Course Structure &Syllabus
of
B. Tech. Program
in
Mechanical Engineering
Academic Year – 2019-20

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, ODISHA

Burla, Sambalpur-768018, Odisha

www.vssut.ac.in

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, BURLA, ODISHA

PROPOSED COURSE STRUCTURE FOR BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING
COURSES TO BE EFFECTIVE FROM JULY/AUGUST 2020

Vision

To be recognised as a centre of excellence in education and research in the field of mechanical engineering by producing innovative, creative and ethical mechanical engineering professionals for socio-economic upliftment of society in order to meet the global challenges.

Mission

Mechanical Engineering Department of VSSUT Burla strives to impart quality education to the students with enhancement of their skills to make them globally competitive through:

M1: Maintaining state of the art research facilities to provide conducive environment to create, analyze, apply and disseminate knowledge.

M2: Fortifying collaboration with world class R&D organizations, educational institutions, industry and alumni for excellence in teaching, research and consultancy practices to fulfil 'Make In India' policy of the Government.

M3: Providing the students with academic environment of excellence, leadership, ethical guidelines and lifelong learning needed for a long productive career.

Programme Educational Objectives (PEO)

The educational objectives of Mechanical Engineering of VSSUT, Burla are to prepare its graduates:

PEO1	To demonstrate successful professional careers with strong fundamental knowledge in Science, Mathematics, English and Engineering Sciences so as to enable them to analyze the Mechanical Engineering related problems.
PEO2	To acquire competency in solving real-life problems and to design/develop sustainable and cost effective products according to the prevailing socio-economic context.
PEO3	To acquire technical knowledge in specialized areas of Mechanical Engineering such as Materials, Design, Manufacturing and Thermal Engineering with a focus on research and higher studies.
PEO4	To improve self-reliant capabilities, soft skills, leadership qualities in order to excel the entrepreneurial skills to serve the nation and the society responsibly and ethically.
PEO5	To provide opportunity to work and communicate effectively in a team and to engage in the process of life-long learning.

PEO-Mission Matrix

	M1	M2	M3
PEO1	**3**	**3**	**1**
PEO2	**2**	**2**	**1**
PEO3	**2**	**3**	**2**
PEO4	**2**	**2**	**3**
PEO5	**3**	**2**	**3**

Programme Outcomes (PO)

The graduates after successful completion of the course will acquire:

PO1	Ability to apply knowledge of mathematics, science and engineering to solve complex problems in engineering.
PO2	Ability to identify, formulate, and solve complex engineering problems using first principle of mathematics, basic science & engineering.
PO3	Ability to design, implement & evaluate engineering projects to meet societal and environmental needs.
PO4	Ability to design and conduct complex engineering experiments as well as to analyse and interpret the experimental data.
PO5	Ability to use the techniques, skills, and modern engineering tools necessary for relevant engineering practices.
PO6	Ability to assess impact of contemporary social issues on professional practice.
PO7	Ability to recognize the sustainability and environmental impact of the engineering solutions.
PO8	Ability to follow prescribed norms, responsibilities and ethics in engineering practices.
PO9	Ability to work effectively as an individual and in a team.
PO10	Ability to communicate effectively through oral, written and pictorial means with engineering community and the society at large.
PO11	Ability to understand and apply engineering and management principles in executing project.
PO12	Ability to recognize the need for and to engage in lifelong learning.

Programme Specific Outcomes (PSO)

Graduates of the program will be able to:

PSO1	Achieve excellence in thermal engineering, machine design, manufacturing systems and industrial engineering by acquiring knowledge in mathematics and basic science.
PSO2	To implement the learned principles of mechanical engineering to analyze, interpret and provide solutions to the real life problems by using state-of-art facilities.
PSO3	Take-up career in industries or to pursue higher studies in mechanical and interdisciplinary programs with high regard for ethical values, environmental and social issues.

VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY, BURLA, ODISHA

PROPOSED COURSE STRUCTURE FOR BACHELOR OF TECHNOLOGY (MECHANICAL ENGINEERING) COURSES TO BE EFFECTIVE FROM JULY/AUGUST 2020

COURSE STRUCTURE FIRST SEMESTER FIRST YEAR (THEORY)				
Sl.No	**Course Code**	**Subject**	**Contact Hrs. L-T-P**	**Credits**
1	BMA01001	Mathematics-I	3-1-0	4
2	BCH01001	Chemistry	3-0-0	3
3	BEC01001	Basic Electronics	3-0-0	3
4	BIT01001	Programming for Problem Solving	3-0-0	3
5	BCE01001	Basic Civil Engg.	3-0-0	3
		SESSIONALS		
1	BCH01002	Chemistry Lab	0-0-3	1.5
2	BEC01002	Basic Electronics Lab	0-0-3	1.5
3	BIT01002	Programming Lab	0-0-3	1.5
4	BCE01002	Engineering Graphics & Design	0-0-3	1.5
		NON-CREDIT		
1	BNC01001	Induction Programme and participation in Clubs/Societies	0-0-0	0
		Total	15-1-12	22

COURSE STRUCTURE SECOND SEMESTER FIRST YEAR (THEORY)				
Sl. No	**Course Code**	**Subject**	**Contact Hrs. L-T-P**	**Credits**
1	BMA02001	Mathematics - II	3-1-0	4
2	BPH02001	Physics	3-0-0	3
3	BEE02001	Basic Electrical Engg.	3-0-0	3
4	BHU02001	English For Business Communication	3-0-0	3
5	BME02001	Engineering Mechanics	3-0-0	3
		SESSIONALS		
1	BPH02002	Physics Lab	0-0-3	1.5
2	BEE02002	Basic Electrical Engg. Lab	0-0-3	1.5
3	BHU02002	Business Communication Skills Lab	0-0-3	1.5
4	BME02002	Workshop & Manufacturing Practices	0-0-3	1.5
		NON-CREDIT		
1	BNC02001	NSS/NCC/Yoga	0-0-0	0
		Total	15-1-12	22

COURSE STRUCTURE THIRD SEMESTER SECOND YEAR (THEORY)				
Sl.No	**CourseCode**	**Subject**	**Contact Hrs. L-T-P**	**Total Credits**
1	**BMA03001**	**Math-III**	**3-1-0**	**4**
2	**BME03001**	**Mechanics of Solid**	**3-0-0**	**3**
3	**BME03002**	**Manufacturing Science and Technology-I**	**3-0-0**	**3**
4	**BME03003**	**Basic Thermodynamics**	**3-0-0**	**3**
5	**BHU03001**	**Economics for Engineers**	**3-0-0**	**3**
SESSIONAL				
1	**BME03004**	**Material Testing Lab**	**0-0-3**	**1.5**
2	**BME03005**	**Machine Drawing**	**0-0-3**	**1.5**
3	**BME03006**	**Workshop Practice-II**	**0-0-3**	**1.5**
4	**BME03007**	**Thermal Engineering and Foundry Lab**	**0-0-3**	**1.5**
NON-CREDIT				
1	**BNC03001**	**Essence of India Traditional Knowledge/ Environmental Sciences**	**2-0-0**	**0**
TOTAL			**14-1-12**	**22**

COURSE STRUCTURE FOURTH SEMESTER SECOND YEAR (THEORY)				
SI. No	**Course Code**	**Subject**	**Contact Hrs. L-T-P**	**Credit**
1	**BME04001**	**Machine Dynamics-I**	**3-1-0**	**3**
2	**BME04002**	**Materials Engineering**	**3-0-0**	**3**
3	**BME04003**	**Fundamentals of Fluid Mechanics**	**3-0-0**	**3**
4	**BMA04001**	**Math-IV**	**4-0-0**	**4**
5	**BHU01001**	**Organisational Behaviour**	**3-0-0**	**3**
SESSIONALS				
6	**BME04004**	**Dynamics and Metrology Lab**	**0-0-3**	**1.5**
7	**BME04005**	**Metallographic Study and Non-Destructive Testing Lab**	**0-0-3**	**1.5**
8	**BME04006**	**Workshop Practice-III**	**0-0-3**	**1.5**
9	**BME04007**	**Fluid Mechanics Lab**	**0-0-3**	**1.5**
NON-CREDIT				
1	**BNC04001**	**Environmental Sciences/ Essence of India Traditional Knowledge**	**2-0-0**	**0**
2	**BNC04002**	**Summer Internship/ Training**	**0-0-0**	**0**
Total			**14-1-12**	**22**

COURSE STRUCTURE THIRD YEAR		FIFTH SEMESTER (THEORY)		
SI. No	**Course Code**	**Subject**	**Contact Hrs. L-T-P**	**Credit**
1	**BME05001**	**Machine Design-I**	**3-0-0**	**3**
2	**BME05002**	**Manufacturing Science and Technology-II**	**3-0-0**	**3**
3	**BME05003**	**Fluid Dynamics and Hydraulic Machines**	**3-0-0**	**3**
4		**Professional Elective –I**	**3-0-0**	**3**
5		**Open Elective–I**	**3-0-0**	**3**
6		**Professional Ethics, Professional Law &Human Values/ Financial Management,Costing, Accounting, Balance Sheet & Ratio Analysis**	**2-0-0**	**2**
SESSIONAL				
1	**BME05004**	**Machine DesignSessional -I**	**0-0-3**	**1.5**
2	**BME05005**	**Metal Cutting and Metal Forming Lab**	**0-0-3**	**1.5**
3	**BME05006**	**Hydraulics Machine Lab**	**0-0-3**	**1.5**
Total			**17-0-9**	**21.5**

COURSE STRUCTURE THIRD YEAR		SIXTH SEMESTER (THEORY)		
SI. No	**Course Code**	**Subject**	**Contact Hrs. L-T-P**	**Credit**
1	**BME06001**	**Machine Design -II**	**3-0-0**	**3**
2	**BME06002**	**Heat Transfer**	**3-0-0**	**3**
3		**Professional Elective –II**	**3-0-0**	**3**
4		**Professional Elective-III**	**3-0-0**	**3**
5		**Open Elective-II**	**3-0-0**	**3**
6		**Financial Management Costing, Accounting, Balance Sheet & Ratio Analysis/Professional Ethics, Professional Law &Human Values**	**2-0-0**	**2**
SESSIONALS				
1	**BME06003**	**Advanced Production and Thermal Engineering Lab**	**0-0-3**	**1.5**
2	**BME06004**	**Machine Design Sessional-II**	**0-0-3**	**1.5**
3	**BME06005**	**Product Design and Production Tooling**	**0-0-3**	**1.5**
NON-CREDIT				
1	**BNC06001**	**Summer Industry Internship/ Training/ Project**	**0-0-0**	**0**
		Total	**17-0-9**	**21.5**

COURSE STRUCTURE SEVENTH SEMESTER FOURTH YEAR (THEORY)				
SL NO	**COURSE CODE**	**SUBJECT**	**CONTACT HRS L-T-P**	**CR**
1	**BME07001**	**Advanced Mechanics of Solid**	**3-0-0**	**3**
2	**BME07002**	**Refrigeration and Air Conditioning**	**3-0-0**	**3**
4		**Professional Elective-IV**	**3-0-0**	**3**
5		**Open Elective-III**	**3-0-0**	**3**
SESSIONALS				
1		**Project - I**	**0-0-6**	**3**
2	**BME07003**	**Heat Transfer and Refrigeration and Air Conditioning Lab**	**0-0-3**	**1.5**
3		**Seminar on internship**	**0-0-3**	**1.5**
TOTAL			**12-0-12**	**18**

COURSE STRUCTURE EIGHTH SEMESTER FOURTH YEAR (THEORY)				
SL NO	**COURSE CODE**	**SUBJECT**	**CONTACT HRS L-T-P**	**CR**
1		**Professional Elective-V**	**3-0-0**	**3**
2		**Professional Elective-VI**	**3-0-0**	**3**
3		**Open Elective-IV**	**3-0-0**	**3**
SESSIONALS				
1		**Project II**	**0-0-12**	**6**
2		**Seminar on Project**	**0-0-2**	**1**
TOTAL			**9-0-14**	**16**

GRAND TOTAL CREDITS: 165

Note: Each hour of practical /lab/sessional class = 0.5 credit
The students should undergo Summer Internship or Project in India or Abroad for a minimum period of 8 weeks either in 4^{th}& 6^{th} Semesters together or in one semester at a stretch.

List of Professional Elective (Third Year)			
Sl. No.	**Category**	**Course Code**	**Subject Name**
1	**BPE-I**	**BMEPE501**	**Machine Dynamics-II**
2		**BMEPE502**	**Metal Forming Process**
3		**BMEPE503**	**Gas Dynamics**
1	**BPE-II**	**BMEPE601**	**Industrial Engineering and Operation Research**
2		**BMEPE602**	**Tribology**
3		**BMEPE603**	**Cryogenic Engineering**
1	**BPE-III**	**BMEPE604**	**Internal Combustion Engine and Gas Turbine**
2		**BMEPE605**	**Introduction to Nanotechnology**
3		**BMEPE606**	**Experimental Stress Analysis**

List of Professional Elective (Fourth Year)

Sl. No.	Category	Course Code	Subject Name
1	**BPE-IV**	**BMEPE701**	**Metrology quality control and Reliability**
2		**BMEPE702**	**Solar energy**
3		**BMEPE703**	**Industrial noise control**
1	**BPE-V**	**BMEPE801**	**Automobile Engineering**
2		**BMEPE802**	**Operation Management**
3		**BMEPE803**	**Fundamentals of Product Design**
1	**BPE-VI**	**BMEPE804**	**Mechanical Engineering Instrument and Control**
2		**BMEPE805**	**Industrial Management**
3		**BMEPE806**	**Two Phase Flow**

List of open elective subjects

Category	SL. NO.	Course Code	OPEN ELECTIVE SUBJECTS
UOE-I	1	BMEOE501	Fatigue, Creep & Fracture
	2	BMEOE502	Power Plant Engineering
	3	BMEOE503	CAD & CAM
UOE-II	1	BMEOE601	Advanced Manufacturing Technology
	2	BMEOE602	Composite Materials and Processing
	3	BMEOE603	Turbomachinery
UOE-III	1	BMEOE701	Mechanical Vibration
	2	BMEOE702	Computational Fluid Dynamics
	3	BMEOE703	Emerging Trends in Manufacturing Technology
UOE-IV	1	BMEOE801	Entrepreneurship
	2	BMEOE802	Finite Element Method
	3	BMEOE803	Non-Conventional Energy

FIRST SEMESTER

B. Tech.: Mathematics-I (Calculus and Linear Algebra) (BMA01001) [3-1-0]

Module 1: Calculus (8 Lectures)

Rolle's theorem, Mean value theorems (statements only) and applications. Introduction to improper integrals. Beta and Gamma functions and their properties.

Module 2: Calculus (8 Lectures)

Convergence of sequence and series, tests of convergence. Fourier series, arbitrary period, even andodd function, half range series.

Module3: Calculus (8 Lectures)

Limit, continuity and partial derivatives (two variables), maxima and minima. Vector and scalar point functions and fields, gradient of a scalar field, directional derivative, divergence of a vector field, curl of a vector field and applications

Module 4:* Linear Algebra *(8 Lectures)

Linear systems of equations, Gauss elimination, linear independence, rank of a matrix, Gauss-Jordan elimination. Vector Space; basis and dimension'

Module 5:* Linear Algebra *(8 Lectures)

Eigenvalues, eigenvectors, some applications of eigenvalue problems, symmetric, skew-symmetric andorthogonal matrices, diagonalization, quadratic forms, complex matrices and forms.

