



**SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE
(AUTONOMOUS)**

(Approved by AICTE, New Delhi, Affiliated to JNTUK, Kakinada)

Accredited by NAAC with 'A+' Grade.

Recognised as Scientific and Industrial Research Organisation

SRKR MARG, CHINA AMIRAM, BHIMAVARAM – 534204 W.G.Dt., A.P., INDIA

Regulation: R23		II / IV - B.Tech. I - Semester							
MECHANICAL ENGINEERING									
COURSE STRUCTURE (With effect from 2023-24 admitted Batch onwards)									
Course Code	Course Name	Category	L	T	P	Cr	C.I.E.	S.E.E.	Total Marks
B23BS2103	Numerical Methods & Transform Techniques	BS	3	0	0	3	30	70	100
B23HS2101	Universal Human Values -II : Understanding Harmony and Ethical Human Conduct	HS	2	1	0	3	30	70	100
B23ME2101	Thermodynamics	PC	3	0	0	3	30	70	100
B23ME2102	Mechanics of Solids	PC	3	0	0	3	30	70	100
B23ME2103	Material Science and Metallurgy	PC	3	0	0	3	30	70	100
B23ME2104	Mechanics of Solids and Materials Science Lab	PC	0	0	3	1.5	30	70	100
B23ME2105	Computer-aided Machine Drawing	PC	0	0	3	1.5	30	70	100
B23ME2106	Python programming Lab	SEC	0	1	2	2	30	70	100
B23MC2101	English Proficiency	MC	2	0	0	-	30	-	30
TOTAL			16	2	8	20	270	560	830

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23BS2103	BS	3	--	--	3	30	70	3Hrs.
NUMERICAL METHODS & TRANSFORM TECHNIQUES								
(For ME)								
Pre-requisites: Basic concepts of calculus.								
Course Objectives: Students are expected to								
1.	Acquire Computational Skills through numerical methods from initial level to advanced level for handling various real-world applications.							
2.	Familiarize with the concepts of transforms techniques, a powerful Mathematical tool in Engineering applications.							
Course Outcomes: At the end of this course, Students will be able to								
S.No	OUTCOME							Knowledge Level
1.	Find the approximate root of a polynomial and transcendental equations by different algorithms and choose appropriate interpolation technique to interpolate or extrapolate a given data with equal and unequal intervals.							K3
2.	Apply certain numerical integration techniques in evaluating complex integrals and numerical algorithms for the approximate solution of certain Initial-Value-problems (IVP's) that arouse in Engineering applications.							K3
3.	Apply Laplace transforms to evaluate Improper integrals, solve differential equations and Engineering applications of time domain to frequency domain.							K3
4.	Determine the Fourier series of periodic signals.							K3
5.	Apply the concepts of Fourier Transform in analyzing the frequency domain of non-periodic signals.							K3
SYLLABUS								
UNIT-I (10Hrs)	Solution of Algebraic and Transcendental Equations: Introduction, Bisection method, Secant method, Method of false position, Iteration method & Newton-Raphson method. Interpolation: Newton's forward and backward interpolation formulae for equi-spaced data, Lagrange's interpolation formula for unequally-spaced data.							
UNIT-II (10Hrs)	Numerical Integration and solution of Ordinary Differential equations: Trapezoidal rule, Simpson's $1/3^{\text{rd}}$ and $3/8^{\text{th}}$ rule. Solution of first order ordinary differential equations subjected to initial conditions by Taylor's method, Picard's method, Euler's method, Modified Euler's method and Fourth ordered Runge - Kuttamethod.							
UNIT-III (12Hrs)	Laplace Transforms: Definition, Laplace transform of standard functions, Properties of Laplace Transforms, Shifting theorems, Transforms of derivatives and integrals, Unit step function, Dirac's delta function. Inverse Laplace transforms: Convolution							

	theorem (without proof). Applications: Solving ordinary differential equations (initial value problems) and integro differential equations using Laplace transforms
UNIT-IV (10Hrs)	Fourier series: Introduction, Periodic functions, Fourier series of a periodic function, Dirichlet's conditions, Even and odd functions, Change of interval, Half-range sine and cosine series.
UNIT-V (12Hrs)	Fourier Transforms: Fourier integral theorem (without proof), Fourier sine and cosine integrals, Infinite Fourier transform, Sine and cosine transforms, Finite Fourier transforms, Properties. Inverse Fourier transforms – Convolution theorem (without proof).
Textbooks:	
1.	Scope and Treatment asin “Higher Engineering Mathematics”, by Dr. B.S.Grewal , 43 rd Edition, Khanna Publishers.
Reference Books:	
1.	Advanced Engineering Mathematics, by Erwin Kreyszig, Wiley
2.	Higher Engineering Mathematics, by B.V.Ramana, Tata Mc Graw Hill Company.
3.	A text book of Engineering Mathematics, by N.P.Bali and Dr. Manish Goyal, Lakshmi Publications.
4.	Peter O'Neil, Advanced Engineering Mathematics, Cengage.
5.	Advanced Engineering Mathematics, by H.K.Dass, S.Chand Company.
e-Resources:	
1.	https://onlinecourses.nptel.ac.in/noc24_ma60/preview
2.	https://archive.nptel.ac.in/courses/111/103/111103070/

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23HS2101	HS	2	1	--	3	30	70	3 Hrs.

UNIVERSAL HUMAN VALUES-II: UNDERSTANDING HARMONY AND ETHICAL HUMAN CONDUCT

(Common to all Programmes of Engineering)

Course Objectives: The objective of this course is to make the student aware of

1	Essential complementarity between 'Values' and 'Skills' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2	Harmony in the human being, family, society and nature/existence
3	Holistic perspective towards life, profession and happiness

Course Outcomes: At the end of this course student will be able to

S. No.	Outcome	Knowledge Level
1	Explain the role of value education in achieving basic human aspirations.	K2
2	Summarize needs to obtain harmony in self(I).	K2
3	Describe criteria for human-human relationship and harmony in society	K2
4	Explain four orders of nature and our existence	K2
5	Interpret significance of harmony in holistic development	K2

Estd. 1980

SYLLABUS

UNIT-I (9 Hrs)	<p>Introduction to Value Education: Understanding Value Education- Need, Basic Guidelines, Content and Process for Value Education Purpose and motivation for the course. Self-exploration as the Process for Value Education - Sharing about Oneself. Myers-Briggs Type Indicator (MBTI) Personality Test. Continuous Happiness and Prosperity – the Basic Human Aspirations and their Fulfilment. Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education) - Exploring Human Consciousness. Happiness and Prosperity – Current Scenario. Method to Fulfil the Basic Human Aspirations - Exploring Natural Acceptance- understanding and living in harmony at various levels.</p>
UNIT-II (9 Hrs)	<p>Harmony in the Human Being: Understanding Human being as the Co-existence of the Self and the Body. Distinguishing between the Needs of the Self and the Body - Exploring the difference of Needs of Self (I) and Body (Happiness and Physical Facility). The Body as an Instrument of the Self (I)' (I being the doer, seer and enjoyer).</p>

	<p>Understanding Harmony in the Self(I) - Exploring Sources of Imagination in the Self(I). Harmony of the Self (I) with the Body (characteristics and activities of 'I' and harmony in 'I').</p> <p>Programme to ensure self-regulation(<i>Sanyam</i>) and Health(<i>Swasth</i>)- Exploring Harmony of Self (I) with the Body.</p>
UNIT-III (9 Hrs)	<p>Harmony in the Family and Society:</p> <p>Harmony in the Family – the Basic Unit of Human Interaction.</p> <p>'Trust' – the Foundational Value in Relationship- Exploring the Feeling of Trust- intention and competence.</p> <p>'Respect' – as the Right Evaluation- Exploring the Feeling of Respect.</p> <p>Other Feelings, Justice in Human-to-Human Relationship.</p> <p>Understanding Harmony in the Society- (society being an extension of family).</p> <p>Vision for the Universal Human Order- Exploring Systems to fulfil Human Goal.</p>
UNIT-IV (6 Hrs)	<p>Harmony in the Nature/Existence:</p> <p>Understanding the harmony in the Nature.</p> <p>Interconnectedness and mutual fulfillment among the four orders of nature- recyclability and self-regulation in nature.</p> <p>Realizing Existence as Co-existence at All Levels - Understanding Existence as Co-existence of mutually interacting units in all pervasive space.</p> <p>Holistic perception of harmony at all levels of existence.</p>
UNIT-V (9 Hrs)	<p>Implications of the Holistic Understanding – a Look at Professional Ethics:</p> <p>Natural acceptance of human values. Definitiveness of (ethical) human conduct.</p> <p>A Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order.</p> <p>Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.</p> <p>Holistic technologies, production systems and management models- typical case studies.</p> <p>Strategies for transition towards value based life and profession (from the present state to Universal Human Order): a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers, b. At the level of society: as mutually enriching institutions and organizations.</p>
Text Books	
1.	R R Gaur, R Sangal, G P Bagaria. "Human Values and Professional Ethics", Excel Books, New Delhi, 2010
2.	R R Gaur, R Asthana, G P Bagaria. "Teachers' Manual for A Foundation Course in Human Values and Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

Reference Books:	
1.	Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2.	Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3.	The Story of Stuff (Book).
4.	The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5.	Small is Beautiful - E. F Schumacher
6.	Slow is Beautiful - Cecile Andrews
7.	Economy of Permanence - J C Kumarappa
8.	Bharat Mein Angreji Raj – Pandit Sunderlal
9.	Rediscovering India - by Dharampal
10.	Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11.	India Wins Freedom - Maulana Abdul Kalam Azad
12.	Vivekananda - Romain Rolland (English)
e-Resources	
1.	https://fdp-si.aicte-india.org/UHV%20II%20Teaching%20Material/UHV%20II%20Lecture%2023-25%20Ethics%20v1.pdf
2.	https://fdp-si.aicte-india.org/UHV-II%20Class%20Note.php
3.	https://fdp-si.aicte-india.org/download/FDPTeachingMaterial/3-days%20FDP-SI%20UHV%20Teaching%20Material/Day%203%20Handouts/UHV%203D%20D3-S2A%20Und%20Nature-Existence.pdf



ENGINEERING COLLEGE
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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME2101	PC	3	--	--	3	30	70	3 Hrs.

