Chand Publication.
3. Fluid Mechanics and hydraulic machines, R. K. Bansal, L.P. Publishing House.

Reference Books

1. Turbo machines, S.M. Yahya , Tata McGraw Hill ,2005
2. Fans, compressor and turbine, S. M. Yahya,Tata McGraw Hill ,2005
3. Steam and gas Turbines, R. Yadav, Central Publishing House, Allahabad, 6th Edition, 1997.
4. Gas Turbines, V. Ganeshan, Published by TMH Education Pvt. Ltd., 3rd Edition.
5. Thermal Engineering, Kumar Vasantdani, Khanna publisher
6. Fluid mechanics and hydraulic machines, Modi and Seth, Standard Book House, 2004

Second Year B. Tech. Mechanical Engineering Semester IV
MEP 218: PROGRAMMING AND COMPUTATIONAL METHODS LAB

Teaching Scheme	
Practical	2 Hrs. /Week
Total Credits	1

Evaluation Scheme	
CIE	50
Total	**50**

List of Experiments:

1. Program on Bisection method
2. Program on Muller's method
3. Program on Newton-Raphson method
4. Program on Gauss Elimination method
5. Program on Seidel method
6. Program on Linear Regression method
7. Program on Simpsons method
8. Program on RK method
9. Program on Picard's method
10. Program on Laplace method

Minimum eight experiments (but not limited to above list) to be conducted from above list.

Submission:
Completed journal with programs (C, C++and Scilab).

Second Year B. Tech. Mechanical Engineering Semester IV
MEP219: METALLURGY LAB

Teaching Scheme	
Practical	2 Hrs./Week
Total Credits	2

Evaluation Scheme	
	Marks
CIE	50
SEE	50
Total	**100**

List of Experiments:

1. Tensile testing of M.S.
2. Hardness testing (Rockwell, Brinell and Vickers).
3. Impact testing (Izod and Charpy) of M.S, Brass and Al Alloy.
4. Non Destructive testing-Dye penetrant and magnetic particle testing.
5. Macroscopic Examinations -Spark Test.
6. Preparation of specimen for microstructure analysis.
7. Study of microstructure of steels and Cast Irons.
8. Study of microstructure of Non-ferrousalloys(Brass, Duralimin, Babbit)
9. Heat treatment of steels (Annealing, Normalizing, Hardening on medium / high carbon steel and Tempering process).
10 Jominy end quench test for hardenability.

Industrial visit should be conducted to observe industrial heat treatment practices.

Submission:
1. Complete Journal with industrial visit report.

SEE: Based on experiments conducted and Practical/Oral Examination at the end of semester

Text Books
3. "Material science and metallurgy for engineers", V.D. Kodgire, Everest Publishers Pune, 12th Edition.
4. "Physical metallurgy", Vijendrasingh, Standard Publishers Delhi

Reference Books
1 "Introduction to physical metallurgy", S.H.Avner, McGraw Hill Book Company Inc, Edition, 2nd , 1974.
2 "Physical Metallurgy for Engineers ", D.S.Clark, W. R. Varney, AN East West Press Pvt. Ltd. , New Delhi, 2nd Edition,1962
3 "Material science and engineering" W.DCallister, Wiley India Pvt.Ltd., 5th Edition.
4 "Heat Treatment of Metals", J L Smith and SC Bhatia, CBS Publishers and distributors, New Delhi, 1st edition, 2008.
5 "Heat Treatments Principles and Practices", T.V. Rajan / C.P. Sharma, Prentice Hall of India Pvt Ltd, New Delhi,

Second Year B. Tech. Mechanical Engineering Semester IV
MEP220: STRENGTH OF MECHANICAL ELEMENTS LAB

Teaching Scheme	
Practical	2 Hrs./Week
Total Credits	2

Evaluation Scheme	
CIE	50
SEE	50
Total	**100**

List of Experiments /Assignments:

1. Problems/ Theory on Stresses and strains.
2. Problems/ Theory on Torsion.
3. Problems/ Theory on Shear force diagram and Bending moment diagram.
4. Problems/ Theory on Bending stresses in beams.
5. Problems/ Theory on Shear stresses in beams.
6. Problems/ Theory on Principal stresses and theories of failures.
7. Problems/ Theory on Deflection of beams and Columns.

8. Find out deflection and stresses induced in cantilever and simply supported beams by using either ANSYS or Hyper Works software.

All experiments to be conducted.

Submission:
Completed Journal.

SEE: Based on experiments conducted and Practical/Oral Examination at the end of semester.