Text Book:

1) Erwin Kreyszig, Advanced Engineering Mathematics (9th Edition), Wiley India Pvt. Ltd
2) S.C. Malik and S. Arora, Mathematical Analysis, New Age International

Reference Books:

1) George B. Thomas, Jr. and Ross L. Finney, Calculus and Analytic Geometry, Addison WesleyPublishing Company
2) B.V. Ramana, Higher Engineering Mathematics, McGraw Hill
3) A. Stroud, Advanced Engineering Mathematics, Industrial Press
4) S.K. Paikray,Text book of Matrix Algebra, Kalyani Publisher

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Recognize basic knowledge of differential calculus, improper integral, Beta and Gamma functions which are useful in various fields of engineering
CO2	Analyse periodic phenomenon and describe Fourier series expansion of periodic function
CO3	Demonstrate functions of several variables that is essential in most of the branches of engineering
CO4	Apply Gauss elimination method and rank of a matrix in solving linear equations
CO5	Implement knowledge of eigenvalues and eigenvectors in a comprehensive manner

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	2	1	-	-	-	1	1
CO2	3	3	2	2	1	2	1	-	-	-	1	1
CO3	3	3	2	2	1	2	1	-	-	-	1	1
CO4	3	3	2	2	1	2	1	-	-	-	1	1
CO5	3	3	2	2	1	2	1	-	-	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	2	1	2	1	-	-	-	1	1

Subject: Chemistry (BCH01001) Credits: 4 [3-1-0]

Module–I (9 Hours)

Schrodinger Wave equations (not to be derived), Application to particle in ID box.
Molecular rotational (microwave) spectroscopy: Basic principle and application to diatomic molecules, selection rules.
Molecular vibrational (IR) spectroscopy: Basic principle, types of vibrations and vibrational frequency, application to Harmonic and anharmonic oscillators, selection rules, modes of vibration.
Electronic (UV-Visible) spectroscopy: Basis principle, types of electronic transitions, The Franck - Condon principle, and Jablonski diagram.

Module – II (9 Hours)
Thermodynamics of Chemical Processes:

Concept of Entropy and free energy, Chemical Potential, Equilibrium Conditions.

Phase equilibria:

Phase, Components, Degree of Freedom, Phase Rule Equation.

Phase Diagrams: One Component Systems – Water and Sulphur, Basic idea of (a) Peritectic system, (b) Eutectoid system, (c) Binary phase diagrams of Pb-Ag & Fe-C system.

Module–III (9 Hours)

Electrochemistry:

Electrode Potentials and its Relevance to Oxidation and Reduction, Types of electrodes, Galvanic cell, Measurement of EMF and application of EMF measurements, Types of reference electrodes (Hydrogen, Glass, Quinhydrone Electrodes,) Determination of pH, Electrochemical energy systems its types (Dry Cells, lead acid cell and Fuel Cells: Construction, reaction, advantages and applications).

Corrosion: Concept, types of corrosion, dry or chemical and wet or Galvanic/electrochemical Corrosion, Factors affecting corrosion.

Module–IV (9 Hours)

Kinetics of complex Chemical Reactions: Reversible, Consecutive and Parallel Reactions, Steady State Approximation, Chain reaction.

Module-V (9 Hours)

Chemistry of engineering materials:

Nanomaterials: Applications of nanomaterials.

Organometallics: Application of organometallics

Books Recommended:

1) P. W. Atkins, Elements of Physical Chemistry, 4th Edition, Oxford University Press
2) C. N. Banwell and E. M. MacCash, Fundamentals of Molecular Spectroscopy, 5th Edition,
3) P. K. Kar, S. Dash and B. Mishra, B.Tech. Chemistry Vol. I, Kalyani Publications

Course Outcomes:

CO1: Apply the basic concept of classical mechanics and quantum chemistry to real life applications & to understand the basic concept of electromagnetic radiation, spectroscopic techniques and their applications.

CO2: Should perceive the spontaneity/feasibility of a process applying thermodynamics concepts and to keep up with the idea of phase equilibria, phase rule and its application to one and two component system.

CO3: Define the application of electrochemistry to commercial electrochemical cell and corrosion.

CO4: Able to apply the basic concept of kinetics of a reaction to complex reactions.

CO5: To demonstrate the properties and applications of organometallics and nanomaterials.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	-	-	-	1	-	-	1	1	1
CO2	3	3	1	-	-	-	1	-	-	1	1	1
CO3	3	3	1	-	-	-	1	-	-	1	1	1
CO4	3	3	1	-	-	-	1	-	-	1	1	1
CO4	3	3	1	-	-	-	1	-	-	1	1	1

Program Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	1	-	-	-	1	-	-	1	1	1

BASIC ELECTRONICS (BEC01001)

MODULE	CONTENT	HOURS
MODULE 1	Introduction to Electronics: - Signals, Frequency Spectrum of Signals, Analog and DigitalSignals, Linear Wave Shaping Circuits: - RC LPF, Integrator, RC HPF, Differentiator. Properties of Semiconductors: - Intrinsic, Extrinsic Semiconductors, Current Flow in Semiconductors, Diodes: - p-n junction theory, Current-Voltage characteristics, Analysis of Diode circuits, Rectifiers, Clippers, Clampers, Special diodes- LED, Photo diode, Zener Diode.	**12**
MODULE 2	Bipolar junction Transistor (BJTs):- Device Structure and Operation, Current-Voltage Characteristics, BJT as an Amplifier and as a Switch. Introduction to Power Amplifiers: - A,B and Ctypes. JFET:- Physical Structure, Operation and Characteristics	**10**
MODULE 3	Feedback Amplifiers: - General Feedback Structure, Properties of Negative Feedback, Four Basic Feedback Topologies (block diagram only), Practical feedback circuit. Operational Amplifiers (OP-AMPs): - The Ideal OP-AMP, Inverting Configuration, Non-Inverting Configuration. OP-AMP Applications (Adder, Subtractor, Integrator, Differentiator).	**08**
MODULE 4	Digital Fundamentals:- Binary Numbers, Signed-binary numbers, Decimal-to-Binary & Binary-to-Decimal Conversion, Binary Addition, Subtraction, Multiplication and Division, Hexadecimal Number Systems, Logic Gates, Boolean Algebra, De Morgan's Theorems, Laws of Boolean Algebra, RS Flip Flop	**06**
MODULE 5	Introduction to Electronic Instruments: - CRO: CRT, Waveform Display, Applications of CRO, Electronic Multimeter, Audio Signal Generator: - Block diagram, Front Panel Controls. Principles of Communication:- Fundamentals of AM & FM, Block diagram of Transmitters	**06**
TEXT BOOK	**1.** Microelectronics Circuits, A.S Sedra, K.C. Smith, Oxford UniversityPress. Selected portions from chapters 1 to 3, 5, 8,13. **2.** Electronics Fundamentals and Applications, D Chattopadhyay and P.C. Rakshit, New Age International Publications. Selected portions fromchapters 4 to 12, 14, 16 to 18,20,21.	
REFERENCE BOOK	1. Integrated Electronics, Millman and Halkias, TMHPublications. 2. Electronic Devices & Circuit Theory, R.L Boylestad and L.Nashelsky, PearsonEducation.	

COURSE OUTCOME: After completion of course student should be able to

1. Understand different types of signals and its application to semiconductor devices andcircuits.
2. Understand different BJTs and itsoperation.
3. Understand the Feedback Amplifiers and Operational Amplifiers.
4. Understand fundamentals of different Digital arithmetic operations and Digitalcircuits.
5. Understand some important Electronic Instruments and Communicationsystems.

Course Outcomes:

Upon completion of the subject the students will demonstrate the ability to:

CO1	Implement different types of signals and its application to semiconductor devices and circuits.
CO2	Analyze the concept of different BJTs and its operation.
CO3	Express the concept of the Feedback Amplifiers and Operational Amplifiers.
CO4	Apply fundamentals of different Digital arithmetic operations and Digital circuits.
CO5	Demonstrate basic principles of important Electronic Instruments and Communication systems.

Relationship of Course Outcomes (CO) to Program Outcomes (PO)

1 – Low 2 – Moderate 3 – High

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	2	1	2	-	-	-	-	1
CO2	3	2	2	3	2	1	1	-	-	-	-	1
CO3	3	2	3	3	2	1	2	-	-	-	-	1
CO4	3	3	3	3	3	1	1	-	-	-	-	1
CO5	3	3	3	3	2	1	3	-	-	-	-	1

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	2	3	3	2	1	2	-	-	-	-	1

PROGRAMMING FOR PROBLEM SOLVING (BIT01001)

L-T-P: 3-0-0 **Cr.-3**

Module I: **(8 Lectures)**

Introduction to computing- Block architecture of a computer, fundamental units of storage: bit, bytes, nibbles, word size. Introduction to problem solving- Basic concepts of an algorithm, program design methods, flowcharts. Level of programming Languages, structure of C program, Compiling and Executing C program

Module II: **(8 Lectures)**

C Language Fundamentals- Character set, Identifiers, Keywords, Data Types, Constant and Variables, Statements. Input &Output - Input & Output Assignments, Formatted Outputs. Operators and Expressions-Operators, Precedence of operators. Decision Control Structure, Loop Control Structure and Case Control Structure.

Module III: **(8 Lectures)**

Functions: Monolithic vs Modular programs, User defined vs standard functions, formal vs Actual arguments, Functions category, function prototypes, parameter passing, Recursion.Arrays1D Array, 2D Array & Multi-Dimensional Array. Strings- Declaration & Initialization, String Handling Functions.

Module IV: **(8 Lectures)**

Pointer variable and its importance, Pointer Arithmetic, Passing parameters, pointer to pointer, pointer to function. Dynamic Memory Allocation. Structure, Nested Structure, Array of Structures, Pointer to Structure, Structure & Functions, Union, Array of Union Variables, Union inside Structure, Bit Fields. Storage Class.

Module V: **(8 Lectures)**

Preprocessor Directives- Types, Pragma Directives, Conditional Directives. typedef, Enumerated Data Type. Files- Reading data from Files, Reading data from Files, Writing data to Files, Error Handling during File Operations. Advanced Issues in Input & Output – using argc&argv.

Text Books:

1. Programming in ANSI C, E Balaguruswamy
2. Computer Fundamentals &Programming in C: ReemaThareja, Oxford University Press.

Reference Books:

1. Let us C- Y.Kanetkar, BPB Publications.
2. Programming with ANSI and Turbo C- Kamthane, A.N. Pearson Education
3. C How to Program- Deitel and Deitel, Pearson Education.
4. The C Programming Language- Brian W. Kernighan and Dennis M. Ritchie, PrenticeHall.

Course Outcomes:

Upon completion of the subject the students will demonstrate the ability to:

1. grasp the fundamentals of Computer and problem solving.
2. conceptualize fundamentals of C Programming along with control structures.
3. Implement different problems on functions and arrays.
4. Apply pointers structures and unions for problem solving.
5. Gain knowledge of pre-processor directives and file operations.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	-	-	-	2	-	-	3
CO2	3	3	3	3	2	-	-	-	2	-	-	3
CO3	3	3	3	3	2	-	-	-	2	-	-	3
CO4	3	3	3	3	2	-	-	-	2	-	-	3
CO5	3	3	3	3	2	-	-	-	2	-	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	-	-	-	2	-	-	3

Basic of Civil Engineering (BCE01001)

Module-II

Introduction to Civil Engineering – Various disciplines of Civil engineering, Importance of Civil engineering in infrastructure development of the country.

Introduction to types of buildings as per NBC, Selection of site for buildings, Components of a residential building and their functions, Introduction to Industrial buildings and types.

Building Planning – Basic requirements, elements, introduction to various building area terms, computation of plinth area, carpet area.

Module-II

Surveying – Principle and objectives, Instruments used, Horizontal measurements, Ranging (direct ranging only), Instruments used for ranging, Leveling – Definition, Principles, Instruments, Preparation of level book, problems on leveling, Modern surveying instruments – EDM, Total station, GPS (Brief discussion)

Building Materials – Bricks, properties and specifications, Cement – Types, properties, grades, other types of cement and uses, Cement mortar – Constituents, Preparation, Concrete – PCC and RCC, Grades, Steel – Use of steel in buildings, types.

Module-III

Building Construction – Foundations, Classification, Bearing Capacity of Soil and related terms (definition only), Masonry Works – classifications, definition of different technical terms, Brick masonry – types, bonds, general principle, Roofs – functional requirements, basic technical terms, roof covering material, Floors – function, types, flooring materials(brief discussion), Plastering and Painting – objectives, types, preparation and procedure of application.

Module-IV

Basic Infrastructure services – air conditioning & purpose, fire protection & materials, Ventilation, necessity & functional requirements, Lifts, Escalators.

Introduction to planning and design aspects of transportation engineering, Transportation modes, Highway engineering – historical development, highway planning, classification of highway, Railway Engineering – cross section of rail track, basic terminology, geometric design parameter(brief discussion only).

Module-V

Airport engineering – development, types, definition, characteristics of aircraft, basic terminology, Traffic engineering – traffic characteristics, traffic studies, traffic operations (signals, signs, markings), Urban engineering – classification of urban road.

Irrigation & Water Supply Engineering – Introduction, Types of Irrigation, different types of hydraulic structures, dam and weirs, types of dam, purpose and functions.

Text Books:

- Basic Civil engineering, Gopi, S., Pearson Publication
- Basic Civil Engineering, Bhavikatti, S. S., New Age.

Reference Books:

- Construction Technology, Chudley, R., Longman Group, England
- Basic Civil and Environmental Engineering, C.P. Kausik, New Age.
- American Society of Civil Engineers (2011) ASCE Code of Ethics – Principles Study and Application

Course Outcomes:

- Analyze the fundamental aspect of building planning.
- Summarize general aspect of building material and surveying.
- Explain about building constructions.
- Judge transportation modes and planning.
- Describe about Airport & Irrigation Structures.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**1**	**3**	**1**	**1**	**-**						
CO2	**3**	**2**	**1**	**1**	**1**							
CO3	**2**	**1**			**3**							
CO4	**3**	**2**	**1**	**2**	**1**	**3**						
CO5	**3**	**2**	**3**	**2**	**1**	**1**	**3**	**1**	**2**	**2**	**2**	**3**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	2	2	2	1	2	3	1	2	2	2	3

SESSIONAL

B Tech Chemistry Lab: BCH01002

List of Experiments to be done (Any ten Experiments)

1. Determination of amount of sodium hydroxide and sodium carbonate in a Mixture.
2. Determination of Total hardness of water by EDTA method.
3. Estimation of calcium present in the limestone.
4. Standardization of KMnO4 using sodium oxalate.
5. Determination of ferrous iron in Mohr's salt by potassium permanganate.
6. Determination of Rate constant of acid catalyzed hydrolysis of ester.
7. Determination of dissolved oxygen in a sample of water.
8. Conductometric titration of strong acid and strong base
9. Determination of Viscosity of lubricating oil by red wood Viscometer.
10. Determination of Flash point of given oil by Pensky Marten's Flash Point Apparatus.
11. Determination of available chlorine in bleaching powder.
12. Preparation of acidic and basic buffer solution and measurement of PH using PH meter

Book Recommended:

B. Tech Practical Chemistry- .

Course Outcomes:

CO1: Develop knowledge of concepts and applications of chemistry, important laboratory analytical techniques, and instrumentation.