THERMODYNAMICS

(For ME)

Course Objectives: The objectives of the course are

1.	To impart the knowledge of the thermodynamic laws and principles
2.	To enable the student to prepare an energy audit of any mechanical system that exchange heat and work with the surroundings.
3.	To Educate the use of working principle of Internal combustion engines (spark ignition and compression ignition) and their performance of Otto, Diesel and Dual cycles.
4.	Provide fundamental concepts of Refrigeration and Psychrometry.

Course Outcomes: At the end of the course students will be able to

S.No.	Outcome	Knowledge Level
1.	Apply the concepts of thermodynamics to real life systems.	K3
2.	Apply the first law of thermodynamics to compute various thermodynamic properties subjected to different thermodynamic processes.	K3
3.	Determine the performance of heat engines and heat pumps using concepts of second law of thermodynamics and entropy.	K3
4.	Use the working principles of Internal combustion engines (spark ignition and compression ignition) and the performance of air standard cycles.	K3
5.	Apply the fundamental concepts of Refrigeration and Psychrometry to understand the working of refrigeration and air conditioning systems.	K3

SYLLABUS

UNIT-I (10Hrs)	Basic Concepts: System, boundary, Surrounding, control volume, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Cycle, Reversibility, Quasi static Process, Irreversible Process, Energy in State and in Transition, Types, Work and Heat, Point and Path function. Zeroth law of thermodynamics, Equation of state- Universal gas constant.
UNIT-II (10Hrs)	First law of thermodynamics: Joule's Experiments-First law of thermodynamics- Isolated systems and steady flow systems- Specific heats at constant volume and pressure- Enthalpy- First law applied to flow systems- Systems undergoing a cycle and change of state First law applied to steady flow processes- various non-flow processes-Properties of end states- Heat transfer and work transfer- Change in internal energy-throttling and

	free expansion processes.
UNIT-III (10Hrs)	<p>Second law of thermodynamics: Limitations of the First Law – Thermal Reservoir, Heat Engine, Heat pump, Parameters of performance, Second Law of Thermodynamics, Kelvin Planck and Clausius Statements and their Equivalence Corollaries, PMM of Second kind.</p> <p>Entropy: Carnot’s principle, Carnot cycle and its specialties, Clausius theorem, Clausius Inequality, Entropy, Principle of Entropy Increase –Third Law of Thermodynamics.</p>
UNIT-IV (10Hrs)	<p>Air standard Cycles: Otto, Diesel, Dual Combustion cycles–Description and representation on P-v& T-s diagram, Thermal Efficiency, Mean Effective Pressure.</p> <p>I.C. Engines: classification, comparison of two stroke and four stroke engines-comparison of S.I. & C.I. engines.</p>
UNIT-V (10Hrs)	<p>Introduction to Refrigeration: working of Air, Vapour compression system Components, COP, Refrigerants.</p> <p>Introduction to Air Conditioning: Psychrometric properties & processes– characterization of sensible and latent heat loads, load concepts of SHF.</p>
Text Books:	
1.	Applied Thermodynamics-I by R. Yadav, Central Book House.
2.	Engineering Thermodynamics, PK Nag 6th Edition , McGraw Hill.
3.	Thermal Engineering, by R. K. Rajput, Lakshmi Publications.
4.	A Treatise on Heat Engineering by Vasandhani and Kumar.
Reference Books:	
1.	I.C. Engines by V. Ganesan.
2.	Thermodynamics-An Engineering Approach by Y Cengel& Boles.
e-Resources	
1.	https://nptel.ac.in/courses/127/106/127106135/#
2.	https://nptel.ac.in/courses/112/103/112103262/#
3.	https://nptel.ac.in/courses/112105128#

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME2102	PC	3	--	--	3	30	70	3 Hrs.

MECHANICS OF SOLIDS

(For ME)

Course Objectives: The objectives of the course are to

1.	Understand the behaviour of basic structural members subjected to uni axial and bi axial loads, to study engineering properties of materials and stress-strain relationship.
2.	Learn fundamental principles of equilibrium, compatibility, and force-deformation relationship, and principle of superposition in linear solids and structures.
3.	Apply the concept of stress and strain to analyse and design structural members and machine parts under axial, shear and bending loads, moment and torsional moment.
4.	Determine stress, strain, deformation of bars; shear forces, bending moments, slopes and deflections of beams.
5.	Analyze determinate axial structural members: beams, torsional members and shells.
6.	Enhance the knowledge of students on different theories applied for analysis of columns and struts.

Course Outcomes: At the end of the course students will be able to

S.No	Outcome	Knowledge Level
1.	Apply analytical techniques to structural members to understand the concepts of simple stresses and strains under various loads, and utilize this understanding to determine principal stresses.	K3
2.	Sketch Shear Force and Bending Moment Diagrams for statically determinate beams, and study structural behavior by interpreting the diagrams.	K3
3.	Determine the flexural and shear stress distributions of beams subjected to bending.	K3
4.	Compute the slope and deflection for statically determinate beams subjected to varying loading conditions and Examine the stresses produced in circular shafts subjected to twisting moments	K3
5.	Apply different theories to design the columns and struts subjected to different load conditions and Calculate the stresses of Industrial components like thin pressure vessels.	K3

SYLLABUS

UNIT-I (10Hrs)	<p>Simple Stresses: Stress, Strain, Stress-Strain curve, Lateral strain, Poisson's ratio, factor of safety and working stress; Bars of varying cross-section, Compound bars, Complementary Shear stress, Strain energy due to axial loading.</p> <p>Complex Stresses: Stresses acting on an inclined plane under uniaxial, biaxial and</p>
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	general state of plane stress, Principal planes and Principal stresses, Mohr's circle for biaxial stresses.
UNIT-II (10Hrs)	Shear Forces and Bending Moments: Beam - types of loads, types of supports, types of beams, Shear Force and Bending Moment; Relationship between Rate of Loading, Shear Force and Bending Moment; S.F. and B.M. diagrams for cantilever, simply supported and over hanging beams subjected to different loads.
UNIT-III (10Hrs)	Flexure Stresses in Beams: Theory of pure bending, Flexural formula, section modulus of rectangular, circular, I, and T sections, Determination of bending stress distribution across various beam sections. Shear stresses in Beams: Shear stresses distribution across various beam sections like rectangular, circular, I and T.
UNIT-IV (10Hrs)	Slope and Deflection of Beams: Relation between curvature, slope and deflection; Slope and deflection of cantilever and simply supported beams – Double integration method, Macaulay's method and moment area method. Torsional Stresses in Shafts: Pure torsion, Torsion formula, analysis of torsional stresses, Power transmitted.
UNIT-V (10Hrs)	Thin Shells: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and volumetric strains – changes in diameter, and volume of thin cylinders. Thin spherical shells- Derivation of formula for circumferential stresses- changes in diameter, and volume of thin spheres. Columns and Struts: Buckling of columns, Euler's theory – Columns with both ends hinged, both ends fixed, one end fixed and other end hinged, one end free and other end fixed, Limitation of Euler's formula, Empirical formulae – Rankine's formula.
Text Books:	
1.	Analysis of Structures by Vazirani and Ratwani - Vol. 1, Khanna Publishers
2.	Introduction to Solid Mechanics by Popov, Pearson Education
Reference Books:	
1.	Strength of Materials by Timoshenko, CBS Publishers.
2.	Strength of Materials by Sadhu Singh, Khanna Publishers.
3.	Strength of Materials by Jindal, Umesh Publications.
e-Resources	
1.	https://mechanicalc.com/reference/strength-of-materials
2.	https://core.ac.uk/download/pdf/47233878.pdf

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME2103	PC	3	--	--	3	30	70	3 Hrs.