Second Year B. Tech. Mechanical Engineering Semester IV
MEP221: THEORY OF MACHINES-I LAB

Teaching Scheme	
Practical	2 Hrs. /Week
Total Credits	1

Evaluation Scheme	
CIE	50
Total	**50**

List of Experiments

1. Study of basic mechanisms. (Demonstration of models, Actual mechanisms etc.)
2. One A3 size sheet of Velocity problems by relative velocity method and Instantaneous center method. (3 Problems on Relative velocity method and 1 Problems on Instantaneous center method problems)
3. One A3 size sheet of Acceleration problems by relative acceleration method. (Minimum 4 problems)
4. Verification of ratio of angular velocities of shafts connected by Hooks joint.
5. One A3 size sheet of Problems on cam profile. (Minimum 4 problems)
6. Experiment on Governor Characteristics for Porter or Hartnell governor.
7. Experiment on Cam Profile
8. Experiment on belt drives.
9. Experiment on Dynamometer
10. Computer aided synthesis of simple mechanisms.
11. Computer aided analysis of simple mechanisms.

Minimum Eight experiments to be conducted from the above list.

Submission:

1. Completed Journal

Second Year B. Tech. Mechanical Engineering Semester IV
MEP222: FLUID AND TURBO MACHINERY LAB

Teaching Scheme	
Practical	2 Hrs. /Week
Total Credits	1

Evaluation Scheme	
CIE	50
Total	**50**

List of Experiments:

1. Study and demonstration of reciprocating pump and hydraulic ram
2. Study of hydraulic devices- Intensifier, Accumulator, Hydraulic jacks, Press, Crane.
3. Study and trial on Pelton wheel.
4. Study and trial on Francis turbine.
5. Trial on Centrifugal pump.
6. Study and trial on reciprocating compressor.
7. Study and trial on centrifugal blower.
8. Study of other types of pumps- Gear pump, Jet pump, Submersible pump, Air lift pump.
9. Industrial visit to Pump/Turbine Manufacturing Industry or Hydro Power Plant.
10. Search and prepare the report on any one hydro power plant.

Minimum Eight experiments to be conducted from the above list.

Submission:

1. Completed Journal with industrial visit report.

Second Year B. Tech. Mechanical Engineering Semester IV
MEP223: COMPUTER AIDED DRAWING (CAD)-II LAB

Teaching Scheme	
Practical	2 Hrs. /Week
Total Credits	1

Evaluation Scheme	
CIE	50
Total	**50**

Course Objectives:

The course aims to:

1 Understand - a) Parametric Modeling Fundamentals and Procedure
b) Computer Aided Manufacturing Fundamentals and Procedure

2 Develop an ability to - a) Create constrained 2-D Sketches
b) Create Solid Models of machine components with drafting
c) Create assembly model (min. 5 components) with drafting

Course Outcomes:

At the end of the course students will be able to

1 Describe 3d modelling commands
2 Prepare design intent and apply appropriate command to construct solid model
3 Use the techniques, skills, and computer aided tools necessary for advance engineering practice

Course Contents

Unit 1 **Introduction to CAD, GUI, 2D Modeling:** Introduction – Introduction to CAD, modeling, simulation, analysis and optimization. Introduction to Graphical User Interface (GUI)

Unit 2 **3D modelling:** Parametric 3 D solid modeling –fundamentals, 2-D sketcher and 3D solid modeling sketch based and dress up feature operations.

Unit 3 **Surface Modeling:** Introduction, various commands in surface modeling.

Unit 4 **Assembly Modeling and Production Drawing :** Assembly modeling – Defining relationship between various parts of machine, creation of constraints, generation of exploded view. Production drawing – Generation of 2-D sketches from parts and assembly 3-D model, Bill of material.

Unit 5 **Geometric Dimensioning and Tolerance, Styling and reverse engineering:** Introduction to ASME Y14.5 – 2009, straightness, perpendicularity, flatness, angularity, roundness, concentricity, cylindricity, run out, profile, true position, parallelism, orientation. Introduction to CAS, Class A Surfaces, Role of Class A Surface Engineer, Requirements for a Surface to fulfil "Class A Surface" Standards, case Studies for Class A Surfaces Creation using reverse engineering.

List of Experiments:

1. Solid Modelling with drafting - 2 Exercises
2. Surface Modelling like mouse, badminton racket, monitor, hair dryer etc. - 2 Exercises
3. Assembly with minimum 5 components like crane hook, tail stock, screw jack, universal coupling etc.
4. Part programming for CNC turning center – 2 parts
5. Part programming for Vertical Machining Center – 2 parts
6. Tool path generation by using suitable CAM software – 2 parts

All experiments to be conducted.

Text Books :

1. "CATIA V5", BY Sham Tikoo.

Reference Books :

1. "Machine Drawing", N. D. Bhatt and V.M. Panchal, Charoter Publications
2. ASME Y14.5, (2009)
3. Help Manuals and Tutorials of Referred Software
4. "Machine Drawing", N. Siddheshwar, P. Kannaiah, V V S Sastry, Tata McGraw Hill

Submission:

1. Completed Journal.

Second Year B. Tech. Mechanical Engineering Semester IV
MEP224: MACHINE SHOP PRACTICE –I

Teaching Scheme	
Practical	2 Hrs. /Week
Total Credits	1

Evaluation Scheme	
CIE	50
Total	**50**

Course Objective:

1. Interpret drawing and machining processes
2. Create job of various shape by using different machine tools.
3. Understand mechanism and application of drilling machine, boring machine.