CO2: Apply fundamental principles for environmental analytical methods.
CO3: Identify suitable analytical techniques for analysing a specific compound in a sample and ensure quality control.
CO4: Implement suitable techniques for sampling and handling of environmental and chemical samples.
CO5: Hands on training on using different laboratory apparatus and equipments including data analysis and conclusions.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	-	1	-	2	-	1	-	1	-
CO2	3	1	2	-	1	-	2	-	1	-	1	-
CO3	3	1	2	-	1	-	2	-	1	-	1	-
CO4	3	1	2	-	1	-	2	-	1	-	1	-
CO4	3	1	2	-	1	-	2	-	1	-	1	-

Program Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1-	PO11	PO12
CO	3	1	2	-	1	-	2	-	1	-	1	-

BASIC ELECTRONICS LAB (BEC01002)

Experiment No.	CONTENT
1	Familiarity with electronic components and devices(Testing of semiconductor diode, Transistor, IC Pins connection) Digital Multimeter should be used.
2	Study and use of CRO to view waveforms and measure its Amplitude and Frequency.
3	Frequency response of LPF and HPF.
4	V-I Characteristics of a Semiconductor Diode. Determining DC and AC resistance.
5	Clipper Circuit.
6	Clamper Circuit.
7	Half Wave and Full Wave Rectifier without Capacitor filter. Record of Waveforms, Measurement of Average and RMS value.
8	V-I (Output) Characteristics of N-P-N/P-N-P Transistor in CE Configuration.
9	OP-AMP: Inverting and Non-Inverting Configuration. Record of Waveforms.
10	Verification of Truth table of Logic gates (AND, OR,NOT, NAND, NOR, EX-OR)
SUPPLEMENTARY BOOK	1. Integrated Electronics, Millman and Halkias, TMHPublications. 2. Electronic Devices & Circuit Theory, R.L Boylestad andL. Nashelsky, PearsonEducation.

Course Outcomes:

Upon completion of the subject the students will demonstrate the ability to:

CO1	Implement Acquire basic knowledge on electronic devices and components
CO2	Analyze different electronics circuits using semiconductor diodes.
CO3	Analyze and develop the characteristics of BJT and FET Circuits.
CO4	Apply fundamentals Operational amplifier circuits.
CO5	Implement knowledge on basic digital logic gates

Relationship of Course Outcomes (CO) to Program Outcomes (PO)

1 – Low 2 – Moderate 3 – High

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	2	1	2	-	-	-	-	1
CO2	3	2	2	3	2	1	1	-	-	-	-	1
CO3	3	2	3	3	2	1	2	-	-	-	-	1
CO4	3	3	3	3	3	1	1	-	-	-	-	1
CO5	3	3	3	3	2	1	3	-	-	-	-	1

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	2	3	3	2	1	2	-	-	-	-	1

PROGRAMMING FOR PROBLEM SOLVING LAB (BHU01002)

L-T-P: 0-0-3 **Cr.-1.5**

Topics to be covered:

1. Programs using Input – Output functions.
2. Programs on variable declaration, assignments, operators and typecasting.
3. Program on selection & iterative constructs.
4. Programs on functions.
5. Programs on arrays.
6. Programs on string manipulation.
7. Programs on pointers.
8. Programs on structure & union.
9. Programs on file handling.
10. A mini-project to be designed by students using features of C.

Course Outcomes

Upon completion of the subject the students will demonstrate the ability to:

CO1: Implement the basicsof C programming.

CO 2: Exercise conditional and iterative statements to develop programs.

CO 3: Exercise user defined functions to solve real time problems.

CO 4: Demonstrate the concept of pointers to access arrays, strings and functions.

CO 5: Create C programs on file manipulations.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	-	-	2	3	-	-	3
CO2	3	3	3	3	2	-	-	2	3	-	-	3
CO3	3	3	3	3	2	-	-	2	3	-	-	3
CO4	3	3	3	3	2	-	-	2	3	-	-	3
CO5	3	3	3	3	2	-	-	2	3	-	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	3	3	2	-	-	2	3	-	-	3

Engineering Graphics & Design (BCE01002)

Course Content

Module-I

Introduction to Engineering Drawing: Drawing instruments, lines, lettering and dimensioning.

Scales: Plain, Diagonal and Vernier Scales.

Module-II

Curves: Parabola, Ellipse, Hyperbola, Cycloid, Epicycloid, Hypocycloid and Involute.

Module-III

Orthographic Projections: Concepts, Orthographic projections of points, Lines, Planes and Solids. Sections of solids; Development of surfaces

Module-IV

Isometric Projections: Principles, Isometric Scale, Isometric Views, Isometric Views of lines, Planes, Simpleand compound Solids.

Module-V

Introduction to Auto-Cad:

Curves: Parabola, Ellipse, Hyperbola, Cycloid, Epicycloid, Hypocycloid and Involute

Reference Books:

1 Engineering drawing by N.D. Bhatt and V.M Panchal, Charotar Publishing House, Anand.

Engineering Drawing by Venugopal, New Age publisher.

Course Outcomes:

1. Revise basics of engineering drawings and curves.
2. Use Orthographic projections of Lines, Planes, and Solids.
3. Apply Sectioning of various Solids and their representation.
4. Change Pictorial views to Orthographic Projections
5. Construct Isometric Scale, Isometric Projections and Views.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**1**	**3**	**1**	**1**							
CO2	**3**	**2**	**1**	**1**	**1**							
CO3	**2**	**1**			**2**							
CO4	**3**	**2**	**1**	**2**	**1**	**1**						
CO5	**3**	**2**	**2**	**2**	**1**	**1**	**3**	**1**	**2**	**2**	**2**	**2**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	**3**	**2**	2	2	**1**	**1**	**3**	**1**	**2**	**2**	**2**	**2**

SECOND SEMESTER

Mathematics-II (Differential Equations and Complex Variables) (BMA02001) [3-1-0]

Module 1: Differential Equations *(8 Lectures)*

Exact ODEs, integrating factors, linear ODEs, Bernoulli equation, homogeneous linear odes of second order, homogeneous linear ODEs with constant coefficients, Euler-Cauchy equations, non-homogeneous ODEs, Applications of ODEs to electric circuits

Module 2: Power Series Solution of Differential Equations *(8 Lectures)*

Series solution of differential equation (excluding Frobenius method), Legendre's equation, Legendre polynomials. Bessel's Equation, properties of Bessel's functions, Bessel Functions of the first and Second Kind.

Module 3: Complex Variables *(8 Lectures)*

Complex valued function, differentiation, analytic function, Cauchy-Riemann equations, harmonic and conjugate harmonic functions, exponential function, trigonometric and hyperbolic functions, logarithm, general power

Module 4: Complex Variables *(8 Lectures)*

Line integral in the complex plane, Cauchy's integral theorem, Cauchy's integral formula, power series, radius of convergence, Taylor and Maclaurin series, singularities and zeros, Laurent series, Cauchy residue theorem (statement only) and applications.

Module 5: Elementary Numerical Methods *(8 Lectures)*

Solution of algebraic and transcendental equations by Newton-Raphson and secant method.

Interpolation: Lagrange's method, divided difference method, Newton's forward and backward method. Numerical Integration: Trapezoidal and Simpson's Rule. Numerical solutions of differential equations: Euler's method and improved Euler's method.

Text Book:

1) Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India Pvt. Ltd, 9th edition.

Reference Books:

1) K.A. Stroud, Advanced Engineering Mathematics, Industrial Press
2) Milton Abramowitz and Irene A. Stegun, *Handbook of Mathematical Functions*, National Bureau ofStandards, Applied Mathematics Series - 55
3) J. Sinha Roy and S. Padhy, Ordinary and Partial Differential Equation, Kalyani Publisher.
4) B.V. Ramana, Higher Engineering Mathematics, McGraw Hill

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Develop adequate knowledge of the effective mathematical tools for the solutions of differential equations that models various physical processes
CO2	Describe power series solution of differential equations
CO3	Demonstrate analytic functions and applications of Cauchy-Riemann equations
CO4	Evaluate integration of complex valued functions, and apply Taylor and Laurent series expansions of functions in various fields of engineering problems
CO5	Compute roots of algebraic and transcendental equations, and also evaluate the integrals by Trapezoidal and Simson's rules

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	2	1	-	-	-	1	1
CO2	3	3	2	2	1	2	1	-	-	-	1	1
CO3	3	3	2	2	1	2	1	-	-	-	1	1
CO4	3	3	2	2	1	2	1	-	-	-	1	1
CO5	3	3	2	2	1	2	1	-	-	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	2	1	2	1	-	-	-	1	1

ENGLISH FOR BUSINESS COMMUNICATION (BHU02001)

Course Description

The course is designed to give students a comprehensive view of communication, its scope and importance in business, and to build the proficiency needed to succeed in today's technologically enhanced workplace. Effective communication is an integral part of life. This course focuses on improving the LSRW skills, i.e. listening, speaking, reading and writing of the students. Students will learn how to communicate effectively though the prescribed syllabus followed by an intensive practice in the language lab. This integrated approach of theory and language lab sessions will help students to communicate clearly with an impact, by improving their verbal and non-verbal communication style, as well as enhancing their competency in grammar and pronunciation. This course further tries to conversant students with the correct practices and strategies in drafting effective business correspondence.

Syllabus

Module 1: Fundamentals of Communication (6 Hours)

- Process of Communication, Types of Communication (Verbal & Non Verbal)
- Channels of Business Communication
- Barriers to Communication.
- Plain English
- Bias free language
- Cross Cultural Communication

Module 2: Communicative Grammar (6 Hours)

- Time and Tense
- Aspects (Perfective & Progressive)
- Verbs of State and Event
- Passive and Active Voice
- Conditionals

Module 3: Sounds of English (06 Hours)

- The Speech Mechanism and Organs of Speech
- Consonant Sounds of English
- Vowel Sounds of English
- Stress Pattern: Syllable, Stress and Intonation.
- Problem sounds for Indian Speakers

Module 4: Business Writing (06 Hours)

- Paragraph writing
- Sentence Linker
- Business Letters
- Report Writing
- Proposal writing

Module 5: Professional Writing (06 Hours)

- ❖ Notice, Circular and Memo writing
- ❖ Agenda & Minute writing
- ❖ Writing Cover letter
- ❖ Résumé (CV) Writing

Reference Books

1. Effective Technical Communication by M Ashraf Rizvi (Tata McGraw Hill)
2. Business Communication by Hory Sanker Mukerjee (Oxford University Press)
3. Better English Pronunciations by J. D.O Conner (Cambridge University Press)
4. A Communicative Grammar of English by G.N. Leech and Jan Svartik (OUP)
5. Business communication by Ramachandran, Lakshmi and Krishna (Macmillan)

Programme Outcomes of BTech Programme

PO1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make

	effective presentations, and give and receive clear instructions.
PO11	Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes

Upon completion of the course the students will demonstrate the ability to:

CO1	Analyse various components of human communication and to identify key elements and principles of organizational communication.
CO2	Apply correct usage of English grammar in writing and speaking.
CO3	Evaluate students' ability to articulate English key sounds as well as its basic rhythm, stress and intonation patterns correctly.
CO4	Compile, plan and structure various forms of business writing in a professional manner.
CO5	Write various business documents appropriate for different business and employment situations.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	1	-	1	-	-	1	3	-	-
CO2	-	-	-	1	-	1	-	-	1	3	-	-
CO3	-	-	-	1	-	1	-	-	1	3	-	-
CO4	-	-	-	1	-	1	-	-	1	3	-	-
CO5	-	-	-	1	-	1	-	-	1	3	-	-

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	-	-	-	-	-	-	-	-	1	3	1	-

ENGINEERING PHYSICS (BPH02001)

Module-I PROPERTIES OF MATTEER

Ideas of Elastic Constants (Y, K, η and σ), relation between elastic constants, torsion pendulum, determination of η, cantilever at one end.

Module-II OSCILLATION AND WAVES

Review of Simple Harmonic Oscillation and application to Compound pendulum, Damped Harmonic Oscillation, Forced Oscillation, Resonance, (Amplitude Resonance, Velocity Resonance, and Sharpness of Resonance).

Module-III OPTICS

Concept of Wave and wave equation, Superposition of Many harmonic waves, Interference, Concept of coherent sources (Division of wave front and division of amplitude), Interference in thin parallel film, Newton's ring (Theory, Application, Determination of Wavelength of Light, Refractive index of liquid)

Concept of Diffraction (Huygen's Principle), Types of Diffraction, Fraunhofer Diffraction due to a single slit and diffraction Grating, Determination of Wavelength, Dispersive Power and Resolving Power of a Plane Diffraction Grating, Polarization, Double Refraction, Half wave Plate, Quarter wave Plate.

Module-IV ELECTROMAGNETISM

Vector Calculus, Gradient, Divergence, Curl (Mathematical Concept), Gauss' Divergence Theorem and Stoke's Theorem (Statement Only), Derivation of Maxwell's Electromagnetic Equations in Differential form and Integral form, Electromagnetic Wave equations for $\vec{E}$ and $\vec{B}$ in vacuum and in conducting medium, Transverse nature of EM waves.

Module-V QUANTUM MECHANICS AND PHOTONICS

Wave particle duality, Matter Wave (de-Broglie Hypothesis), Wave Functions, Observables as Operators, Eigen Functions and Eigen Values, Normalization, Expectation Values, Schrodinger equation (Time Dependent and Time Independent), Particle in a box.

Lasers: Introduction and Characteristics of Lasers, Einstein's Coefficients and Relation between them, Lasing Action (Population Inversion, Three and Four level Pumping Schemes), Different types of Lasers (Ruby lasers, He-Ne Lasers).

Text Book:

1. Principle of Engg. Physics: Md. N. Khan and S. Panigrahi
2. Engg. Physics: H.K. Malik and A.K. Singh

Reference Books:

1. Oscillations and Waves: N. Subramanyam and Brij Lal
2. Optics: A. Ghatak
3. Electrodynamics: D.J. Griffith
4. Concept of Modern Physics: A. Beiser
5. Lasers: Theory and Applications: K. Thyagarajan and A.K. Ghatak

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Explain the concepts of Stress, Strain, Elastic Modulus and Elastic Constant, Bending of Beams and identify the importance Elastic properties in Engineering Applications
CO2	Demonstrate simple harmonic Oscillator, Damped Harmonic and Forced Oscillators. Express Quality factor and resonance with applications
CO3	Explain the link between Simple Harmonic Motion and Waves. Understand the principle of superposition, the need of coherent sources, analyze the difference between Interference and Diffraction and their applications. Illustrate the concept of Polarization of light and its applications.
CO4	The basic mathematical concepts related to electromagnetic vector fields, Understand the concepts related to Gauss law, Electric and magnetic Flux, Faraday‘s law, induced emf, Displacement current, Ampere’s Circuital law and Maxwell‘s equations. Expalin the transverse nature of electromagnetic wave
CO5	Identify and understand the kinds of experimental results which are incompatible with classical physics, Interpret the wave function and apply operators to it to obtain information about a particle's physical properties Solve the Schrodinger equation to obtain wave functions for some basic, physically important types of potential in one dimension Describe the requirements for a system to act as a laser. To explain lasing with need of metastable state and population inversion To explain the drawbacks of three level laser system and its solution in four level laser system.