MATERIAL SCIENCE AND METALLURGY

(For ME)

Course Objectives:

1.	To impart knowledge about the engineering materials and their properties and predict their behavior under different working conditions and methods.
2.	To impart knowledge about space lattices, crystal structures and crystal defects.
3.	To acquaint the knowledge about the cooling curves and Phase diagrams of different alloy systems.
4.	To impart knowledge about different heat treatment and surface hardening methods in improving the mechanical properties of steels.
5.	To acquaint knowledge about ferrous & Non-ferrous alloys, particularly Steel and Cast Irons.
6.	To impart knowledge about composite materials and its manufacturing processes.

Course Outcomes: At the end of the course, the students will be able to

S.No	Outcome	Knowledge Level
1.	Determine the properties of metals with respect to crystal structure and understand imperfection in crystals.	K3
2.	Apply knowledge of phase diagram to explain the change in parameters for iron-carbon system and also understand the effect of heat treatment.	K3
3.	Determine various Time Temperature Transformation(TTT) curves and explain surface hardening methods to obtain specific material properties.	K3
4.	Choose various engineering materials based on their compositions and properties used for the specified applications.	K3
5.	Demonstrate comprehensive knowledge of composites, manufacturing techniques and application including smart materials.	K3

SYLLABUS

UNIT-I (10 Hrs)	Structure of crystalline solids: Atomic structure & bonding in solids- Unit cell, Space lattice, Crystallization of metals, Crystal structures and its types-calculations of radius, Coordination Number and Atomic Packing Factor for different cubic structures- Grain and grain boundaries, effect of grain boundaries- Imperfection in solids, point defects, Line defects, Planar defects and Volume defects-Concept of Slip & twinning.
UNIT-II (10 Hrs)	Phase diagrams: Basic terms-Solid solutions - Gibbs phase rule- Lever rule – cooling curves- Phase diagrams - construction of phase diagrams- eutectic systems- Invariant reactions, eutectic, peritectic, eutectoid, peritectoid reactions, metatectic & monotectic

	reactions- Study of binary phase diagrams such as Cu-Ni, Fe-Fe ₃ C and Al-Si -Heat treatment of steel- Annealing, and its types, normalizing, hardening, tempering, martempering, austempering.
UNIT-III (10 Hrs)	Time Temperature Transformation(TTT) diagrams: Construction of TTT diagram, TTT diagram for hypoeutectoid and hypereutectoid steels, CCT diagram-Surface hardening processes like case hardening, carburizing, cyaniding, nitriding, age hardening treatment, Cryogenic treatment, Induction hardening, Flame hardening, hardenability, Jominy end-quench test.
UNIT-IV (10 Hrs)	Engineering Alloys: Ferrous Alloys: Steels- Classification of Steels-Effect of alloying elements of steel - Properties, composition, and uses of Plain carbon, low carbon, medium & high carbon steels. stainless steels, high speed steels, Hadfield steels, tool and die steels - Cast irons- Structure and properties of grey CI, white CI, malleable CI, SG Cast iron, Alloy cast iron Non-Ferrous Alloys- Copper & its alloys: brasses & bronzes, The light alloys:Al, Mg, Titanium and its alloys- Shape Memory Alloys, Super alloys
UNIT-V (8 Hrs)	Composites: Introduction, classification, Manufacturing using Stir Casting, Spray Layup, Filament Winding, Resin Transfer Moulding - Applications of composites. Introduction to Nano materials and smart materials. Powder Metallurgy: Production of metal powders - Powder Metallurgy process and its applications
Text Books: Estd. 1980 ENGINEERING COLLEGE AUTONOMOUS	
1.	Materials Science & Engineering- An Introductionl, William .Callister Jr. Wiley India Pvt. Ltd. 6th Edition, 2006, New Delhi.
2.	Material Science and Metallurgy for Engineersl, Dr. V.D Kodgire and S.V Kodgire.
3.	Physical Metallurgy, Principles & Practicesl, V Raghavan.PHI 2nd Edition 2006, New Delhi.
Reference Books:	
1.	Introduction to Physical Metallurgy by Sidney H AvnerTata McGraw-Hill Education 1997.
2.	Materials Science and Engineering: A First Course By V. Raghavan Phi 5th Edition 2011, New Delhi.
Online Learning Resources:	
1.	https://archive.nptel.ac.in/courses/113/106/113106032/
2.	https://www.youtube.com/watch?v=9Sf278j1GTU
3.	https://www.coursera.org/learn/fundamentals-of-materials-science .
4.	https://www.coursera.org/learn/material-behavior .

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME2104	PC	--	--	3	1.5	30	70	3 Hrs.

MECHANICS OF SOLIDS & MATERIALS SCIENCE LAB

(For ME)

Course Objectives:

1.	Evaluate the values of yield stress, ultimate stress, and bending stress of the given specimen under tension test and bending test.
2.	Conduct the torsion test to determine the modulus of rigidity of the given specimen.
3.	Justify the Rockwell hardness test over with Brinell hardness and measure the hardness of the given specimen.
4.	Examine the stiffness of helical springs by Compression and Tension tests.
5.	Analyze the microstructure and characteristics of ferrous and nonferrous alloy specimens.

Course Outcomes:

S.No	Outcome	Knowledge Level
1	Analyze the stress-strain behavior of different materials.	K4
2	Analyze the relationship between load and deformation of different material/ components e.g. spring and shafts, under the influence of axial / torsional loads	K4
3	Obtain the strength of different materials under impact loads and to determine the indentation hardness of different materials on different hardness scales	K4
4	Categorize various materials by studying microstructures	K4
5	Compare the hardness of treated and untreated steels.	K4

List of Experiment's

1.	Tensile test on a mild steel specimen
2.	Compression test on wooden specimen.
3.	Torsion Test on solid circular shaft.
4.	Impact test on given material a.) Charpy test b.) Izod test
5.	Hardness test on given material a.) Brinell's hardness test b.) Rockwell hardness test
6.	Tests on Compression and tension helical springs.
7.	Preparation and study of the microstructure of mild steel, medium carbon, and high carbon steels
8.	Preparation and study of the microstructure of Non-Ferrous metals
9.	Study of microstructures of cast iron

10.	Study of microstructures of heat-treated steels
11.	Study of Hardenability of steels by Jominy End Quench test
Reference Books:	
1.	Strength of Materials, by Timoshenko
2.	Strength of Materials -By Jindal, Umesh Publications
3.	Physical metallurgy laboratory manual
Reference Links:	
1.	https://virtuallabs.github.io/exp-rockwell-hardness-experiment-iiith/objective.html
2.	https://smnitk.vlabs.ac.in/exp/izod-impact-test
3.	https://sm-nitk.vlabs.ac.in/exp/rockwell-hardness-test
4.	https://sm-nitk.vlabs.ac.in/exp/vickers-hardnesstest



Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME2105	PC	--	--	3	1.5	30	70	3 Hrs.

COMPUTER-AIDED MACHINE DRAWING

(For ME)

Course Objectives

1.	Introduce conventional representations of material and machine components.
2.	Train to use software for 2D and 3D modeling.
3.	Familiarize with thread profiles, riveted, welded and key joints.
4.	Impart solid modeling of machine parts and their sections.
5.	Explain creation of 2D and 3D assembly drawings and familiarize with limits, fits, and tolerances in mating components

Course Outcomes

S.No.	Outcomes	Knowledge Level
1.	Use the knowledge of various standards and specifications to identify and select machine components.	K3
2.	Apply assembly conventions, to prepare a part or assembly for integration into a larger system.	K4
3.	Interpret the knowledge of fits and tolerances in various real-world applications.	K3
4.	Illustrate the advanced CAD packages to enhance design capabilities and efficiency.	K4

SYLLABUS

The following are to be done by any 2D software package

Conventional representation of materials and components:

Detachable joints: Drawing of thread profiles, hexagonal and square-headed bolts and nuts, bolted joint with washer and locknut, stud joint, screw joint and foundation bolts.

Riveted joints: Drawing of rivet, lap joint, butt joint with single strap, single riveted, double riveted double strap joints.

Welded joints: Lap joint and T joint with fillet, butt joint with conventions.

Keys: Taper key, sunk taper key, round key, saddle key, feather key, woodruff key.

Couplings: rigid – Muff, flange; flexible – bushed pin-type flange coupling, universal coupling, Oldham's' coupling.

The following exercises are to be done by any 2D software package:

Sectional views:

Creating solid models of complex machine parts and sectional views.