Course Outcomes:

1. To understand given drawing of a component
2. Hands on experience on working with lathe machine
3. Hands on experience on carpentry
4. Hands on experience on working with drilling machine

List of Experiments"

1. Drawing part details and preparation of process sheet
2. Metal bar cutting as per dimensions.
3. Facing and centre drilling operation
4. Plane turning and Knurling operation
5. Threading/Taper turning/ Drilling operation
6. Study and calculation of pattern allowances
7. Job cutting and pattern dimensioning
8. Different carpentry operations on pattern
9. Different carpentry operations on pattern
10. Finishing and submission of job

Submission:

1. Completed Turning and pattern job
2. Completed diary with Process sheet

Text Books:

1. P. C. Sharma., Production technology, S. Chand and Company Ltd., New Delhi.
2. HajraChowdhary, Elements of Workshop Technology, Vol. I, Media Promoters & Publications, Bombay.

Reference Books:

1. Machine Tools and Mfg. Technology, Steve F. Krar, Mario Rapisarda, Albert F. Check
2. O. P. Khanna, Foundry technology, Khanna Publishers, New Delhi.
3. P L Jain, Principles of foundry technology, Tata McGraw-Hill, New Delhi.
4. HajraChowdhary, Elements of Workshop Technology, Vol. I, Media Promoters & Publications, Bombay
5. B.S. Raghuvanshi, Workshop Technology, Vol. II, DhanapatRai Publications, New Delhi, 10th Edition, 2000
6. W.A.J. Chapman, Workshop Technology, Vol. II, Viva Books, New Delhi,
7. Production Technology, R. K. Jain, Khanna Publishers, Delhi, 15th Edition, 2000.

Second Year B. Tech. Mechanical Engineering Semester IV

MEL212: ENVIRONMENTAL STUDIES (Mandatory Studies)

Teaching Scheme	
Lectures	2 Hrs. /Week
Total Credits	2

Evaluation Scheme (Annual Evaluation in Sem II)	
SEE	70
Project	30
Total	**100**

Course Objectives

1. To define multidisciplinary nature of environmental studies.
2. To explain causes and effects of environmental pollution.
3. To explain social issues of the environment.
4. To describe eco-friendly and sustainable development in environment.

Course Outcomes

At the end of the course students will be able to

1. Understand definition and importance of environment.
2. Identify causes and effects of environmental pollution.
3. Understand control measure of industrial pollution.
4. Understand social issues and local Environmental problems (Group project)

Unit 1 **Biodiversity and its Conservation:** **6 Hrs.**

Introduction - Definition: genetic, species and ecosystem diversity, Bio-geographical classification of India. Value of biodiversity: Consumptive use, productive use, social, ethical, aesthetic and option values. India as a mega-diversity nation. Western Ghats as a bio-diversity region.

Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Unit 2. **Environmental Pollution**: **10 Hrs.**

Definition: Causes, effects and control measures of Air pollution. Water pollution. Soil pollution, Marine pollution.
Noise pollution. Thermal pollution & Nuclear hazards.
Solid Waste Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution.

Unit 3. **10Hrs.**

Social Issues and Environmental protection:

Disaster Management: Floods, earthquake, cyclone and landslides. Tsunami. Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns. Environmental Ethics: Issue and possible solutions. Global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products.

Environment Protection and project work

From unsustainable to sustainable development. Environment protection act. Air (Prevention and Control of Pollution) Act. Water (Prevention and Control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act.

Text Books:

1. Environmental Studies for Undergraduates publisher Shivaji University Kolhapur
2. Environmental Studies by Erach Bharucha, publisher University Press.
3. Environmental Studies by Tiwari and Khulbe publisher IK International Kanpur

References :

1) Agarwal, K.C.2001, Environmental Biology, Nidi Pub. Ltd., Bikaner.

2) Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad 380013, India, Email:mapin@icenet.net (R)

3) Brunner R.C.,1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
4) Clank R.S. Marine Pollution, Clanderson Press Oxford (TB)

5) Cunningham, W.P. Cooper, T.H. Gorhani, E. & Hepworth, M.T.2001, Environmental Encyclopaedia, Jaico Pub. Mumbai, 1196p

6) De A.K., Environmental Chemistry, Wiley Western Ltd.
7) Down to Earth, Centre for Science and Environment , New Delhi.(R)

8) Gleick, H.,1993, Water in crisis, Pacific Institute for studies in Dev., Environment & Security. Stockholm Env. Institute. Oxford Univ. Press 473p

9) Hawkins R.E., Encyclopaedia of Indian Natural History, Bombay Natural History Society, Bombay (R)

10) Heywood, V.H.& Watson, R.T.1995, Global Biodiversity Assessment, Cambridge Univ. Press 1140p.

11) Jadhav, H. and Bhosale, V.M.1995, Environmental Protection and Laws, Himalaya Pub. House, Delhi 284p.

12) Mickinney, M.L. and School. R.M.1196, Environmental Science Systems and Solutions, Web enhanced edition, 639p.

13) Miller T.G. Jr., Environmental Science. Wadsworth Publications Co. (TB).