Table	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	POP11	PO12
CO1	3	3	2	2	1	-	-	1	-	1	-	1
CO2	3	3	3	2	1	-	-	1	-	1	-	2
CO3	3	3	3	3	1	-	-	1	-	1	-	2
CO4	3	3	3	2	1	-	-	1	-	1	-	2
CO5	3	3	2	3	2	-	-	2	-	2	-	2

BASIC ELECTRICAL ENGINEERING (BEE02001)

MODULE-I (8 HOURS)

D.C circuit analysis and network theorems: Concept of network, Active and passive elements, voltage and current sources, concept of linearity and linear network, unilateral and bilateral elements, source transformation, Kirchoff's Law: loop and nodal methods of analysis, star delta transformation, network theorems: Thevenin's theorem, Norton's theorem, maximum power transfer theorem. Transients, in R-L, R-C and R-L-C circuits with DC Excitation.

MODULE-II (8 HOURS)

Single phase and three phase ac circuit: Sinusoidal, square and triangular waveforms-average and effective value, form the peak factors, concept of phasors, phasors representation of sinusoidally varying voltage and current, analysis of series-parallel RLC circuits. Apparent, active and reactive powers, power factor, power factor improvement, resonance in series and parallel circuits, bandwidth and quality factors, star and delta connections, balanced supply and balanced load, line and phase voltage/current relation, three phase power measurements.

MODULE-III (8 HOURS)

Magnet circuit & principle of electromechanical energy conversion: Analogy between electric and magnetic circuit, magnetic circuits with DC and AC excitation, magnetic leakage, BH curve, hysteresis and eddy current losses, magnetic circuit calculation, mutual coupling. Principles of dc motor & generator, types, emf equation of DC machine, torque equation of motor, Speed control of dc motor. characteristics and applications of DC motors.

MODULE-IV (8 HOURS)

AC MACHINES: Single Phase Transformer: Principle of operation, construction, emf equation, equivalent circuit, power losses, efficiency, Introduction to auto transformers. Three Phase Induction Motor: Type, principle of operation, slip-torque Characteristics, applications. Single Phase Induction Motor: Principle of operation and introduction to methods of starting, applications. Three Phase Synchronous Machines: Principle of operation of alternator and synchronous motor, emf equation, voltage regulation, applications.

MODULE-V (7 HOURS)

Measurement Instruments & Introduction to Power System: Types of instruments: construction and working principle of PMMC and MI type voltmeter and ammeters, single phase dynamometer type wattmeter and induction type energy meter, use of shunts and multipliers: general layout of electrical power system and function of its elements, concept of grid, Introduction to power converters.

TEXT BOOKS

[1]. Edward Hughes (revised by Ian McKenzie Smith), "Electrical & Electronics Technology", Pearson Education Limited. Indian Reprint 2002, 10th Edition.
[2]. D.Kulshreshtha, "Basic Electrical Engineering" TMH, 1st Edition.

REFERENCE BOOKS

[1]. C.L. Wadhwa, "Electrical Engineering", New Age International Publishers, 2nd Edition.
[2]. S. Parker Smith, "Problems in Electrical Engineering", Asia Publications, 10th Edition.

Course Outcomes:

Upon completion of the subject the students will demonstrate the ability to:

CO1	Implement principles of DC network, theorems and transients.
CO2	Analyze the concept of Single phase and three phase AC circuits.
CO3	Express the concept of magnetic circuit and DC machines.
CO4	Apply basic principles of AC machines and their working.
CO5	Demonstrate basic principles of measuring instruments and power system.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	1	2	1	-	-	-	-	1

ENGINEERING MECHANICS (BME02001)

Course Contents

Module - I (8 Hours)

Concurrent forces on a plane: Composition, resolution and equilibrium of concurrent coplanar forces, method of moment.General case of forces on a plane: Composition and equilibrium of forces in a plane, plane trusses, method of joints and method of sections, plane frame, equilibrium of ideal systems.

Module-II (8 Hours)

Friction: Problems involving dry friction, Ladder, WedgesPrinciple of virtual work.

Module - III (8 Hours)

Parallel forces on a plane: General case of parallel forces, center of parallel forces and center of gravity, centroid of composite plane figure and curves, Theorems of Pappus.

Moments of inertia: Plane figure with respect to an axis in its plane and perpendicular to the plane, Polar moment of inertia, parallel axis theorem

Module – IV (8 Hours)

Rectilinear translation: Kinematics, principle of dynamics, D Alembert's Principle,

Principle of work and energy for a particle and a rigid body in plane motion, Conservation of energy, Principle of impulse and momentum for a particle and a rigid bodies in plane motion, Conservation of momentum, System of rigid bodies, Impact, direct and central impact, coefficient of restitution.

Module – V (8 Hours)

Curvilinear translation: Kinematics, equation of motion, projectile, D Alembert's principle of curvilinear motion. Kinematics of rotation of rigid body.

Text Book:

1. Engineering Mechanics: S Timoshenko & Young; 4th Edition (International edition) McGraw Hill.

Reference Books:

1. Fundamental of Engineering mechanics (2nd Edition): S Rajesekharan& G ShankaraSubramanium; Vikas Pub. House Pvt ltd.
2. Engineering mechanics: K. L. Kumar; Tata MC Graw Hill.

Upon completion of the subject the students will be able to:

CO1	Draw free body diagrams and determine the resultant of forces and/or moments.
CO2	Solve the problems involving dry friction.
CO3	Determine the centroid and second moment of area of sections.
CO4	Apply Newton's laws and conservation laws to elastic collisions and motion of rigid bodies.
CO5	Determine the various parameters in projectile motion.

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	-	-	-	3	1	-	1
CO2	3	3	2	1	2	-	-	-	3	1	-	1
CO3	3	3	2	1	2	-	-	-	3	1	-	1
CO4	3	3	2	1	2	-	-	-	3	1	-	1
CO5	3	3	2	1	2	-	-	-	3	1	-	1

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	1	2	-	-	-	3	1	-	1

PHYSICS LABORATORY (BPH02002)

List of Experiments

1. Determination of acceleration due to gravity by using Bar pendulum
2. Determination of surface tension of water by capillary rise method
3. To draw the characteristics of a bipolar junction transistor
4. To determine the rigidity modulus of the material of a wire by using Barton's apparatus.
5. Determination of wave length of monochromatic light with the help of Newton's ring apparatus.
6. Determination of grating element of a diffraction grating using spectrometer.

Course Outcomes

Upon completion of the subject the students will demonstrate the ability to:

CO1	Express the idea of calculation of acceleration due to gravity at any place using the concept of oscillatory system and simple harmonic motion.
CO2	Demonstrate the working and operational technique to calculate the mechanical properties of fluid and other materials.
CO3	Evaluate the voltage, current, power and characteristics behaviour of the electronic devices.
CO4	Analyze the mechanical properties of any material with the idea of elasticity and its various applications.
CO5	Implement the measurement of different characteristic properties and related calculations of optical devices.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	2	1	1	3	3	1	1
CO2	3	3	2	1	3	2	1	1	3	3	1	1
CO3	3	3	2	1	3	2	1	1	3	3	1	1
CO4	3	3	2	1	3	2	1	1	3	3	1	1
CO5	3	3	2	1	3	2	1	1	3	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	3	2	1	1	3	3	1	1

BASIC ELECTRICAL ENGINEERING LABORATORY (BEE02002)

List of Experiments

1. Preliminary: Preparation of symbol chart for various systems & components as per ISS, to study the constructional & operational features for Voltmeter, Ammeter, Wattmeter, Frequency meter, multi-meter and Rheostat, Study of safety rules as per ISS
2. Measurement of the armature & field resistance of D.C. Machine by volt-amp method. & Starting and speed control of a D.C. shunt motor
3. Study of BH Curve
4. Determination of open circuit characteristics (O.C.C) of D.C shunt generator when separately excited at different speeds.
5. Measurement of earth resistance and insulation resistance.
6. Starting of Induction motor and measurement of three phase power & power factor by 2-wattmeter method.
7. Callibration of a single phase Energy Meter by directed loading & Phantom loading.
8. Obtaining the voltage, current, power and power factor of fluorescent lamp.
9. Demonstration of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging - slip ring arrangement) and single-phase induction machine.
10. Demonstration of (a) dc-dc converters (b) dc-ac converters – PWM waveform

Course Outcomes

Upon completion of the subject the students will demonstrate the ability to:

CO1	Express the safety rules as per ISS and symbols of different electrical components and the use of various electrical instruments in laboratory.
CO2	Demonstrate the working and operational characteristics of dc motor and dc generator.
CO3	Evaluate the voltage, current, power and power factor of fluorescent lamp.
CO4	Implement the measurement of earth resistance and insulation resistance and demonstrate the internal structure of different machines.
CO5	Analyze the connection and calibration of single phase energy meter, three phase power and power factor by two wattmeter method and basic idea about converters.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	3	2	1	1	3	3	1	1
CO2	3	3	2	1	3	2	1	1	3	3	1	1
CO3	3	3	2	1	3	2	1	1	3	3	1	1
CO4	3	3	2	1	3	2	1	1	3	3	1	1
CO5	3	3	2	1	3	2	1	1	3	3	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	1	3	2	1	1	3	3	1	1

Business Communication and Presentation Skills Lab (BHU02002)

Course Description

Good communication skills are indispensable for the success of any professional. The English language, in particular, has become essential in the lives of young engineers who aspire to build their careers anywhere in the world. In this regard the language laboratory plays an important role in developing the students' basic proficiency in English. Since a large number of engineering students completed their education from vernacular medium schools, they lack the basic English language proficiency which is a detrimental factor during recruitment drives in engineering colleges. In this context the language laboratory is very helpful in practicing and assessing students' speech in different communication environments. It provides them facilities to learn pronunciation, accent, stress and rudimentary communicative English grammar along with various practice sessions like presentations, group discussions, debates, case studies which are the part and parcel of corporate life.

Syllabus (Assignments)

1. Functional English grammar: Practice and exercises
2. Practice of English phonemes
3. Reading comprehension
4. Drafting business correspondence
5. Understanding the importance of body language
6. Oral presentations (Self Introduction, Extempore, Formal Presentation, power point presentations etc.)
7. Group discussion
8. Preparation for appearing an interview
9. Situational conversation practice

Reference Books

1. Effective Technical Communication by M Ashraf Rizvi (Tata McGraw Hill)
2. Business Communication by Hory Sanker Mukerjee (Oxford University Press)
3. Better English Pronunciations by J. D.O Conner (Cambridge University Press)
4. A Communicative Grammar of English by G.N. Leech and Jan Svartik (OUP)
5. Business communication by Ramachandran, Lakshmi and Krishna (Macmillan)

Programme Outcomes of BTech Programme

PO1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes

Upon completion of the sessional the students will demonstrate the ability to:

CO1	Analyse various components of effective human communication and to apply them during various practice sessions.
CO2	Apply correct usage of English grammar in writing and speaking.
CO3	Articulate English key sounds as well as its basic rhythm, stress and intonation patterns correctly.
CO4	Compile, plan and structure various forms of business writing in a professional manner.
CO5	Confidently face various recruitment drives and qualify them.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	1	-	-	1	3	-	-
CO2	-	-	-	-	-	1	-	-	1	3	-	-
CO3	-	-	-	-	-	1	-	-	1	3	-	-
CO4	-	-	-	-	-	1	-	-	1	3	-	-
CO5	-	-	-	-	-	1	-	-	1	3	-	-

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	-	-	-	-	-	-	-	-	1	3	1	-

WORKSHOP & MANUFACTURING PRACTICES (BME02002)

Course content

1. **Carpentry Section**:

Study of different Hand tools, measuring instruments and equipments used in Carpentry work. Safety precautions.

Preparation of Job:
Wooden rack/bench/chair/stool (any one)

Includes the operations:

Measuring, Marking, Sawing, Planing, Chiseling, Mortesing, Tenoning, making Half-lap joint, Mortese&Tenon joint and Nail joint.

2. **Fitting Section**:

Study of different Hand tools, measuring instruments and equipments used in Fitting work. Safety precautions. Study of Drilling Machine and Grinding Machine.

Preparation of Job:

Paper Wt. / Square or Rectangular joint (male-female joint) (any one)

Includes the operations:

Measuring, Marking, Filing, Sawing, Drilling, Tapping, Dieing and Punching.

3. **Black Smith Section**:

Study of different Hand tools, equipments, Open hearth furnace and Induction furnaces used in Blacksmith work. Different types of heat treatment processes. Safety precautions.

Preparation of Job:

Weeding hook/Hexagonal headed bolt/Chisel (any one)

Includes the operations:

Measuring, Marking, Cutting, Upsetting, Drawing down, Bending, Fullering and Quenching.

Course Outcomes:
Upon completion of the subject the students will be able to:

CO1	Acquire knowledge on different types of hand tool, measuring instruments and machine tools are used in Fitting, Carpentry and Smithy work.
CO2	Know about different types of operations and joints performed in different shops i.e. in Fitting and Carpentry.
CO3	Know about the forging temperature of different types of ferrous metals and different types of operation (e.g. upsetting, edging, flattening and bending etc.) carried out on hot metals to prepare jobs.
CO4	Acquire skills for the preparation of different types of jobs Carpentry/fitting/smithy shops by using different types of hand tools and machine tools.
CO5	Understand the importance of safety precaution in different shops.

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	2	2	1	1	3	1	2	1
CO2	-	-	1	-	2	2	1	1	3	1	2	1
CO3	-	-	-	-	1	2	1	2	3	1	2	1
CO4	-	-	-	-	3	2	1	1	3	1	2	1
CO5	-	-	-	-	-	-	-	1	2	1	1	1

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	-	-	1	-	2	2	1	1	3	1	2	1

THIRD SEMESTER

Mathematics-III (Transforms, Probability and Statistics and Multi variate Analysis) [3-1-0]

(BMA03001)

Module 1: **Laplace Transforms** ***(10 Lectures)***

Laplace transforms, inverse transforms, linearity, shifting, transforms of derivatives and integrals,solution of ODEs, unit step function, Dirac's delta function, differentiation and integration of transforms, convolution, integral equations.

Module 2: **Fourier Transforms** ***(8 Lectures)***

Basic concept of Fourier integral, Fourier sine and cosine integral, condition of convergence, Fouriertransformation, Fourier sine transform, Fourier cosine transform, properties.

Module 3: **Probability** ***(6 Lectures)***

Random variables, probability distributions, mean and variance, Binomial, Poisson and hyper-geometric distributions, Normal distribution.

Module 4: **Statistics** ***(8 Lectures)***

Random sampling, point estimation of parameters, maximum likelihood estimation, confidenceintervals, testing of hypotheses for mean and variance, correlation and regression.

Module 5: **Multi-variate Analysis** ***(8 Lectures)***

Line integrals, double integrals, change of order, Green's theorem (statements only), surface integrals, triple integrals, Divergence theorem of Gauss (statements only), Stoke's theorem (statements only) and applications.