Assembly drawings: (Any four of the following using solid model software)

Lathe tool post, tool head of shaping machine, tail-stock, machine vice, gate valve, carburetor, piston, connecting rod, eccentric, screw jack, plumber block, axle bearing, pipe vice, clamping device, Geneva cam, universal coupling.	
Production drawing: Representation of limits, fits and tolerances for mating parts. Use any four parts of above assembly drawings and prepare manufacturing drawing with dimensional and geometric tolerances.	
Text Books:	
1.	Machine Drawing, by N.D.Bhatt, Charotal Publishing House.
2.	Machine Drawing by K.L Narayan, P. Kannaiah and K. Venkata Reddy, New Age.publiations
Reference Books:	
1.	Engineering Drawing, by A.C.Parkinson, Wheeler Publishing.
2.	Production Drawing by K.L Narayan, P. Kannaiah and K. Venkata Reddy, New Age.
e-Resources	
1.	https://eedocs.wordpress.com/wp-content/uploads/2014/02/machinedrawing.pdf
2.	https://archive.nptel.ac.in/courses/112/105/112105294/
3.	https://www.edx.org/learn/engineering/dassault-systemes-solidworks-solidworks-cadfundamentals?index=product&queryID=c90b35a82a6ef58b0d6f89679c63f6a1&position=2&linked_from=autocomplete&c=autocomplete
4.	https://www.youtube.com/watch?v=0bQkS3_3Fq4



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Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME2106	SEC	--	1	2	2	30	70	3 Hrs.

PYTHON PROGRAMMING

(For ME)

Course Objectives:

1	Introduce core programming concepts of Python programming language.
2	Demonstrate about Python data structures like Lists, Tuples, Sets and dictionaries.
3	Implement Functions, Modules in Python Programming and to create practical and contemporary applications using these.

Course Outcomes:

S.No	Outcome	Knowledge Level
1	Demonstrate various operations on Built-in data types & Strings	K3
2	Solve Computational Problems using Modular Programming through Functions and Modules	K3
3	Apply Data Science methods and techniques on real time data.	K3

SYLLABUS

1.	<p>Introduction: Introduction to python programming, Installing and Using Jupyter Notebook.</p> <p>Parts of Python Programming Language: Identifiers, Keywords, Statements and Expressions, Variables, Operators, Precedence and Associativity, Data Types, Indentation, Comments, Reading Input, Print Output, Type Conversions, Dynamic and Strongly Typed Language.</p> <p>Control Flow Statements: if statement, if-else statement, if...elif...else, Nested if statement, while Loop, for Loop, continue and break Statements.</p> <p>Sample Exercises:</p> <ol style="list-style-type: none"> 1. Write a program to find the largest element among three Numbers. 2. Write a Program to display all prime numbers within an interval 3. Write a program to swap two numbers without using a temporary variable. 4. Demonstrate the following Operators in Python with suitable examples. <ul style="list-style-type: none"> ❖ Arithmetic Operators ❖ Relational Operators ❖ Assignment Operators ❖ Logical Operators ❖ Bit wise Operators ❖ Ternary Operator ❖ Membership Operators ❖ Identity Operators
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	<p>5. Write a program to add and multiply complex numbers</p> <p>6. Write a program to print multiplication table of a given number.</p>
<p>2.</p>	<p>Functions & Modules: Built-In Functions, Commonly Used Modules, Function Definition and Calling the function, return Statement and void Function, Scope and Lifetime of Variables, Default Parameters, Keyword Arguments, *args and **kwargs, Command Line Arguments. Modules: random module, os module.</p> <p>Strings: Creating and Storing Strings, Basic String Operations, Accessing Characters in String by Index Number, String Slicing and Joining, String Methods, Formatting Strings.</p> <p>Lists: Creating Lists, Basic List Operations, Indexing and Slicing in Lists, Built-In Functions Used on Lists, List Methods, del Statement.</p> <p>Sample Exercises:</p> <ol style="list-style-type: none"> 1. Write a program to define a function with multiple return values. 2. Write a program to define a function using default arguments. 3. Write a program to find the length of the string without using any library functions. 4. Write a program to check if the substring is present in a given string or not. 5. Write a program to perform the given operations on a list: <ul style="list-style-type: none"> ❖ addition ❖ insertion ❖ slicing 6. Write a program to perform any 5 built-in functions by taking any list.
<p>3.</p>	<p>Dictionaries: Creating Dictionary, Accessing and Modifying key: value Pairs in Dictionaries, Built-In Functions Used on Dictionaries, Dictionary Methods, del Statement.</p> <p>Tuples and Sets: Creating Tuples, Basic Tuple Operations, tuple() Function, Indexing and Slicing in Tuples, Built-In Functions Used on Tuples, Relation between Tuples and Lists, Relation between Tuples and Dictionaries, Using zip() Function, Sets, Set Methods, Frozenset.</p> <p>Sample Exercises:</p> <ol style="list-style-type: none"> 1. Write a program to create tuples (name, age, address, college) for at least two members and concatenate the tuples and print the concatenated tuples. 2. Write a program to count the number of vowels in a string (No control flow allowed). 3. Write a program to check if a given key exists in a dictionary or not. 4. Write a program to add a new key-value pair to an existing dictionary. 5. Write a program to sum all the items in a given dictionary.
<p>4.</p>	<p>Files: Types of Files, Creating and Reading Text Data, File Methods to Read and Write Data, Reading and Writing Binary Files, Reading and Writing CSV Files</p> <p>Sample Exercises:</p> <ol style="list-style-type: none"> 1. Write a program to sort words in a file and put them in another file. The output file should have only lower-case words, so any upper-case words from source must be lowered. 2. Python program to print each line of a file in reverse order. 3. Python program to compute the number of characters, words and lines in a file.

	<ol style="list-style-type: none"> 4. Write a program to create, display, append, insert and reverse the order of the items in the array. 5. Write a program to add, transpose and multiply two matrices.
5.	<p>Introduction to Data Science:</p> <p>NumPy: NumPy arrays using Array function, Integer Indexing, Array Indexing, Boolean Array Indexing, Slicing and Iterating Arrays, Arithmetic Operations on NumPy arrays, Mathematical Functions in NumPy, changing shape of an array, Stacking and Splitting of arrays, Broad Casting in arrays.</p> <p>Pandas: Pandas Series, Pandas Data Frame</p> <p>Sample Exercises:</p> <ol style="list-style-type: none"> 1. Python Program to demonstrate creation of Numpy Arrays. 2. Python program to demonstrate basic slicing, integer and Boolean indexing. 3. Python Program to Manipulate Numpy Arrays. 4. Python program to demonstrate Mathematical and Statistical Operations on Numpy Arrays. 5. Python program to create Series and Data Frame Objects using the sample data. 6. Python Program to demonstrate various operation on Series and Data Frame Objects.
Reference Books:	
1	Gowrishankar S, Veena A., Introduction to Python Programming, CRC Press.
2	Python Programming, S Sridhar, J Indumathi, V M Hariharan, 2 nd Edition, Pearson, 2024
3	Introduction to Programming Using Python, Y. Daniel Liang, Pearson
e-Resources:	
1.	https://python-iitk.vlabs.ac.in/
2.	https://virtual-labs.github.io/exp-arithmetic-operations-iitk/
3.	https://cse02-iiith.vlabs.ac.in/

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23MC2101	MC	2	--	--	--	30	--	--
ENGLISH PROFICIENCY								
(Common to ME, IT, CSIT, AIDS& AIML)								
Course Outcomes: After completion of this course, students will be able to								
S.No	Outcome							Knowledge Level
1.	Interpret IELTS & TOEFL listening comprehension texts.							K2
2.	Demonstrate essential speaking skills in academic, professional, and real-life contexts.							K2
3.	Interpret the written discourse by applying effective reading strategies.							K2
4.	Construct coherent and cohesive paragraphs, e-mails, letters, and essays.							K3
SYLLABUS								
UNIT-I	Listening Skills Listening as a receptive skill Listening skills for IELTS, TOEFL, Duolingo, PTE, and other competitive examinations.							
UNIT-II	Speaking Skills JAM/ Extempore Debate / Group Discussion Presentation Skills							
UNIT-III	Reading Skills Types of Reading(Intensive and Extensive Reading, Skimming, Scanning) Reading/Summarizing News Paper Articles							
UNIT-IV	Writing Skills Essay Writing(Argumentative, Analytical and Descriptive essays for GRE, TOEFL & IELTS) E-Mail / Letter Writing Resume Writing							
UNIT-V	Integrated Language Skills Listening Skills for Speaking and Writing Reading Skills for Writing and Speaking							
Text Books:								
1.	Interchange (5 th edition) by Jack C.Richards, CUP, 2017.							
Reference Books:								

1.	Fundamentals of Technical Communication (1 st edition) by Meenakshi Raman, Sangeeta Sharma of OUP, 2014.
2.	The Oxford Guide to Writing and Speaking (3 rd edition) by John Seely OUP, 2013.
3.	Effective Technical Communication (2 nd edition) by M. Ashraf Rizwi. TataMcGrawhill, 2017.
e-Resources:	
1	BBC Learning English - Learn English with BBC Learning English - Homepage
2	Grammar Learn English (britishcouncil.org)
3	Duolingo English Test
4	IELTS Test Preparation Materials - Videos, Practice tests, Articles and More (idp.com)





**SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE
(AUTONOMOUS)**

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Recognised as Scientific and Industrial Research Organisation