Text Book:

Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India Pvt. Ltd, 9th edition

Reference Books:

1) B.V. Ramana, Higher Engineering Mathematics, McGraw Hill
2) K.A. Stroud, Advanced Engineering Mathematics, Industrial Press

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Develop adequate knowledge of Laplace and Fourier transforms, and apply this idea to solve differential equations
CO2	Describe unit step function and Dirac's delta function which are useful in engineering problems
CO3	Apply Binomial, Poisson and Normal distributions in probabilistic models
CO4	Demonstrate random sampling and estimation of parameters
CO5	Evaluate multiple integrals and with various applications

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	2	1	-	-	-	1	1
CO2	3	3	2	2	1	2	1	-	-	-	1	1
CO3	3	3	2	2	1	2	1	-	-	-	1	1
CO4	3	3	2	2	1	2	1	-	-	-	1	1
CO5	3	3	2	2	1	2	1	-	-	-	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: No Correlation

Program Articulation Matrix row for this Course

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	2	1	2	1	-	-	-	1	1

MECHANICS OF SOLIDS

Course Contents

Module – I (8 Hours)

Stress & Strain:Definition of stress, stress tensor, normal and shear stresses in axially loaded members. Stress-strain relationship, Hooke's law, Poisson's ratio, shear stress, shear strain, modulus of rigidity. Relationship between material properties of isotropic materials.Stress-strain diagram for uniaxial loading of ductile and brittle materials.Introduction to mechanical properties of metals hardness, impact.

Composite Bars in Tension & Compression: Temperature stresses in composite rods – statically indeterminate problem.

Module – II (10 Hours)

Two Dimensional State of Stress and Strain: Principal stresses, principal strains and principal axes, calculation of principal stresses from principal strains. Stresses in thin cylinder and thin spherical shells under internal pressure, wire winding of thin cylinders.

Torsion of solid circular shafts, twisting moment, strength of solid and hollow circular shafts andstrength of shafts in combined bending and twisting.

Module – III (8 Hours)

Shear Force And Bending Moment Diagram: For simple beams, support reactions for statically determinant beams, relationship between bending moment and shear force, shear force and bending moment diagrams.

Pure bending:theory of initially straight beams, distribution of normal and shear stress, beams of two materials. Deflection of beams by integration method and area moment method.

Module – IV (8 Hours)

Closed coiled helical springs.

Module – V (6 Hours)

Buckling of columns: Euler's theory of initially straight columns with various end conditions, Eccentric loading of columns. Columns with initial curvature.

Text Books:

1. Strength of materials, G. H. Ryder, McMillan India Ltd.
2. Elements of Strength of Materials, S. P. Timoshenko, D. H. Young, East West Press Pvt. Ltd.

Reference Books:

1. Introduction to solid mechanics, H. Shames, Prentice Hall India, New Delhi
2. Engineering mechanics of solid, E. P. Popov, Prentice Hall India, New Delhi
3. Engineering physical metallurgy, Y. Lakhtin, MIR pub, Moscow.

Course Outcomes

Upon completion of the course, students will be able to:

CO1	Gain a fundamental understanding of the concepts of stress and strain by analysis of solids and structures.
CO2	Study engineering properties of materials, force-deformation, stress-strain relationship & learn fundamental principles of equilibrium, compatibility, and force-deformation relationship, and principle of superposition in linear solids and structures.
CO3	Analyze determinate and indeterminate axial members, torsional members, and beams, and determine axial forces, torque, shear forces, and bending moments.
CO4	Learn the fundamental concepts of the method of superposition, flexibility method, and stiffness method as applied to problems involving statically determinate and indeterminate axial and torsional members, and beams.
CO5	Analyse and design thin, thick cylinders and springs.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1			3			1		1		1		1
CO2		1	1		2			1				
CO3		2	1		1			3		2		
CO4		1	1		1			2		3		
CO5		1	2		1			2		1		2

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	1	1	1		1			2		2		1

MANUFACTURING SCIENCE AND TECHNOLOGY-I

Course Contents

Module-I (10 Hours)

Sand Casting Process: Introduction, pattern-types, materials, allowances, moulding sand-composition, properties, testing; Core: core material (core sand), properties of core materials, types of core, core prints, chaplets, moulding types, moulding procedures, gating system: gates, riser, design of gating system for simple casting shape.

Module-II (6 Hours)

Melting furnaces for ferrous and non ferrous metals: Basic idea in cupola, induction furnace and Electric arc furnace, Charge calculation.Degasification, Solidification and Cooling of casting.

Module – III (8 Hours)

Special Casting Processes: Continuous casting process , Precision Investment casting process, Centrifugal casting process, Die casting, Shell mould casting, Permanent mould casting, Pressure casting process, Squeeze casting . Casting cleaning, Casting defects and remedial measures, Inspection of casting.

Module – IV(10 Hours)

Welding Process: Fusion Welding: Principles of welding, Physics of welding, Types of welded joints, Joint design preparation. Oxyfuel gas welding: Fuel gases, Types of flames, Welding equipments, Welding techniques. Electric arc welding: Principle of arc, Arc welding, Arc welding equipments, Electrodes, Manual metal arc welding, Carbon arc welding. TIG and MIG welding, Submerged arc welding, Electro-slag welding, Thermit welding, Resistance welding.

Module –V (6 Hours)

Plasma arc welding,Electron beam welding, Laser beam welding, Under water welding, Diffusion Bonding. Introduction to brazing, soldering and adhesive bonding. Welding defects and testing, weldability of metal, Welding safety Cutting: Oxyfuel gas cutting, Arc cutting, Plasma cutting.

Text Books:

1. Manufacturing Technology Vol-I, (Foundry Forming and Welding), P. N. Rao, 3rd edition TMH
2. Manufacturing Technology Vol-II, P. N. Rao , 3rd edition TMH

Reference Books:

1. Principle of Metal Casting, R. W. Heine, C. R. Loper, P. C. Rosenthal , 2nd edition TMH
2. Welding and Welding technology, R. L. Little , TMH
3. Welding Engg. & Technology, R. S. Parmar, Khanna Pub.
4. Manufacturing Engineering & technology, S. Kalpakjain, S. R.Schmid, 4th Low Price Edition

Course Outcomes

Upon completion of the course, students will be able to:

CO1	Define basic concept and fundamentals of sand casting.
CO2	Apply knowledge of the processes and furnaces used for melting of ferrous and non-ferrous metals.
CO3	Incorporate basic concept of some special casting processes.

CO4	Define fundamental knowledge of welding and the details about the welding and cutting processes.
CO5	Implement the knowledge of advanced welding processes in various applications.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	1	3	2	3	-	-	-	1	2	-	2
CO2	3	1	3	2	3	-	-	-	1	2	-	2
CO3	3	1	3	2	3	-	-	-	1	2	-	2
CO4	3	1	3	2	3	-	-	-	1	2	-	2
CO5	3	1	3	2	3	-	-	-	1	2	-	2

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	1	3	2	3	-	-	-	1	2	-	2

BASIC THERMODYNAMICS

Course Contents:

Module-I (8 Hours)

Basic Concepts: Thermodynamics system and surrounding, state, properties, processes, and cycles. Thermodynamic equilibrium and Quasi-static process.

Properties of a pure substance: The pure substance and its phase change process, property diagram and thermodynamic table, Ideal gas equation of state, P-V-T behavior of low and moderate density gases.

Module-II (8 Hours)

Work and Heat: Definition of work, Moving boundary work for simple compressible system, Definition of heat and modes of heat transfer, Comparison of heat and work.

First Law of Thermodynamics: First law for a closed system undergoing a cycle, undergoing a cycle, and undergoing a change of state. Internal energy as system properties, Enthalpy a thermodynamic property, Internal energy, enthalpy and specific heats of ideal gases. Application of first law to different thermodynamic processes.First law of thermodynamics for a control volume and its application to steady and unsteady flow processes.

Module-III (8 Hours)

Second Law of Thermodynamics: Heat Engine, Refrigerators and Heat Pumps, Second law of thermodynamics, Equivalence of Kelvin-Plank and Clausius statement, Reversible and Irreversible processes. Carnot cycle and its proposition.Thermodynamic temperature scale.

Entropy: Inequality of Clausius, Entropy: a property of a system , Entropy change of a control mass in reversible and irreversible processes, Entropy change for solid, liquid and ideal gases. Entropy generation and Principle of increase of entropy.

Module-IV (8 Hours)

Available energy, Reversible work and Irreversibility, Availability and Second law efficiency, Exergy balance equation.

Thermodynamic property relations: The Maxwell relations, The Claperon equation.

Module-V (8 Hours)

Gas Power Cycles: Basic considerations in power cycle analysis. Air standard assumptions.Otto, Diesel and Simple Brayton cycles.

Text Book:

1. Thermodynamics, P K Nag, Publisher: TMH
2. Fundamentals of Thermodynamics,Sonntag, R.E., Borgnakke, C., and Van Wylen, G.J.. Willey Publisher.

Course Outcomes:

Upon completion of the course, students will be able to:

CO1	Define the concepts of continuum, Thermodynamic systems, Thermodynamic properties, Thermodynamic equilibrium and evaluate properties ofpure substance, Work and Heat
CO2	Apply the First law of thermodynamics to analyze closed system and control volume.
CO3	Apply the Second Law of Thermodynamicsto evaluate the performance of thermal power plant, refrigerator and heat pump and evaluate principle of increase of entropy.
CO4	Evaluate Availability, Irreversibility and the Second Law efficiency.
CO5	Analyze Air standard cycles.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	3	2	3	2	1	1	-		-	-	2
CO2	3	3	2	3	3	1	1	-		-	-	2
CO3	3	3	1	2	1	1	1	-		-	-	2
CO4	3	3	2	-	2	1	1	-		-	-	2
CO5	3	3	3	2	2	1	1	-		-	-	2

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	3	2	2	2	1	1	-	-	-	-	2

Economics for Engineers (3-0-0)

Course Objectives:

- To understand the basic economic principle as a consumer in an economy
- To be able to know the utility measurement in the presence of risk and uncertainty
- To prepare the Engineering students to learn about the production process and analyse the cost/revenue data.
- To provide the foundation for engineers to make good decisions in business environment and learn about the market mechanism.
- To be able to make decision on project alternatives and justify projects on an economic basis

Syllabus:

Module-1:

Theory of Demand: Demand and Utility, Demand function and the factors determining demand, Law of Demand, Reasons for downward sloping demand curve, Exceptions to the law of demand. The market forces of Supply and Demand, Elasticity of demand and its application, Utility analysis: cardinal and ordinal measurability of utility, Assumptions of cardinal utility analysis, law of diminishing marginal utility, Consumer's equilibrium: Principle of equi-marginal utility

Module-2:

Indifference curve analysis of demand: Concepts, properties, Equilibrium of the consumer, Price Consumption Curve (PCC) and Income Consumption Curve, Decomposition of price effect into income effect and substitution effect, Revealed preference hypothesis, Individual choice under Risk and Uncertainty: St. Petersburg paradox and Bernoulli's hypothesis, Neumann-Morgenstern method of constructing utility index, Friedman-Savage hypothesis, Markowitz hypothesis

Module-3

Production function: short run analysis, Total product, Average product and Marginal product, output elasticity of input, law of variable proportion, Long run production function: Isoquants and concepts of returns to scale, Optimum factor combinations, Homogeneous Production Function, Cobb–Douglas production function, CES Production function, Cost Analysis: Concepts, Accounting cost, Fixed and variable cost, opportunity cost, Short run and long run cost curves, Relationships between average cost and marginal cost

Module-4

Market and its classifications, Perfect competition: Characteristics, Short run and long run equilibrium of firm under perfect competition. Monopoly market: Price and output determination. Modern theories of firms: Baumol's theory of sales revenue maximisation, Bain's limit pricing model

Module-5

Time value of money: use of cash flow diagram, Annual economic worth, present worth, future worth, Internal Rate of Return (IRR), Net Present Value (NPV), Payback period method, Analysis of public projects: Cost-Benefit analysis, cost effectiveness

Reference Books:

1. Koutsoyiannis, A. (1979). Modern Microeconomics. The Macmillan Press Ltd., London
2. Varian, H. R. (1992). Introduction to Micro Economic Analysis, Norton and company, New York
3. Salvatore, D. (2008). Microeconomics: theory and applications. Oxford University Press
4. Pindyck, R. S., D. N. Rubinfeld and P. L. Meheta (2009). Microeconomics, Pearson India, New Delhi
5. Panneerselvam, R. (2007). Engineering Economics, Prentice-Hall of India, New Delhi
6. Henderson, J. M. and R. E. Quant (2011). Microeconomic Theory: A Mathematical Approach, Indian Higher Education, New Delhi
7. Intriligator, M. D., R. G. Bodkin and C. Hsiao(1995). Econometric Models, Techniques, and Applications, Pearson India, New Delhi

Programme Outcomes of BTech Programme

PO1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective

	presentations, and give and receive clear instructions.
PO11	Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Outcomes:

Upon completion of the subject the student will be able to :

CO1	Utilise economics principles in consumption process
CO2	Describe the utility measurement and measure the utility associated with risk
CO3	Efficient use of resources in production and take decision regarding optimum output
CO4	Describe market mechanism and analyse product market to take proper decisions
CO5	Implement economic principles in company related decision making

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	2	2	-	-	-	3	3
CO2	-	-	-	-	-	3	2	2	-	-	2	1
CO3	-	-	-	-	-	3	3	-	-	-	3	-
CO4	-	-	-	-	-	2	2	1	1	1	3	-
CO5	-	-	-	-	-	1	2	1	2	-	3	1

Program Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	-	-	-	-	-	3	2	1	1	1	3	2

SESSIONAL

MATERIALS TESTING LAB

1. To study the stress -strain characteristics of Mild Steel by conducting tension test on U.T.M and determination of Young's modulus.
2. Hardness test of the Brass, Aluminum and copper specimen.
3. Ductility test of the Steel, Copper and Aluminum.
4. Fatigue test of the mild steel specimen.
5. Experiment on screw jack and determination of MA, VR and efficiency of screw jack machine.
6. Determination of MA, VR and efficiency of worm and worm wheel machine.
7. Impact strength of Mild steel and Aluminum using Izod impact test machine.
8. Determination of torsional rigidity of steel wire.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2	3	2	3	3	1	-	-	1	-	2	-
CO2	2	3	2	3	3	1	-	-	1	-	2	-
CO3	2	3	2	3	3	1	-	-	1	-	2	-
CO4	2	3	2	3	3	1	-	-	1	-	2	-
CO5	2	3	2	3	3	1	-	-	1	-	2	-

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	2	3	2	3	3	1	-	-	1	-	2	-

Machine Drawing

Course Contents

1. Screw threads,
2. Screwed fastening,
3. Keys, Cotter joints,
4. Knuckle joints,
5. Rivetted joints,
6. Flange coupling,
7. Engine parts,
8. Introduction to computer graphics,
9. Computer aided drawing.

Text Books:

1.Machine Drawing by N.D. Bhatt, Charotar Publishing House, 2003.
2. Machine Drawing by N. Sidheswar, P. Kannaiah and V.V.S. Sastry, Tata McGraw Hill Book Company, New Delhi, 2000.

Refference Books:

1.Kannaih, P., Production Drawing, New Age International, 2009
2. Machine Drawing by S.C. Sharma, Standard Publishers Distributers.

Course outcomes

Upon completion of the course, students will be able to:

CO1	Understand how to represent themachine parts used by machine drawing.
CO2	Draw the machine elements including different types of screw threads, single start, multistart threads and threads, screw fastenings, different types of nuts and boltsand their sectional views
CO3	Drawing of joints of machine parts and their sectional views such as: rivetted joints, cotter joints, knuckle joints, rivetted joints and flanged couplings.
CO4	Construct the assembly drawing using part drawings of machine components or engine parts.
CO5	Introduction to computer graphics, computer aided drawing.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	2	2	1	3	1	3	-	2
CO2	3	3	2	1	2	2	1	3	1	3	-	2
CO3	3	3	2	1	2	3	1	3	1	3	-	2
CO4	3	3	2	1	2	3	1	3	1	3	-	2
CO5	3	3	2	1	2	3	1	3	1	3	-	2

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	3	2	1	2	3	1	3	1	3	-	2

WORKSHOP PRACTICE-II

Course Contents

1. Foundry shop:

Study of different Hand tools, equipments, Cupola & Oil fired furnace, different types of pattern and green sand used in Foundry and casting work. Safety precautions.

Preparation of Job:

Sand moulding and Casting with core and without core.

Includes the operations:

(i) Preparation of moulding sand using moisture, binder and additives.

(ii) Preparation of green sand mould by using single piece pattern, cope and drag pattern, split pattern etc.

(iii) Melting of Aluminium and its alloys using Oil fired furnace.

(iv) Pouring and casting of Aluminium.

(v) Fettling of cast product.

2. Welding shop:

Study of different Hand tools, equipments, different methods of arc welding, oxy-acetylene gas welding, plasma cutting, tungsten inert gas welding (TIG), metal inert gas welding (MIG) and spot welding.Safety precautions.

Preparation of Job:

Study Table/Shoe Stand/ Tea table/Kitchen Stools(any one)

Includes the operations:

(i) Measuring and Marking, Cutting, Grinding, Setting, Tacking, Welding, Chipping, Finishing, Brazing & soldering.

(ii) Oxy-acetylene Gas welding & Arc welding by AC/DC power source.

(iii) Study of MIG, TIG & Spot welding.

Course Outcomes:

Upon completion of the course, students will be able to:

CO1	Acquire knowledge on different types of hand tool, measuring tools, and machine tools are used in foundry shop and welding shop.
CO2	Know selection of materials, types and allowances of patterns used in casting processes and analyze the components of moulds.
CO3	Acquire knowledge on design of core, core print and gating system, and melting & pouring of molten metal casting processes.
CO4	Understand different types of arc, gas, solid state and resistance welding processes and acquire knowledge on different types joints carried out in welding.
CO5	Understand the importance of safety precaution in foundry shop and welding shop.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	1	-	2	1	1	1	2	-	2	1
CO2	-	-	1	1	2	2	1	-	3	-	2	1
CO3	-	-	1	2	3	2	1	-	3	1	2	1
CO4	-	-	1	1	3	2	1	-	3	-	1	1
CO5	-	-	1	1	-	1	-	-	-	-	-	1

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	-	-	1	1	2	2	1	1	3	1	2	1

THERMAL ENGINEERING AND FOUNDRY LAB

Course Contents

A. Thermal engineering:

1. Study of IC engine (cut model).
2. Study of Cochran Boiler.
3. Load test on Rusten Diesel Engine.
4. Performance test on two stage reciprocating air Compressor.

B. Foundry:

1. Determination of Grain Fineness Number (GFN) of a given moulding sand.
2. Determination of permeability number and compressive strength of a given moulding sand.
3. Determination of clay content of given moulding sand.
4. Determination of moisture content of given moulding sand.

Course Outcomes

Upon completion of the course, students will be able to:

CO1	Demonstrate the knowledge to express the working principle of IC engine and identify important IC engine component including fuel injection system
CO2	Demonstrate the knowledge of load and Morse test of Ruston diesel engine and Fraud's hydraulic dynamometer to obtain the requisites.
CO3	Express the knowledge in Cochran Boiler and demonstrate the performance test of a two stage reciprocating air compressor.
CO4	Evaluate grain fineness number and permeability number and compressive strength of a given moulding sand.
CO5	Evaluate the clay content and moisture content of a given sand mould.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	3	2	1	2	1	-	2	3	2
CO2	2	3	2	3	2	1	2	1	-	2	3	2
CO3	2	3	2	3	2	1	2	1	-	2	3	2
CO4	2	3	2	3	2	1	2	2	-	2	3	2
CO5	2	3	2	3	2	1	2	2	-	2	3	2

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	2	3	2	3	2	1	2	2	-	2	3	2

FOURTH SEMESTER

MACHINE DYNAMICS-I

Course Contents

Module – I(8 Hours)

Mechanisms: Basic kinematic concepts & definitions, mechanisms, link, kinematic pair, degrees offreedom, kinematic chain, degrees of freedom for plane mechanism, Gruebler's equation, inversion of mechanism, four bar chain & their inversions, single slider crank chain, double slider crank chain & their inversion.

Module – II (8 Hours)

Kinematics analysis: Determination of velocity using graphical and analytical techniques, instantaneouscentre method, relative velocity method, Kennedy theorem, velocity in four bar mechanism, slider crank mechanism, acceleration diagram for a slider crank mechanism, kleins construction method, rubbing velocity at pin joint, coriolli's component of acceleration & it's applications

Module – III (8 Hours)

Inertia force in reciprocating parts: Velocity & acceleration of connecting rod by analytical method,piston effort, force acting along connecting rod, crank effort, turning moment on crank shaft, dynamically equivalent system, compound pendulum, correction couple, friction, pivot & collar friction, friction circle, friction axis.

Module – IV (8 Hours)

Friction clutches: Transmission of power by single plate, multiple & cone clutches, belt drive, initialtension, Effect of centrifugal tension on power transmission, maximum power transmission.

Gear trains: Simple trains, compound trains, reverted train &epicyclic train

Module – V (8 Hours)

Brakes & dynamometers: Classification of brakes, analysis of simple block, band & internal expandingshoe brakes, braking of a vehicle, absorbing & transmission dynamometers, prony brakes, rope brakes, band brake dynamometer, belt transmission dynamometer & torsion dynamometer

Text Book:

1. A text book of theory of machine, R. K. Bansal, J. S. Brar, Laxmi Publication Pvt.Ltd.

Reference Books:

1. Theory of machines, S. S. Ratan,TMH
2. Theory of machine, Thomas Bevan, TMH

Course Outcomes:

Upon completion of the course, students will be able to:

CO1	Understand the principles of kinematic pairs, chains and their classification, DOF, inversions, equivalent chains and planar mechanisms.
CO2	Synthesize planar four bar and slider crank mechanisms for specified kinematic conditions with computation of velocity and acceleration.
CO3	Understand the gear terminologies and to calculate velocity of gears in a gear train.
CO4	Converse the effect of various types of friction in power transmission
CO5	Analyze different types of brakes and measure the brake power using dynamometers.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	-	1	-	-	3	-	-	3
CO2	-	-	-	-	-		1	2		1	-	1
CO3	-	2	-	-	-	2	3	2	2	2	1	2
CO4	-	-	-	1	-	-	1	-	-	2	2	2
CO5	-	-	-	1	-	-	-	2	2	2	2	3

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	1	-	1	-	1	3	3	1	3	3	3	1

MATERIALS ENGINEERING

Course Contents:

Module – I (8 Hours)

Crystal geometry: Space Lattices, Unit cells, Crystal Structure, Crystal directions and planes Mechanism of Crystallization, Defects in crystalline materials, plastic deformation by slip and twining. Effects of cold working on properties, Review of strengthening methods.

Module-II (8 Hours)

Classification of engineering materials: Classification of Ferrous and Nonferrous Alloys, Ferrous Alloys: Steel and cast iron-basic differences, Nonferrous Alloys: Polymer, Ceramics, Composites.

Module –III (8 Hours)

Constitutions of Alloys: Pure metal, intermediate alloy phase, solid solution: Substitutional and interstitial.HumeRothary's rules for solid solution. Gibb's Phase rules, PhaseDiagram:-Binary phase diagram, iron-carbon equilibrium diagram, and phase transformation in iron-carbon system.

Module –IV (12 Hours)

Heat Treatment of Steels: Introductory ideas on structure and properties of materials, Annealing: different types of annealing, Normalizing, Hardening: Time Temperature Transformation (TTT) diagram, different cooling curves and transformation on continuous cooling, Tempering, sub-zero treatment of steel, Defects due to heat treatment. Surface Hardening of Steels:-Induction hardening, Flame hardening, Case hardening: Carburizing, Nitriding, Cyaniding, carbonitriding, Diffusion coating.

Module – V (6 Hours)

Introductory Ideas on Ferrous Alloys:-, Effect of alloying elements on the properties of steels, general Classifications of steel, Cast Iron: types of Cast Iron.

Course Outcomes:

Upon completion of the course, students will be able to:

CO1	Understand the crystal structure and classification of materials.
CO2	Understand the classification of ferrous and nonferrous alloy and study their applications.
CO3	Interpret the phase diagrams of materials.
CO4	Understand heat treatment and surface hardening processes affecting mechanical properties of metals and alloys.
CO5	Understand the effect of alloying elements.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	3	3	-	1	2	-	-	1	1
CO2	3	3	2	3	2	-	2	-	-	-	3	1
CO3	3	3	3	3	3	-	-	-	-	-	2	1
CO4	3	3	3	3	3	-	2	-	-	-	2	1
CO5	3	3	3	3	3	-	2	-	-	-	2	1

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	3	3	3	3	-	2	-	-	-	2	1

FUNDAMENTALS OF FLUID MECHANICS

Course Contents:

Module – I(8 Hours)

Introduction and Fundamental Concepts: Definition of a fluid, Scope of fluid mechanics, Basicequations and methods of analysis, Fluid as a continuum, Physical properties of fluids: Viscosity Newtonian and Non Newtonian Fluids, Surface Tension, Vapor pressure, Velocity field: One, two and three dimensional Flows, Path lines, streamline and streak line, Stress field., Classification of fluid motion: Viscous and Inviscid flows, Laminar and Turbulent Flows, Compressible and incompressible flows.

Module – II(8 Hours)

Fluid Statics: Basic equation of fluid statics, Manometers, Hydrostatic force on plane and curvedsubmerged surface, Centre of pressure, Buoyancy, Stability of immersed and floating bodies, Fluid masses subjected to uniform acceleration, Free and Forced vortex.

Basic equations in Integral form for a Control Volume: Relation of system Derivatives to thecontrol volume formulation (Reynolds Transport equation), Conservation of mass, Momentum equation for inertial and non-inertial control volume, The angular momentum principle and its application.

Module – III (8 Hours)

Differential Analysis to Fluid Motion: Conservation of mass, Motion of a fluidelement(Kinematics):Stream function for two dimensional incompressible flow and concept of flow net, Fluid Translation, Fluid Rotation and fluid deformation, Vorticity vector: Concept of rotational and irrotational flow.

Module – IV(8 Hours)

Incompressible Inviscid flow: Euler's equations of motion, Bernoulli equation: Integration of Eulerequation along a streamline, Derivation using rectangular coordinates,Static,dynamic and stagnation pressure, Limitation of Bernoulis equation, kinetic energy correction factor, Relation between the first law of Thermodynamics and the Bernoulli equation.

Module – V (8 Hours)

Flow through pipes (Incompressible Flow): Laminar and turbulent flows in pipes- Hydraulic meanradius, Concept of friction loss, Darcy-Weisbach equation- Moody's diagram, Flows in sudden expansion and contraction, Minor losses in fittings, Branched pipes in parallel and series, Transmission of power, Water hammer in pipes, Sudden closure condition.

Measurements: Pitot tube, Venturimeter, Orifice meter, Notches and weir, Hook Gauge.

Text Book:

1. Fluid Mechanics: Som&Biswas, TMH Publisher.

Reference Book:

- Introduction to Fluid Mechanics, Fox & McDonald, Willey Publisher.
- Fluid Mechanics, F.M White, McGrawHill Publisher

Course Outcomes

Upon completion of the course, students will be able to:

CO1	Gain a fundamental understanding of the concepts of stress and strain by analysis of solids and structures.
CO2	Study engineering properties of materials, force-deformation, stress-strain relationship & learn fundamental principles of equilibrium, compatibility, and force-deformation relationship, and principle of superposition in linear solids and structures.
CO3	Analyze determinate and indeterminate axial members, torsional members, and beams, and determine axial forces, torque, shear forces, and bending moments.
CO4	Learn the fundamental concepts of the method of superposition, flexibility method, and stiffness method as applied to problems involving statically determinate and indeterminate axial and torsional members, and beams.
CO5	Analyse and design thin, thick cylinders and springs.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1			3			1		1		1		1
CO2		1	1		2			1				
CO3		2	1		1			3		2		
CO4		1	1		1			2		3		
CO5		1	2		1			2		1		2

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	1	1	1		1			2		2		1

MATHEMATICS-IV (Numerical Methods)

Module I: **Errors and Root Extraction** ***(8 Lectures)***

Definition and sources of error, Propagation of errors, finding roots of algebraic and transcendental equations by Bisection method, Newton's method, Secant method, fixed point iteration method.

Module I: **Interpolation*(8 Lectures)***

Interpolation, Lagrange's interpolation, Newton's divided differences, Forward differences, Backward differences, Central differences, Interpolation error.

Module I: **Numerical integration** ***(8 Lectures)***

Numerical integration: Newton-Cotes Integration formula (without derivation), Trapezoidal rule, Simpson's rule, Gaussian quadrature, Errors in Numerical Integration.

Module I: **Numerical Solution of Differentianal Equations** ***(8 Lectures)***

Solution of ODE's: Euler's method, Improved Euler's method, Runge-Kutta Methods of order-2 and 4.

Module I: **Numerical Solution of system of linear equations*(8 Lectures)***

Numerical Solution of system of linear equations, Gauss Elimination method, LU decomposition, Gauss-Jordan Elimination method, Gauss Jacobi and Gauss-seidal iteration methods

Text Books:

1. An introduction to numerical analysis, Jain, Iyengar and Jain, New AgeInternational
2. Numerical Analysis, B. S. Grewal, Khanna Publishers

Course Outcomes

Upon completion of the subject the students will be able to:

CO1	Recogniserecursive definitions and structural induction
CO2	Demonstrate equivalence of relations, recurrence relations and generating functions
CO3	Describe Euler and Hamilton paths, Planar graphs, Graph colouring with applications
CO4	Recognise Group structure, homomorphism, isomorphism and automorphism
CO5	Analyse Lattice theory and Boolean algebras

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	2	1	-	-	-	1	1
CO2	3	3	2	2	1	2	1	-	-	-	1	1
CO3	3	3	2	2	1	2	1	-	-	-	1	1
CO4	3	3	2	2	1	2	1	-	-	-	1	1
CO5	3	3	2	2	1	2	1	-	-	-	1	1

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Course	3	3	2	2	1	2	1	-	-	-	1	1

ORGANIZATIONAL BEHAVIOUR Credit- 3-0-0 Class Hours - 30

Syllabus

Module I (6 hours)

Fundamentals of OB: Learning objectives, Definition, scope and importance of OB, why to study OB, Relationship between OB and the individual, Evolution of OB, Theoretical framework

(cognitive), Behavioristic and social cognitive, Models of OB, New Challenges of OB Manager,Limitations of OB

Learning: Nature of learning, Determinant of learning, How learning occurs, Learning and OB

Case Study Analysis

Module II (6 hours)

Personality: Definition and importance of personality for performance, Nature and Determinants of personality, Theories of Personality, Personality Traits, Personality and OB

Perception: Meaning and concept of perception, Perceptual process, Importance of perception in OB Motivation: Definition & Concept of Motive & Motivation, Theories of Motivation (Herzberg's Two Factor model Theory, Maslow's Need Hierarchy, Aldefer's ERG theory)

Case Study Analysis

Module III (6 hours)

Communication: Importance, The Communication Process, Types of communication, Barriers to communication, Communication networks, Making communication effective

Groups in organization: Nature, Types of Groups, Why do people join groups? Stages of Group

Development, Group cohesiveness, Group decision making and managerial implication,

Developing Work Teams, Team Building, Effective team building

Leadership: Concept of Leadership, Styles of Leadership, Theories of leadership (Trait theory,

Behavioral theory, Contingency theory), How to be an effective leader, Success stories of

today's Global and Indian leaders.