SRKR MARG, CHINA AMIRAM, BHIMAVARAM – 534204 W.G.Dt., A.P., INDIA

Regulation: R23		II / IV - B.Tech. II - Semester							
MECHANICAL ENGINEERING									
COURSE STRUCTURE									
(With effect from 2023-24 admitted Batch onwards)									
Course Code	Course Name	Category	L	T	P	Cr	C.I.E.	S.E.E.	Total Marks
B23HS2201	Managerial Economics and Financial Analysis	HS	2	0	0	2	30	70	100
B23BS2205	Complex Variables and Statistical Methods	ES	3	0	0	3	30	70	100
B23ME2201	Manufacturing processes	PC	3	0	0	3	30	70	100
B23ME2202	Thermal Engineering	PC	3	0	0	3	30	70	100
B23ME2203	Theory of Machines	PC	3	0	0	3	30	70	100
B23ME2204	Thermal Engineering Lab	PC	0	0	3	1.5	30	70	100
B23ME2205	Manufacturing processes Lab	PC	0	0	3	1.5	30	70	100
B23ME2206	Advanced 3D and Surface Modelling	SEC	0	1	2	2	30	70	100
B23ME2207	Design Thinking & Innovation	ES	1	0	2	2	30	70	100
B23MC2202	Environmental Science	MC	2	0	0	-	30	-	30
TOTAL			17	1	10	21	300	630	930

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23HS2201	HS	2	--	--	2	30	70	3Hrs.
MANAGERIAL ECONOMICS AND FINANCIAL ANALYSIS								
(Common to AIDS, CSE, CIC, CSG, CSIT, CE, ECE, EEE, ME)								
Course Objectives: Students are expected to								
1.	Understand the concept and nature of Managerial Economics, its relationship with other disciplines, the Concept of Demand and Demand forecasting							
2.	Familiarize about the Concepts of Cost and Break-Even Analysis							
3.	Learn about accounting cycle and preparation of Financial Statements							
4.	Understand the nature of markets and the Pricing Methods							
5.	Know the concept of Capital, Sources of Raising Finance and Depreciation							
Course Outcomes: At the end of the course the student will be able to								
S.No	Outcome							Knowledge Level
1.	Interpreting the importance of Managerial Economics, demand analysis and methods of demand forecasting							K2
2.	Describe about the usefulness of Cost Analysis and Break Even Analysis							K2
3.	Apply the principles of accounting to convert the transactions and events into Journal, Ledger and Trail balance							K3
4.	Compute the results of Business by preparing Final Accounts							K3
5.	Illustrate the nature of markets and pricing theories							K2
6.	Explain the Types of capital, their sources and importance & estimation of Depreciation							K2
SYLLABUS								
UNIT-I (12 Hrs)	Introduction to Managerial Economics and demand Analysis: Managerial Economics: Definition of Economics & Classification of Economics (Micro & Macro), Meaning, Nature, & Scope of Managerial Economics. Demand Analysis: Concept of Demand, Determinants of Demand, Demand schedule, Demand curve, Law of Demand and its exceptions. Elasticity of Demand, Types of Elasticity of Demand. Importance of Demand Forecasting and its Methods.							
UNIT-II (8 Hrs)	Cost Analysis: Importance of cost analysis, Types of Cost- Actual cost Vs Opportunity cost, Fixed cost Vs Variable cost, Explicit Vs Implicit cost, Historical cost Vs Replacement cost, Incremental cost Vs Sunk cost; Elements of costs – Material, Labour, Expenses; Methods of costing - Job costing, contract costing, Process costing, Batch costing, Unit costing, Service costing, Multiple costing. Break-even analysis: Determination of Break-							

	even Point Applications, Assumptions and Limitations of Break-even analysis (Theory only).
UNIT-III (12 Hrs)	Introduction to Financial Accounting: Importance of Accounting - Double Entry System of Accounting - Types of Accounts - Journal, Ledger, Trail Balance, Trading Account, Profit and Loss Account and Balance Sheet (Final Accounts with Simple adjustments).
UNIT-IV (8 Hrs)	Introduction to Markets & Pricing Policies Market Structures: Salient Features of Perfect Competition, Monopoly, Monopolistic competition, Oligopoly and Duopoly. Pricing: Importance of pricing and its meaning; Methods of Pricing: Cost Based -Full cost, Mark-up, Marginal & Break-even; Demand Based -Penetrating, Skimming; Competition Based -Going rate, Sealed Bid, Discount; Internet Pricing -Flat-rate, Usage sensitive.
UNIT-V (8 Hrs)	Capital & Depreciation: Types of Capital-Fixed capital & Working Capital, Components of Working Capital, Factors influencing Working capital. Methods of Raising Finance - Short term, Medium term and Long term. Depreciation – Meaning, Importance and causes of depreciation; Methods of Depreciation-Straight line and Diminishing Balancing methods (Theory only).
Text Books:	
1.	AR Aryasri, Managerial Economics and Financial Analysis, TMH Pvt. Ltd, New Delhi
2.	Dr. N. Appa Rao, Dr. P. Vijaya kumar: Managerial Economics and Financial Analysis, Cengage Publications, NewDelhi
Reference Books:	
1.	Dr.B.Kuberudu & T.V.Ramana :Managerial Economics and Financial anaysis, Himalaya Publishing House
2.	Varshney R.L, K.L Maheswari, Managerial Economics, S. Chand & Company Ltd,
3.	Shashi K.Gupta & R.K.Sharma Management Accounting, Kalyani Publishers
4.	Maheswari S.N, An Introduction to Accountancy, Vikas Publishing House Pvt Ltd

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23BS2205	ES	3	--	--	3	30	70	3Hrs.

COMPLEX VARIABLES AND STATISTICAL METHODS

(For MECH)

Course Objectives: Students are expected to

1.	Familiarize with the concepts of complex variables, analytic functions and Calculus of complex functions.
2.	Familiarize with the foundations of probability and statistical methods.
3.	Handle the applications relevant to their disciplines concerned.

Course Outcomes: After the completion of this course, Students will be able to

S.No	Outcome	Knowledge Level
1.	Apply the concepts of analyticity and General Cauchy's Integral Formula in complex integrals that arouse in applications of different disciplines.	K3
2.	Determine the Taylor and Laurent series of a simple function, converts complex integrals in to simpler integrals by indenting the contours using the calculus of residues	K3
3.	Predict the distribution suitable to the data and handle the situation of uncertainty.	K3
4.	Find the maximum error of the estimate using the concepts of Sampling theory.	K3
5.	Use appropriate tests of hypothesis to give the inferences on Parameters based on Statistics.	K3

SYLLABUS

UNIT-I (10Hrs)	Functions of a Complex Variable and Complex Integration: Introduction, Continuity, Differentiability, Analyticity, Cauchy-Riemann equations in Cartesian and polar coordinates, Harmonic and conjugate harmonic functions, Milne – Thomson method. Complex integration: Line integral, Cauchy's integral theorem, Cauchy's integral formula, Generalized integral formula (all without proofs) and problems on above theorems.
UNIT-II (12Hrs)	Series Expansions and Residue Theorem: Radius of convergence – Expansion of function as a Taylor's series, Maclaurin's series and Laurent's series. Types of Singularities: Isolated – Essential singularities – Pole of order m– Residues – Residue theorem (without proof)–Evaluation of real integral of the types $\int_{-\infty}^{\infty} f(x) dx$ and $\int_c^{c+2\pi} f(\cos \theta, \sin \theta) d\theta$.
UNIT-III (14Hrs)	Probability and Distributions: Baye's theorem, Random variables, Discrete and Continuous random variables, Distribution functions, Probability mass function,

	Probability density function and Cumulative distribution function. Mathematical Expectation and Variance. Binomial, Poisson, Uniform and Normal distributions.
UNIT-IV (8Hrs)	Sampling Theory: Introduction, Population and Samples, Sampling distribution of Means and Variance (definition only), Point and Interval estimations, Maximum error of estimate, Central limit theorem (without proof), Estimation using t , χ^2 and F -distributions.
UNIT-V (10Hrs)	Tests of Hypothesis: Introduction, Statistical Hypothesis – Null and Alternative Hypothesis, Type I and Type II errors, Level of significance, One tail and two-tailed tests, Test of significance for large samples: Single and two proportions and Small Samples: Student's t - test, - Single and difference means, F -test, χ^2 -test.
Text Books:	
1.	B. S. Grewal, Higher Engineering Mathematics, 44 th Edition, Khanna Publishers.
2.	Miller and Freund's, Probability and Statistics for Engineers, 7/e, Pearson, 2008.
Reference Books:	
1.	J. W. Brown and R. V. Churchill, Complex Variables and Applications, 9 th edition, Mc-Graw Hill, 2013.
2.	S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, 11/e, Sultan Chand & Sons Publications, 2012.
3.	Jay I. Devore, Probability and Statistics for Engineering and the Sciences, 8 th Edition, Cengage.
4.	Shron L. Myers, Keying Ye, Ronald E Walpole, Probability and Statistics Engineers and the Scientists, 8 th Edition, Pearson 2007.
5.	Sheldon, M. Ross, Introduction to probability and statistics Engineers and the Scientists, 4 th Edition, Academic Foundation 2011
e-Resources	
1.	https://archive.nptel.ac.in/courses/112/102/112102316/
2.	https://archive.nptel.ac.in/courses/111/105/111105077/

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME2201	PC	3	--	--	3	30	70	3 Hrs.