Case Study Analysis

Module IV (6 hours)

Conflict: Nature of conflict, Sources of Conflict, Conflict resolutions, Stages of conflict episode,Conflict management technique

Transactional Analysis (TA): Meaning of TA, Ego states, Types of transactions, Life position

Case Study Analysis

Module V (6 hours)

Organizational Change: Why organizational change? Types of Organizational Change, Planned change, Kurt Lewin's-Three step model, Resistance to Change, Managing resistance to change. Organizational Culture: Meaning & definition, Types of culture, creating, sustaining and

changing a culture, Concept of workplace spirituality.

International OB: Introduction to International business, Individual and group behavior in International organization, How culture influence International OB?

Case Study Analysis

Reference Books

1. Stephen P. Robbins, Organizational Behaviour, Printice Hall of India, New Delhi, 2013

2. K. Aswathappa, Organizational Behaviour, Himalaya Publishing House, Bombay, 2018

3. Nelson, D. L., and Quick, J. C. (2007)., Understanding Organizational Behaviour (3rded.)., Thompson South-Western Publication

4. Pareek, U. (2012), Understanding Organizational Behaviour (3rded.)., Oxford University Press.

Programme Outcomes of BTech Programme

PO1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

COURSE OUTCOMES: At the end of this course, the students will be able to

CO1	Explain the transition process of management thought from traditional period to modern approaches**.**
CO2	Transfer the different motivational theories and evaluate motivational strategies used in a variety of organizational settings.
CO3	Identify and analyze the factors affecting individual and group behavior and evaluate the appropriateness of various leadership styles.
CO4	Evaluate the appropriateness of various conflict management strategies used in organizations and develop strategies for resolving group conflict.
CO5	Explain how organizational change and culture affect working relationships within organizations.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	**2**	**2**	**2**	**1**	**1**	**3**	**2**
CO2	-	-	-	-	-	**1**	**1**	**1**	**3**	**1**	**-**	
CO3	-	-	-	-	-	**2**	**1**	**-**	**3**	**3**	**3**	**-**
CO4	-	-	-	-	-	**-**	**1**	**-**	**1**	**2**	**1**	**1**
CO5	-	-	-	-	-	**3**	**1**	1	**2**	**1**	3	**3**

Program Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	-	-	-	-	-	**2**	**1**	**1**	**3**	**2**	**3**	**2**

SESSIONAL

DYNAMICS AND METROLOGY LAB

Course Content:

A. Dynamics Lab:

1. Determination of rigidity modulus of a given wire
2. Dermination of M.I of a fly wheel.
3. Determination of mechanical advantage & velocity ratio of various lifting machines.
4. Determination of Torque & Brake Power using brake dynamometer.
5. Determination of Performance characteristics of spring loaded Governor.
6. Determination of Performance characteristics of universal loaded Governor
7. Determination of Natural frequency of torsional vibration.

A. Metrology Lab:

1. Measurement of the diameter of holes and the distance between their centres
2. Measurement of thread parameters using Tool maker's Microscope.
3. Measurement of accuracy of slip gauge using optical flat.
4. Measurement of thread parameters using Profile Projector.

Course Outcomes:

Upon completion of the course, students will be able to:

CO1	Understand the performance characteristics of different dynamically loaded machine components.
CO2	Demonstrate the applications of governor, dynamometer and flywheel in different mechanical devices.
CO3	Determine the torsional vibration characteristics and various system properties.
CO4	Understand precision and accuracy in measurement of different parameters related to various machine elements.
CO5	Demonstrate the application of tool maker microscope and profile projector in measuring thread parameter.

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	3	2	3	3	-	1	1	-	-	1	1
CO2	3	3	2	3	3	-	1	1	-	-	1	1
CO3	3	3	2	3	3	-	1	1	-	-	1	1
CO4	3	3	2	3	3	-	1	1	-	-	1	1
CO5	3	3	2	3	3	-	1	1	-	-	1	1

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO	3	3	2	3	3	-	1	1	-	-	1	1

METALLOGRAPHIC STUDY AND NON-DESTRUCTIVE TESTING LAB

Course contents

A. Metallographic Study:

1. Sample(mild steel and cast iron) preparation.
2. Microstructure study of a steel specimen using metallographic microscope.
3. Microstructure study of a cast iron specimen using metallographic microscope.

B. ND Testing :

1. Flaw detection by ultrasonic method.
2. Flaw detection by Eddy Current method.
3. Detection of surface defect by magnetic particle test
4. Detection of surface defect by liquid penetration method

Course Outcomes

Upon completion of the course, students will be able to:

CO1	Demonstrate the knowledge to prepare the specimens for metallographic examination with best practice.
CO2	Interpret and analyze the microstructure of materials for improving their mechanical properties.
CO3	Analyze the flaw on the surface of the material using theoretical knowledge and practical skill on Ultrasonic testing.
CO4	Inspection of the discontinuities located on or near the surface of the work piece by using Eddy current.
CO5	Detection of surface defects by using magnetic particle test and liquid penetration method

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	3	2	2	3	-	1	2	1
CO2	3	2	2	2	2	1	1	2	-	2	2	2
CO3	2	2	2	2	3	2	1	3	-	1	3	1
CO4	2	2	2	2	3	2	1	3	-	1	3	1
CO5	2	2	2	2	3	2	1	3	-	1	3	1

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	2	2	2	2	3	2	1	3	-	1	3	1

WORKSHOP PRACTICE–III

Course contents

1.**Turning shop** :

Study of different types of Lathe machines, mechanisms, methods of taper turning, accessories, attachments, hand tools and precision measuring instruments. Safety precautions.

Preparation of Job:

Machining of a cylindrical mild steel work piece as per the given job diagram using different types of single point cutting tools.

Includes the operations:

(i) Use of different precision measuring instruments like Vernier Caliper, Micrometer, Vernier Depth Gauge etc.

(ii) Use of different marking instruments.

(iii) Centring, Facing, Drilling, Plain Turning, Grooving, Step Turning, Taper Turning, Thread cutting, Knurling and Chamfering.

3. Machine shop:

Study of different machines such as Milling, Shaper, Planner, Slotter, Surface Grinder, Radial Drilling &Gear Hobbing. Different Mechanisms of machine tools, different types single and multipoint cutting tools, different types of milling cutters and work and cutting tool holding devices. Safety precautions.

Preparation of Job:

(i) Machining of Spur gear/Helical gear using Universal column and knee type Milling machine.

(ii) Machining of rectangular slot of the given dimension on a rectangular cast iron work piece using a Universal horizontal push type Shaper machine.

Includes the operations:

a. Flat surface machining, machining of slots, machining of grooves, keyways etc

b. Machining of gears using index head attachment.

Course Outcomes:

At the end of the course, the student will be able to:

CO1	Acquire knowledge on different types of hand tool, measuring tools, machine tools and mechanisms of machine tools (Crank &Slotted link, open & cross belt drive Quick return Mechanism) used in Turning and machine shop.
CO2	Acquire knowledge on manufacturing of gears i.e spur , helical gears etc and different types of machining operations e.g. planning, slotting, key way cutting, drilling etc in machine shop.
CO3	Acquire knowledge on different parts of lathe machine, accessories, attachments and their functions.
CO4	Understand different types machining operations e.g. facing, plain turning, step turning,threading,taper turning and knurling in lathe machine.
CO5	Understand the importance of safety precaution in both machine shop and turning shop.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	1	-	2	1	1	1	2	1	2	1
CO2	1	-	2	1	2	2	1	-	3	-	2	1
CO3	-	-	1	2	3	2	1	-	3	1	2	1
CO4	-	-	2	2	3	2	1	-	3	-	1	1
CO5	-	-	1	1	-	1	-	1	-	-	-	1

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	1	-	2	2	2	2	1	1	3	1	2	1

FLUID MECHANICS LAB

Course Content

1.To determine the Metacentric height of a Ship model.

2. Verification Of Bernoulli's Theorem.

3.Determination of Value Of Co-efficient of discharge for Venturimeter fitted in a pipe.

4.To determine Darcy-Weisbach Co-efficient to different pipe sizes and study of f Vs Re relation.

5.To determine Chezy's C and Manning's N in a rectangular channel.

6.Determine Co-efficient of discharge for the given Orificmeter.

7.To determine Reynold's number experimentally.

Course outcomes

Upon completion of the course, students will be able to:

CO1	To know the practical application of Buoyancy force and meta centre effect.
CO2	Apply Bernoulli's principle in determining the coefficient of discharge of various flow meters.
CO3	Compute the friction factor for fluid flow through set of pipes.
CO4	Discuss the effect of change in pressure head, flow rate and the coefficient of discharge of flow meters.
CO5	Exhibit ethical principles in engineering practices.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	1					1				1	
CO2	2	1					1				1	
CO3	2	1					1				1	
CO4	3	2					1				1	
CO5	2	1					2				1	

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	2	1					1				1	

FIFTH SEMESTER

MACHINE DESIGN- I

Course Contents

Module – I (8 Hours)

Introduction to machine design: Stages in design, standardization interchangeability,strength, rigidity, engineering materials, ferrous, nonferrous ,Indian standard specification for ferrous materials, allowable stress, factor of safety.

Module – II (8 Hours)

Design of joints: Riveted, welded and bolted joints based on different types of loading,illustrative problems with solutions. Design of cotter joints with socket and spigot, with a gib, design of knuckle joint.

Module – III (8 Hours)

Design of shaft : Solid and hollow shaft based on strength and on rigidity design of key andpins, design of couplings-only protective type of solid flange coupling.

Module – IV (8 Hours)

Design of spring: Helical, leaf springs.

Module – V (8 Hours)

Design of belt, rope chain drives and screw jack.Illustrative problems with solutions.

(Data Books are allowed)

Text books:

1. Machine Design, P. C. Sharma, D. K. Agrawal–Kataria And Sons
2. Mechanical Engg. Design, J. E. Shigley, I. C. Mitchelle-–TMH
3. Any data book

Reference book:

1. Elements of machine design, Pandya& N.C.E Shah

Course Outcomes

Upon completion of the course, students will be able to:

CO1	Analyze the stress and strain on mechanical components; and understand, identify and quantify failure modes for mechanical parts
CO2	Demonstrate knowledge on basic machine elements used in machine design; design machine elements to withstand the loads and deformations for a given application, while considering additional specifications.
CO3	Approaches a design problem successfully, taking decisions when there is not a unique answer and proficient in the use of software for analysis and design.
CO4	To work in teams to analyze and design various types of brakes and clutches and present their designs orally and in writing.
CO5	To identify the characteristics of their designs that has safety, societal, or environmental impact.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	3	3	1	1	-	1	-	-	1	1
CO2	3	1	3	3	1	1	1	1	1	-	-	-
CO3	3	1	3	3	1	1	-	1	-	-	-	1
CO4	3	1	3	3	1	1	1	1	-	1	1	1
CO5	3	1	3	3	1	1	-	1	-	-	-	-

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	1	3	3	1	1	-	1	-	-	-	1

MANUFACTURING SCIENCE AND TECHNOLOGY-II

Course Contents

Module-I(8 Hours)

Classification of Metal Machining Processes, Tool Materials, Types of Tools-Single Point and Multipoint, Tool Geometry And Nomenclature: ASA, ORS and NRS System, Effect of Tool Geometry and Effect of Machining Variables on Machining.

Mechanism of Chip Formation, Shear deformation and shear plane Types of Chips, Factors Involved in Chip Formation, Effect of Cutting Variables on Chip Reduction Co-efficient.

Module-II (8 Hours)

Force System In Turning: Merchants circle diagram, Velocity relationship, stress in conventional shear plane. Energy of cutting process, restricted cutting, Ernst and Merchant angle relationship, measurement of forces – dynamometers for measuring turning and drilling forces.

Module-III (12 Hours)

Evaluation of Machinability, Mechanism of Tool Wear, Tool Life, Taylors Tool Life Equations, Determination of Optimum Cutting Speed In Machining, Thermal Aspects of Machining, Chip-Tool Interface Temperature, Cutting Fluids. Economics of machining.

Jigs and Fixtures:- Principle, Types of Turning, Milling fixture and Drilling, Boring Jigs, Principles of Location and Clamping, Tool Guidance

Module-IV (6 Hours)

Non Conventional Machining Processes: Principle, Process and application of AJM, USM, ECM, EDM, LBM

Module-V (8 Hours)

Principles of CNC Technology, Automation, Concept of CAD-CAM softwares and CIM

Text Books:

1. Metal Cutting Theory and Practice, A Bhattacharya, New Central Book Agency.
2. Machining and Machine Tools, A B Chattopadhyay, Wiley-India Publication.
3. Manufacturing Technology Metal Cutting and Machine Tools, P N Rao, TMH Publication.

Reference Books:

1. Metal Cutting Principles, M C Shaw, CBS Publication.
2. Manufacturing science, A Ghosh, A K Mallik, EWP PVT LTD.
3. Metal Cutting, E M Trent, P K Wright, Butterworth Heinemann Publication
4. A Textbook of Production Engineering, P C Sharma, S Chand Publications.
5. Computer Control of Manufacturing Systems, Y Koren, McGraw Hill Publication.
6. CNC Technology and Programming, T Raj, DhanpatRai Publication.

Course outcomes

Upon completion of the course, students will be able to:

CO1	Analysis of critical factors in material removal processes
CO2	Evaluate the role of each process parameter during machining of various advanced materials
CO3	Solve the various problems for the given profiles to be imparted on the work specimens and Design of fixtures and jigs for proper adaptability in the manufacturing system
CO4	Selection of the best process out of the available various advanced non-traditional machining processes for the given job assignment
CO5	Use of latest gadgets in automation in machining

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	3	2	2	1	-	-	-	-	-	3
CO2	2	2	2	3	3	3	-	-	-	-	-	2
CO3	2	1	3	2	2	2	-	-	-	-	-	2
CO4	2	3	1	3	3	1	-	-	-	-	-	2
CO5	3	3	2	1	1	1	-	-	-	-	-	3

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	3	3	3	3	3	-	-	-	-	-	3

FLUID DYNAMICS AND HYDRAULIC MACHINES

Course Contents

Module – I (8 Hours)

Dimensional Analysis and Principles of Model Testing: Dimensional homogeneity, Dimensional analysis, Rayleigh's method and Buckingham Theorem. Similarity laws and model studies.Distorted models.