MANUFACTURING PROCESSES

(For ME)

Course Objectives:

1.	Know the working principle of different metal casting processes and gating system.
2.	Classify the welding processes, working of different types of welding processes and welding defects.
3.	Know the nature of plastic deformation, cold and hot working process, working of a rolling mill and types, extrusion processes.
4.	Understand the principles of forging, tools and dies, working of forging processes.
5.	Know about the Additive manufacturing.

Course Outcomes: At the end of the course students will be able to

S.No	Outcome	Knowledge Level
1.	Apply the principles of metal casting for manufacturing various mechanical components.	K3
2.	Classify Various types of welding processes and welding defects.	K4
3.	Apply the Knowledge of metal forming to cold and hot worked components.	K3
4.	Identify suitable tools and dies for various forging processes.	K3
5.	Identify suitable Additive manufacturing process for manufacturing various mechanical components.	K3

SYLLABUS

UNIT-I (10Hrs)	Casting: Steps involved in making a casting – Advantage of casting. Types of patterns – Materials used for patterns, pattern allowances. Types of furnaces, Casting defects- causes and remedies. Basic principles and applications of special casting processes - Centrifugal casting, Die casting, Investment casting, Permanent mould casting and shell molding.
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UNIT-II (10 Hrs)	Welding: Classification of welding processes, types of welded joints and their characteristics, Gas welding, Different types of flames and uses, Oxy – Acetylene Gas cutting. Basic principles of Arc welding, submerged arc welding, TIG & MIG welding, Resistance welding, Friction welding, Friction stir welding, Forge welding, Explosive welding; Plasma Arc welding, Laser welding, electron beam welding, Soldering & Brazing. Welding defects –causes and remedies.
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UNIT-III (10 Hrs)	Bulk Forming: Plastic deformation in metals and alloys-recovery, recrystallization. Hot working and Cold Working-Strain hardening and Annealing. Bulk forming processes: Forging-Types of Forging, forging defects and remedies; Rolling – fundamentals, types of rolling mills. Extrusion -Types of extrusion, Impact extrusion, Hydrostatic extrusion; Wire drawing and Tube drawing.
UNIT-IV (10 Hrs)	Sheet metal forming: Blanking and piercing, Deep drawing, Stretch forming, Bending, Spring back and its remedies, Coining, Spinning, Types of presses and press tools. High energy rate forming processes: Principles of explosive forming, electromagnetic forming, Rubber pad forming, advantages and limitations.
UNIT-V (10 Hrs)	Additive manufacturing: Steps in Additive Manufacturing (AM), Classification of AM processes, Advantages of AM, and types of materials for AM, VAT photo polymerization AM Processes, Extrusion - Based AM Processes, Powder Bed Fusion AM Processes, Direct Energy Deposition AM Processes, Post Processing of AM Parts, Applications .
Textbooks:	
1.	Kalpakjain S and Steven R Schmid, Manufacturing Processes for Engineering Materials, 5/e, Pearson Publications, 2007.
2.	P.N. Rao, Manufacturing Technology -Vol I, 5/e, McGraw Hill Education, 2018.
Reference Books:	
1.	A.Ghosh & A.K.Malik, Manufacturing Science, East West Press Pvt. Ltd, 2010.
2.	Lindberg and Roy, Processes and materials of manufacture, 4/e, Prentice Hall India Learning Private Limited, 1990.
3.	R.K. Jain, Production Technology, Khanna Publishers, 2022.
4.	Sharma P.C., A Text book of Production Technology, 8/e, S Chand Publishing, 2014.
5.	H.S. Shaun, Manufacturing Processes, 1/e, Pearson Publishers, 2012.
6.	WAJ Chapman , Workshop Technology, 5/e, CBS Publishers & Distributors Pvt. Ltd, 2001.
7.	Hindustan Machine Tools, Production Technology, Tata McGraw Hill Publishers, 2017.
8.	Ian Gibson, David W Rosen, Brent Stucker., Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, 2/e, Springer, 2015.
e-Resources	
1.	https://www.edx.org/learn/manufacturing/massachusetts-institute-of-technology-fundamentals-of-manufacturing-processes
2.	https://onlinecourses.nptel.ac.in/noc21_me81/preview
3.	https://www.coursera.org/learn/introduction-to-additive-manufacturing-processessera
4.	https://archive.nptel.ac.in/courses/112/103/112103263/
5.	https://elearn.nptel.ac.in/shop/nptel/principles-of-metal-forming-technology/?v=c86ee0d9d7ed

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME2202	PC	3	--	--	3	30	70	3 Hrs.

THERMAL ENGINEERING

(For ME)

Course Objectives: The objectives of the course are to

1.	To expose the basic principles of steam properties and industrial application of steam
2.	To analyze the energy transfers and transformations in these components including individual performance evaluation
3.	To study the thermodynamic analysis of Rankine cycle and its modifications.

Course Outcomes: At the end of the course students will be able to

S.No	Outcome	Knowledge Level
1.	Apply the phenomena of pure substances in calculating the properties of steam in different scenarios.	K3
2.	Compute the performance parameters of ideal and modified Rankine cycles.	K3
3.	Solve the problems of steam nozzles in power plants to estimate their performance.	K3
4.	Outline the functionality of steam turbines in power plants to estimate their performance.	K3
5.	Determine various performance parameters of steam Condensers.	K3

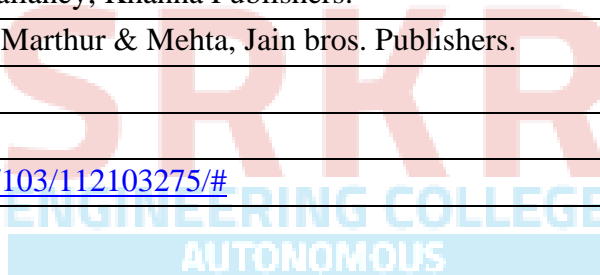
Estd. 1980

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SYLLABUS

UNIT-I (10Hrs)	Properties of Pure Substance: Definition of pure substance, phase change of a pure substance, p-T (Pressure-Temperature) diagram for a pure substance, p-V-T(Pressure-Volume-Temperature) surface, phase change terminology and definitions, Formation of steam, determining various properties like Enthalpy, Entropy, Internal energy during steam formation, Enthalpy-Entropy (h-s) charts (Mollier's diagram), Determination of dryness fraction using Tank or bucket calorimeter, throttling calorimeter, separating and throttling calorimeter.
UNIT-II (10Hrs)	Vapor Power Cycles: Vapor power cycle- Rankine cycle- Reheat cycle (single Reheater)- Regenerative cycle- Thermodynamic variables effecting efficiency and output of Rankine and Regenerative cycles (Single open feed water heater)- Improvements of efficiency, Binary vapor power cycle
UNIT-III (10Hrs)	Steam Nozzles: Type of nozzles- Flow through nozzles- Condition for maximum discharge- Nozzle efficiency- Super saturated flow in nozzles- - Steam injectors

UNIT-IV (10Hrs)	Steam Turbines: Classification of steam turbines- Impulse turbine and reaction turbine- Compounding in turbines- Velocity diagrams in impulse and reaction turbines- Degree of reaction- Condition for maximum efficiency of reaction turbines
UNIT-V (10Hrs)	Steam Condensers: Classification of condenser- Jet, Evaporative and surface condensers- Vacuum and its measurement- Vacuum efficiency- Sources of air leakage in condensers- Condenser efficiency- Daltons law of partial pressures- Determination of mass of cooling water.
Text Books:	
1.	Thermodynamics and Heat Engines by R.Yadav, Volume -II , Central Publishing House.
2.	Heat Engineering by Vasandani and D.S Kumar, Metropolitan Book Company, New Delhi.
3.	Engineering Thermodynamics, PK Nag 6th Edition , McGraw Hill.
4.	Thermal Engineering, by R. K. Rajput, Lakshmi Publications.
5.	A Treatise on Heat Engineering by Vasandhani and Kumar.
Reference Books:	
1.	Thermal Science and Engineering by D.S. Kumar, S.K. Kataria and Sons.
2.	Thermal Engineering by PL Ballaney, Khanna Publishers.
3.	Thermal Engineering by M.L. Marthur & Mehta, Jain bros. Publishers.
e-Resources	
1.	https://nptel.ac.in/courses/112/103/112103275/#



Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME2203	PC	3	--	--	3	30	70	3Hrs.
THEORY OF MACHINES								
(For ME)								
Course Objectives: The objectives of the course are to								
1.	Demonstrate Various basic mechanisms and their applications.							
2.	Familiarize the velocity and acceleration in mechanisms.							
3.	Explain the importance of gyroscopic couples and gear profile							
4.	Describe the balancing of rotating masses, follower motions and cam profiles.							
5.	Explain the importance of mechanical vibrations and turning moment diagrams							
Course Outcomes : At the end of the course students will be able to								
S.No	Outcome							Knowledge Level
1.	Demonstrate the different mechanisms and their inversions.							K3
2.	Analyze velocity and acceleration of different links in the mechanisms.							K4
3.	Apply the principle of gyroscopic couple in ships, aero planes and road vehicles & Study of gear profiles							K3
4.	Determine balanced masses in rotating machines and sketch cam profiles.							K3
5.	Apply free and damped vibration of single degree freedom systems, Turning moment diagrams and flywheel							K3
SYLLABUS								
UNIT-I (10Hrs)	Simple Mechanisms: Classification of mechanisms – Basic kinematic concepts and definitions –Degree of freedom, mobility – Grashof’s law, kinematic inversions of four bar chain and slider crank chains, inversions of some common mechanisms- Quick return mechanism, straight line mechanisms: Paucellier, Hart, Scott- Russel, Hooke’s joint							
UNIT-II (10Hrs)	Plane and motion analysis: Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using relative velocity method – kinematic analysis of simple mechanisms – slider crank mechanism– Coriolis component of acceleration.							
UNIT-III (10Hrs)	Gyroscope: Principle of gyroscope, gyroscopic effect in an aeroplane, ship, car and two wheelers, simple problems Gear Profile: Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing, spur gear contact ratio and interference/undercutting, epicyclic and							

	regular gear train kinematics.
UNIT-IV (10Hrs)	<p>Balancing of Rotating masses: Need for balancing, balancing of single mass and several masses in different planes, using analytical and graphical methods.</p> <p>Cams: Classification of cams and followers- Terminology and definitions – Displacement diagrams–Uniform velocity, Uniform acceleration and deceleration, simple harmonic motions, derivatives of follower motions- construction of Cam profiles: knife edge, roller follower with radial and off-set follower motions</p>
UNIT-V (10Hrs)	<p>Vibrations: Introduction, degree of freedom, types of vibrations, free natural vibrations, Newton method and energy method for single degree of freedom. Damped vibrations- under damped, critically damped and over damped systems, Transverse vibrations of simply supported shaft with UDL and number of point loads- Dunkerly’s method</p> <p>Turning Moment Diagrams and Flywheels: Turning moment diagrams for steam engine, I.C engine and Multi Cylinder Engine. Crank effort – coefficient of fluctuation of energy, coefficient of fluctuation of speed – Fly Wheel.</p>
TextBooks:	
1.	S.S.Rattan, Theory of Machines, 4/e, Tata Mc-Graw Hill, 2014.
2.	R.S. Khurmi, J.K. Gupta, Theory of machines , S. Chand Publishers
ReferenceBooks:	
1.	P.L.Ballaney, Theory of Machines & Mechanisms, 25/e, Khanna Publishers, Delhi, 2003.
2.	J.E.Shigley, Theory of Machines and Mechanisms, 4/e, Oxford, 2014.
3.	G.K.Groover, Mechanical Vibrations, 8/e, Nemchand Bros, 2009.
4.	Norton, R.L., Design of Machinery – An Introduction to Synthesis and Analysis of Mechanisms and Machines, 2/e, McGraw Hill, New York, 2000
3.	William T. Thomson, Theory of vibration with applications, 4/e, Englewood Cliffs, N.J.: Prentice Hall, 1993.
e-Resources	
1.	https://archive.nptel.ac.in/courses/112/104/112104114/
2.	https://www.youtube.com/watch?v=0uQAPnaW5D4&list=PLWPirh4EWFpEECWjyAysIZ6WikwHUy72R
3.	https://pdfcoffee.com/1theory-of-machines-pdf-free.html

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME2204	PC	0	0	3	1.5	30	70	3hrs
THERMAL ENGINEERING LAB								
(For ME)								
Course Objectives:								
1.	Understand the importance of fuel characterization through testing procedures.							
2.	Gain insights into the relationship between fuel properties and engine performance.							
3.	Explore concepts of Efficiency, friction and other performance parameters measurement in engines.							
4.	Understand the working of two stroke and four stroke engines.							
Course Outcomes: At the end of the course students will be able to								
S. No.	Outcome							Knowledge Level
1.	Assess the environmental, societal safety and health issue through determining the flash & fire point of various lubricating oils as well as fuels, along with computing the viscosity of lubricating oils							K5
2.	Compute the economical speed, Efficiency and Frictional power of IC Engines by Williams's line method and Morse test.							K3
3.	Analyze the performance parameters of IC Engines and able to draw the heat balance sheet.							K4
4.	Compute various events associated with air intake and exhaust in a four stroke and two stroke engines.							K3
SYLLABUS								
1.	Study of the variation of viscosity w.r.t. temperature for the given sample of mono-grade lubricating oil expressed as a time of flow in seconds by means of various viscometers.							
2.	Determination of the Flash point & Fire point of the given sample of lubricating oil by the Cleveland's open cup apparatus and by the Pensky Martins apparatus.							
3.	To draw the valve timing diagram of a given 4-stroke petrol or diesel engine model.							
4.	To draw the Port timing diagrams 2-stroke petrol engine model.							
5.	Load test on single cylinder diesel Engine.							
6.	Morse test on dual cylinder horizontal diesel engine.							
7.	Economical speed test on single cylinder horizontal diesel engine.							
8.	Heat balance sheet on I.C. Engines.							
9.	Performance test on multi cylinder diesel engine.							
10.	Performance test on Variable Compression Ratio (V.C.R.) engine and Exhaust gas analyzer.							

Reference Books:

1. Thermal Engineering, by R.K.Rajput.
2. Internal Combustion Engines by V. Ganesan, McGraw-Hill.

E-Resources:

1. <https://nptel.ac.in/courses/112103316>
2. <https://nptel.ac.in/courses/112103262>



Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME2205	PC	--	--	3	1.5	30	70	3 Hrs.
MANUFACTURING PROCESSES LAB								
(For ME)								
Course Objectives:								
1.	To impart hands-on practical exposure on manufacturing processes and equipment.							
Course Outcomes: At the end of the course students will be able to								
S. No	Outcome							Knowledge Level
1.	Apply the knowledge of casting to make various sand moulds.							K3
2.	Determine various moulding sand properties.							K3
3.	Apply a suitable welding process for preparing a component.							K3
4.	Apply the knowledge of forging & sheet metal to prepare various components.							K3
5.	Demonstrate the procedures of 3D printing and metal Castings.							K3
SYLLABUS								
1.	Prepare a sand mould of stepped pulley.							
2.	Prepare a sand mould of bend pipe.							
3.	Inspect the grain fineness number of silica sand.							
4.	Examine the moisture and clay content in the given moulding sand.							
5.	Analyze the compression & shear strength of moulding sand specimen.							
6.	Analyze the hardness of moulding sand specimen.							
7.	Prepare a vent rod using forging operations.							
8.	Prepare a S-hook using forging operations.							
9.	Prepare a lap joint & butt joint by arc welding process.							
10.	Prepare a welded joint using Gas welding.							
11.	Demonstrate of simple parts on a 3D printing Machine.							
12.	Demonstrate of metal Casting process.							
ReferenceBooks:								
1.	ElementsofWorkshopTechnologyVol-1Manufacturing Processes by S.K.HajraChoudhury, A.K.Hajra Choudhury, Nirjhar Roy, MPP, Pvt. Ltd.							
2.	Manufacturing Technology- Foundry, Forming and Welding by P.N.Rao, Tata McGraw Hill Publishing Company.							

Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME2206	SEC	--	1	2	2	30	70	3 Hrs.
ADVANCED 3D & SURFACE MODELING								
(For ME)								
Course Objectives:								
1.	Develop skills in using modeling software and mastering the modeling package							
2.	Develop skills in using modeling software to create 2D sketches.							
3.	Develop skills in using modeling software to create 3D models.							
4.	Develop skills in using modeling software to create Assemblies.							
Course Outcomes: At the end of the course the students will be able to								
S.No	Outcome							Knowledge Level
1.	Use the basic commands of drafting in the modeling tools.							K3
2.	Sketch 2D drawing with tools available in the modeling package							K3
3.	Create detailed 3D parts using advanced features within the modeling software.							K4
4.	Draft surface drawing using tools in package							K3
5.	Choose diverse mating relations to construct detailed assembly drawing for models							K5
List of Experiment								
1.	Introduction to Modeling Package: Initiating the graphics package; Setting the paper size, space; setting the limits, units; use of snap and grid commands. Using of primitives (line, arc, circle, ellipse, triangle etc.)							
2.	Practice sketches and designing profiles 3 to 4 basic sketches							
3.	Practice sketches and designing profiles with constraints 3 to 4 basic sketches							
4.	Practice of sketches using operation tools with 3 to 4 basic sketches							
5.	Introduction to Solid Modeling Techniques: Study the 3D solids (primitives) and solids toolbar options Using any standard 3D modeling Packages.							
6.	Using the Extrude, Revolve and Extrude cut Practice 3D sketches (3 to 4) using the modeling packages.							
7.	Using the Boolean Operation and pattern (circular & linear) tool practice 3D sketches (3to 4) using the modeling packages.							
8.	Using the Groove and Loft tools, Multi section solids, fillet and chamfer practice 3D sketches (3to 4) using the modeling packages.							
9.	Introduction to Geometrical Shape Design workbench, Creation of surfaces							
10.	Practice basic sketch base feature tools of circles, spline, helix and spiral							
11.	Practice of few blend, multi-sections, Trimming, fill surfaces							

12.	Using advanced Assembly modeling-Top down and Bottom Up Approaches with any standard 3D modeling Packages and Drafting using respective modeling package.
Reference Books:	
1.	Engineering Drawing, by N.D.Bhatt, Charotal Publishing House
2.	Machine Drawing, by N.D.Bhatt, Charotal Publishing House
3.	Catia V5-6R2016 for Designers by Sham Tickoo BPB Publications.
4.	Soildworks Essentials Dassault Systèmes SolidWorks Corporation
Reference Links:	
1.	https://www.youtube.com/watch?v=0bQkS3_3Fq4
2.	https://www.edx.org/learn/engineering/dassault-systemes-solidworks-solidworks-cadfundamentals?index=product&queryID=c90b35a82a6ef58b0d6f89679c63f6a1&position=2&linked_from=autocomplete&c=autocomplete



Course Code	Category	L	T	P	C	C.I.E.	S.E.E.	Exam
B23ME2207	ES	1	--	2	2	30	70	3 Hrs.

DESIGN THINKING & INNOVATION

(Common to all Programmes of Engineering)

Course Objectives:

1.	Bring awareness on innovative design and new product development.
2.	Explain the basics of design thinking.
3.	Familiarize the role of reverse engineering in product development.
4.	Train how to identify the needs of society and convert into demand.
5.	Introduce product planning and product development process.

Course Outcomes: After completion of this course, students will be able to

S.No	Outcome	Knowledge Level
1.	Define the concepts related to design thinking.	K1
2.	Explain the fundamentals of Design Thinking and innovation.	K2
3.	Apply the design thinking techniques for solving problems in various sectors.	K3
4.	Analyse to work in a multidisciplinary environment.	K4
5.	Evaluate the value of creativity.	K5

SYLLABUS

UNIT-I (10Hrs)	Introduction to elements and principles of Design, basics of design-dot, line, shape, form as fundamental design components. Principles of design. Introduction to design thinking, history of Design Thinking, New materials in Industry.
UNIT-II (10 Hrs)	Design thinking process (empathize, analyze, idea & prototype), implementing the process in driving inventions, design thinking in social innovations. Tools of design thinking - person, costumer, journey map, brainstorming, product development. Activity: Every student presents their idea in three minutes, Every student can present design process in the form of flow diagram or flow chart etc. Every student should explain about product development.
UNIT-III (10 Hrs)	Art of innovation, Difference between innovation and creativity, role of creativity and innovation in organizations. Creativity to Innovation. Teams for innovation, Measuring the impact and value of creativity. Activity: Debate on innovation and creativity, Flow and planning from idea to innovation, Debate on value-based innovation.
UNIT-IV (10 Hrs)	Problem formation, introduction to product design, Product strategies, Product value, Product planning, product specifications. Innovation towards product design Case studies.

	Activity: Importance of modeling, how to set specifications, Explaining their own product design.
UNIT-V (10 Hrs)	Design Thinking applied in Business & Strategic Innovation, Design Thinking principles that redefine business – Business challenges: Growth, Predictability, Change, Maintaining Relevance, Extreme competition, Standardization. Design thinking to meet corporate needs. Design thinking for Startups. Defining and testing Business Models and Business Cases. Developing & testing prototypes. Activity: How to market our own product, about maintenance, Reliability and plan for startup.
Textbooks:	
1.	Tim Brown, Change by design, 1/e, Harper Bollins, 2009.
2.	Idris Mootee, Design Thinking for Strategic Innovation, 1/e, Adams Media, 2014.
Reference Books:	
1.	David Lee, Design Thinking in the Classroom, Ulysses press, 2018.
2.	Shrrutin N Shetty, Design the Future, 1/e, Norton Press, 2018.
3.	William lidwell, Kritinaholden, & Jill butter, Universal principles of design, 2/e, Rockport Publishers, 2010.
4.	Chesbrough.H, The era of open innovation, 2003.
e-Resources:	
1.	Define the concepts related to design thinking.
2.	Explain the fundamentals of Design Thinking and innovation.
3.	Apply the design thinking techniques for solving problems in various sectors.
4.	Analyse to work in a multidisciplinary environment.
5.	Evaluate the value of creativity.

Course Code	Category	L	T	P	C	C.I.E	S.E.E	Exam
B23MC2202	MC	2	--	--	--	30	--	--

ENVIRONMENTAL SCIENCE

(Common to AIDS, AIML, CE, CSBS, CSIT, IT and ME.)

Course Objectives: The objective of the course is to impart:

1. Overall view on natural resources.
2. Awareness on ecosystem and its services.
3. Various environmental challenges induced due to unplanned anthropogenic activities.
4. Consciousness on the social issues, environmental legislation and global treaties

Course Outcomes: At the end of the course, the students will be able to

S. No	Outcome	Knowledge Level
1	Describe natural resources and their interaction	K2
2	Illustrate ecosystem types, biodiversity and conservation strategies	K2
3	Summarize contaminants of environment and preventive methods	K2
4	Explain protection of environment by employing constitutional provisions	K2
5	Explain global scenario of surroundings and social conditions	K2

Estd. 1980

AUTONOMOUS

SYLLABUS

UNIT-I (8 Hrs)	<p>Multidisciplinary Nature of Environmental Studies: Definition, Scope and Importance – Need for Public Awareness. Natural Resources: Renewable and non-renewable resources – Natural resources and associated problems. Forest resources – Use and over – exploitation, deforestation, case studies – Timber extraction – Mining, dams and other effects on forest and tribal people. Water resources – Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources: Growing energy needs, renewable and non-renewable energy sources use of alternate energy sources</p>
UNIT-II (8 Hrs)	<p>Ecosystems: 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, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem. b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystems (ponds,</p>

	streams, lakes, rivers, oceans, estuaries) Biodiversity and Its Conservation : Introduction and Definition - genetic, species and ecosystem diversity – Bio-geographical classification of India – Value of biodiversity: consumptive use, Productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – 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-III (6 Hrs)	Environmental Pollution: Definition, Cause, effects and control measures of: a. Air Pollution. b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards. Solid Waste Management: Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides
UNIT-IV (6 Hrs)	Social Issues and the Environment: From Unsustainable to Sustainable development – Urban problems related to energy watershed management – Resettlement and rehabilitation of people; its problems and concerns – Carbon credits, Mission LiFE. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust –Wasteland reclamation – Consumerism and waste products. Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act. Issues involved in enforcement of environmental legislation – Public awareness.
UNIT-V (6 Hrs)	Human Population And The Environment: Population growth, variation among nations. Population explosion – Family Welfare Programmes. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information Technology in Environment and human health – Case studies. Field Work: Visit to a local area to document environmental assets River/forest grassland/hill/mountain – Visit to a local polluted site- Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds – river, hill slopes, etc.
Text Books:	
1.	Erach Bharucha, Text book of Environmental Studies for Undergraduate Courses, Universities Press (India) Private Limited, 2019.
2.	Palaniswamy, Environmental Studies, 2/e, Pearson education, 2014.
3.	S. Azeem Unnisa, Environmental Studies, Academic Publishing Company, 2021.
4.	K. Raghavan Nambiar, “Text book of Environmental Studies for Undergraduate Courses as per UGC model syllabus”, SciTech Publications (India), Pvt. Ltd, 2010.

5	K. V. S. G. Murali Krishna, The Book of Environmental Studies, Savera Publishing House.
6	Environmental Studies, R. Rajagopalan, 2 nd Edition, 2011, Oxford University Press.
Reference Books:	
1.	Deeksha Dave and S.S. Katewa, Textbook of Environmental Studies, 2/e, Cengage Learning.
2.	M. Anji Reddy, “Textbook of Environmental Sciences and Technology”, BS Publication, 2014.
3.	J.P. Sharma, Comprehensive Environmental studies, Laxmi publications, 2006.
4.	J. Glynn Henry and Gary W. Heinke, Environmental Sciences and Engineering, Prentice Hall of India Private limited, 1988.
5.	G.R. Chatwal, A Text Book of Environmental Studies, Himalaya Publishing House, 2018
6.	Gilbert M. Masters and Wendell P. Ela, Introduction to Environmental Engineering and Science, 1/e, Prentice Hall of India Private limited, 1991.
e-Resources	
1.	https://onlinecourses.nptel.ac.in/noc23_hs155/preview
2.	https://www.edx.org/learn/environmental-science/rice-university-ap-r-environmental-science-part-3-pollution-and-resources?index=product&objectID=course-3a6da9f2-lec07.pdf (iasri.res.in)
3.	http://ecoursesonline.iasri.res.in/Courses/Environmental%20Science-I/Data%20Files/pdf/lec07.pdf
4.	https://www.youtube.com/watch?v=5QxxaVfgQ3k