Navier stokes equation and its solution: Derivation and its exact solution to plane and circular Couetteflow, fully developed flow between infinite parallel plates, axial flow though circular pipe and annulus

Module – II (8 Hours)

Boundary layer theory: Boundary layer growth over a flat plate. Boundary layer thickness, Nominalthickness, displacement thickness, momentum thickness and energy thickness, laminar and turbulent boundary layer, Momentum integral equation using momentum principle.Boundary Layer Separation and its control.

Drag and lift: Drag and lift coefficient, pressure drag and friction drag on stream lined body and bluffbody, Drag over flat plate, Profile drag. Drag characteristics of sphere, cylinder and disc Circulation and lift on a circular cylinder, Magnus effect, Circulation and lift on an Aerofoil.

Module – III (8 Hours)

Hydraulic Turbines: Classification of turbines, Different heads and efficiencies of turbines, Study ofPelton , Francis and Kaplan Turbines, Specific speed and unit quantities, performance of turbines, Governing of turbines, Cavitation in reaction turbines, Principles of similarity applied to turbines.

Module – IV (8 Hours)

Centrifugal Pump: Principle, classification, pressure changes in a pump .Velocity vector diagrams andwork done, minimum speed of pump to deliver liquid, multistage pumps. Similarity Relations and specific speed.

Reciprocating pump: Principle of working, slip, work done, effect of acceleration and frictionalresistances, separation, air vessels.

Module – V (8 Hours)

Miscellaneous machines: Hydraulics - Intensifier, ram, coupling, press, accumulator & Air injectionpump

Text Books:

1. Fluid Mechanics & Hydraulics Machines. Modi, Seth, Standard Book House
2. Introduction to Fluid Mechanics & Fluid Machines, S. K .Som, G .Biswas, TMH Pub. (p) Ltd

Reference Books:

1. S. L. Dixon, Fluid mechanics and thermodynamics of turbo machinery: Butterworth
2. Dr. R. K. Bansal, Fluid Mechanics and Hydraulic Machines, Laxmi Pub. (P) Ltd.

Course Outcomes

Upon completion of the subject the students willbe able to:

CO1	Develop and analyze models for the prototype using Dimensional analysis.
CO2	Apply the N-S equation for differentPhysical problems.
CO3	Describe and analyzethe working of various types of hydraulic turbines.
CO4	Describe and analyzethe working of centrifugal and reciprocating pumps.
CO5	Design various components of pumps and turbines.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	3	2	1	1	2	1	-	-	-	-	1

PROFESSIONAL ELECTIVE

METAL FORMING PROCESS

Course contents

Module –I (9 Hours)

Introduction: Principle of plastic deformation and yield criteria, Fundamental of hot and cold working processes, Effect of strain rate on forming process.

Forging: Open die forging, Drop forging, Press forging, Load estimation in forging, Forging design, allowances, die design for drop forging, design of flash and gutter, Upset forging die design, forging defects and inspection.

Module –II (9 Hours)

Rolling: Principle of rolling, Rolling stand arrangement, Rolling load calculation, Roll passes, Flat rolling, Pipe rolling, Defects in rolled products.

Extrusion: Forward and backward extrusion, Hydrostatic Extrusion, Extrusion Forging, Load estimation in extrusion, Extrusion of tubes, Calculation of force in hot extrusion, Effect of Extrusion Variables, Extrusion Defects.

Module –III (9 Hours)

Drawing: Wire drawing, Rod and tube drawing, Drawing forces, Drawing defects.

Sheet Metal Forming and bending: Sheet metal working-shearing, blanking piercing, deep drawing operation. Die design for sheet metal operations, progressive and compound die, strippers, stops, strip layout. Principle of bending,Spring back effect, Coining.

Module – IV(9 Hours)

Powder Metallurgy Forming Process: Method of Powder production, Powder characteristic analysis, Powder annealing, Precompaction studies, Cold compaction Studies, Sintering and sintering atmosphere, Post sintering operations (coining, infiltration, hot forging etc.) Hot and cold iso-static pressing, Properties of P/M products and applications.

Module – V (4 Hours)

Advanced forming processes: High energy rate forming, explosive forming, electro hydro forming, electromagnetic forming, rubber die forming.

Course Outcomes

Upon completion of the course, students will be able to:

CO1	To be able to relate to plastic deformation of metals is achieved on industrial scale
CO2	Analyze the concept of technological procedures in industrial manufacturing processes related to pressure shaping of metals
CO3	To be able to use the upset forging to practically analyse stresses and strains in typical pressure shaping
CO4	To Analyze cold rolling of aluminium alloy on a two-high laboratory rolling mill and carry out tensile test, hardness test and impact Test on the rolled product
CO5	To be able to relate to hardening and strengthening occurring in pressure shaping of metals

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	1	1	1	-	-	-	-	1
CO2	3	3	3	1	1	3	1	-	-	-	-	1
CO3	3	3	3	1	1	3	1	-	-	-	-	1
CO4	3	3	3	1	1	3	1	-	-	-	-	1
CO5	3	3	2	1	1	3	1	-	-	-	-	1

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	3	1	1	3	1	-	-	-	-	1

FATIGUE, FRACTURE AND CREEP

Course Contents

Module-I (8 Hours)

Fatigue: Fatigue under normal conditions, Controlling factors in fatigue. Design for fatigue. Fracture Theories of strength and working stresses.

Module-II (8 Hours)

Creep: Temperature and Creep Stress-strain properties, creep in tension, Creep in bending, Creep in Torsion, Creep buckling, Members subjected to creep and combined stresses.

Module-III (8 Hours)

Fracture: Basic modes of fracture, Grifth theory of Brittle fracture.

Module-IV (8 Hours)

Irwin's theory of fracture in elastic-plastic materials.

Module-V (8 Hours)

Theories of linear elastic fracture mechanics, stress intensity function, Fracture toughness testing.

Text Books:

1. Strength and Resistance of Materials – by J.M. Less les, Chapter 6, 7, 8 & 11.
2. Fracture Mechanics – KN Heller.

Reference Books:

1. Mechanical Behaviour of Engg. Materials by J. Marin Chapter 7 & 8.

Course Outcomes

At the end of the syllabus students will be able to:

CO1	Use simple continuum mechanics and elasticity to determine the stresses, strains, and displacements in a loaded structure.
CO2	Understand the mathematical modelling of the elements of plastic deformation, with respect to continuum and microscopic mechanisms.
CO3	Use creep data to predict the life of structures at elevated temperatures and the understanding of mechanisms of creep deformation and fracture.
CO4	Understand fracture mechanics principle to quantitatively estimate failure criteria for both elastically and plastically deforming structures, in the design of life prediction strategies, and for fracture control plans, with examples from automotive, aerospace, medical, and other industries.
CO5	Design and develop metals, ceramics, composites, and biological materials for optimal failure and fatigue analysis.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	3	3	1	-	-	-	-	-	1
CO2	3	3	2	3	3	1	-	-	-	-	-	1
CO3	3	3	2	3	3	1	-	-	-	-	-	1
CO4	3	3	2	3	3	1	-	-	-	-	-	1
CO5	3	3	2	3	3	1	-	-	-	-	-	1

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	3	2	3	3	1	-	-	-	-	-	1

GAS DYNAMICS

Course Contents:

Module-I (8 Hours)

Fundamental Aspects of Gas Dynamics: Introduction, Isentropic flow in a stream tube, speed ofsound, Mach waves .One dimensional Isentropic Flow: Governing equations, stagnation conditions, critical conditions, maximum discharge velocity, isentropic relations

Module-II (8 Hours)

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

Module-III (8 Hours)

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

Module-IV (8 Hours)

Generalized Quasi-One-Dimensional Flow: Governing equations and influence coefficients, solution procedure for generalized flow with and without sonic point,

Module-V (8 Hours)

Two-Dimensional Compressible Flow: Governing equations, vorticity considerations, the velocity potential, linearized solutions, linearized subsonic flow, linearized supersonic flow, method of characteristics.

Text Books:

1. F. M. White, Viscous Fluid Flow. 2nd ed. New York: McGraw-Hill, 1991.
2. A.H. Shapiro, Compressible Fluid Flow 1 and 2. Hoboken NJ: John Wiley.

Reference Books:

1. L. D. Landau, E. M. Lifshitz, Fluid Mechanics. 2nd ed., Butterworth-Heinemann, 1995.
2. H. W. Liepmann, A. Roshko, Elements of Gas Dynamics, Dover Pub, 2001.
3. P. H. Oosthuizen W. E. Carscallen, Compressible Fluid Flow, NY, McGraw-Hill, 1997.

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Formulate and solve problems in one -dimensional steady compressible flow
CO2	Analyzethe flow with normal, oblique shocks and expansion wave
CO3	Solve flow through variable area ducts with friction and heat transfer
CO4	Analyze the flow in generalized quasi-one-dimensionaland its applications
CO5	Solve two-dimensional compressible flow and its analysis

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	3	2	3	-	3	1	-	1
CO2	3	3	3	1	3	2	3	-	2	1	-	1
CO3	3	3	2	3	3	3	3	-	3	1	-	1
CO4	3	1	2	3	3	3	3	-	2	1	-	1
CO5	3	3	3	3	3	3	3	-	3	1	-	1

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	3	2	3	2	3	-	3	1	-	1

OPEN ELECTIVE

MACHINE DYNAMICS-II

Course Objectives:

- To impart the knowledge of theory of shape and action of tooth properties and methods of generation of standard tooth profiles
- To give concepts of gyroscope and its effects
- To introduce the basic concept of governors
- To provide information of balancing, dynamics of machines and basic knowledge of cams
- To give awareness on the phenomenon of vibration and its effects.

Module – I (8 Hours)

Toothed Gears: Theory of shape and action of tooth properties and methods of generation of standardtooth profiles, standard proportion, interference and undercutting, methods for eliminating interference, minimum number of teeth to avoid interference

Module – II (8 Hours)

Gyroscope: Gyroscopic couple, plane disc, analysis of forces on bearing due to forced precession ofrotating disc mounted on shaft, gyroscopic effect on a two wheel and a four wheel vehicle, gyroscopic stabilization

Module – III (8 Hours)

Governors: Centrifugal governors – Watt, Porter and Proell governors ,spring loaded governors – Hartnell governors, sensitiveness, stability, isochronisms, hunting, governer effort and power ,curves of controlling force , effect of friction.

Module – IV (6 Hours)

Balancing: Balancing of revolving masses in one plane and different planes,partial balancing of singlecylinder,engine balancing of multi-cylinder engine, V and radial engine, methods of direct and reverse cranks

Dynamics of Machine: Turning moment diagram, flywheel

Cams: Simple harmonics, constant velocity and acceleration types, displacement, velocity andacceleration of follower,cams with specified contours

Module – V (10 Hours)

Vibration : Introduction to vibration, causes of vibration, elimination of vibration, types of vibration-longitudinal, transverse, torsional; definition of terminology like natural frequency, amplitude, time period , free vibration, forced vibration, resonance, degree of freedom with examples, calculation of natural frequency of un-damped single degree of freedom system by Newton's 2^{nd} Law, D-Alembert's principle and energy method, Equivalent spring constant for the system having different types of combination of springs and calculation of their natural frequencies , calculation of natural frequency of single degree of spring – mass system taking mass of spring into account

Text Books:

1. Theory of Machines, S SRatan , TMH
2. Theory of machine, R K Bansal, Laxmi Pub. Pvt. Ltd.,

Reference Books:

1. Mechanism of Machine theory, Rao and Dulchipati, New Age Publication
2. Theory of Mechanism and Machine, Ghosh and Mallick ,East West Press

Course Outcomes:

Upon completion of the course, students will be able to:

CO1	Expressthe mechanism of tooth profile, interference and undercutting
CO2	Evaluate the gyroscopic effect in engineering systems and incorporate stabilization in it
CO3	Demonstrate the dynamics of different types of governor and express different important governor terminologies.
CO4	Implement the concept of balancing in unbalanced engineering systems to balance it and be able to analyse and design cam and gear mechanisms for a given motion or a given input/output motion or force relationship.
CO5	Develop a sense and apply the knowledge about basics of vibration and critical speeds with respect to machine dynamics, in engineering systems.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	1	2	2	-	2	2	2
CO2	3	3	3	3	2	2	-	2	-	1	3	1
CO3	3	3	3	3	3	2	1	2	-	3	3	1
CO4	3	3	3	3	3	2	1	1	-	3	2	2
CO5	3	3	3	3	3	1	2	2	-	3	3	3

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	3	3	3	3	2	1	2	-	2	2	2

POWER PLANT ENGINEERING

Course Contents:

Module– I (8 Hours)

Introduction:-Energy sources for generation of electric power, principal types of power plant,their special features and applications

Steam Power Plant: Selection of sites, general layout of modern steam power plant, highpressure boilers, sPROFESSIONALELECTIVEr heater and air preheater, fluidised bed boilers, fuel and ash handling equipments, water treatment plant, spray ponds and cooling towers, steam condenser type and calculation

Module– II (10 Hours)

Steam Power Plant Cycles: Rankine cycles, Modified Rankine cycles, reheat cycles,regenerative cycles

Introduction to Steam Flow through Nozzles, Steam Turbines: Types of nozzles, Isentropicflow through nozzles, Effect of friction, Nozzle efficiency, Critical Pressure ratio and maximum discharge, throat and exit area. Classification: impulse and reaction turbines, difference between two, Types of power in steam turbine, steam turbine governing and control

Module– III (8 Hours)

Nuclear Power Plant: Classifications and essential component of nuclear reactor, heavy watermoderator and cooled reactors, CANDU reactors, light water reactor, gas cooled reactors, liquid metal cooled reactors, disposal of nuclear waste

Module– IV (8 Hours)

Power Plant Economics: Plant investment cost, fixed charges, operating costs, energy cost anddepreciation, factors of affecting economics of the generation and distribution

Module–V (6 Hours)

Pollution And Its Control: Air water pollution by thermal power plant and its control, thermalpollution by thermal and nuclear power plants, radioactive pollution, methods suggested to reduce pollution.

Course Outcomes

Upon completion of the subject the students will be able to:

CO1	Summarize the general layout, components and performance characteristicsof a modern steam power plant.
CO2	Determine efficiencies and power output insteam power cycles.
CO3	Describe the basic principles of nuclear power plants, reactors and their working.
CO4	Present a sound knowledgeabout performance parameters in power plant economics and able to carry out tariff calculations.
CO5	Realise the detrimental effects of power plants, causes of pollution and know about the preventive measures to be carried out to have a sustainable environment.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	1	2	1	1	-	-	-	1
CO2	3	3	3	2	2	1	1	-	-	-	-	1
CO3	3	3	3	1	2	2	2	2	-	-	-	1
CO4	3	3	3	1	1	1	-	1	-	-	3	1
CO5	1	1	2	1	1	2	3	2	-	-	-	1

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	3	1	1	2	1	2	-	-	3	1

CAD &CAM

Course Contents:

Module - I (8 Hours)

Fundamentals of CAD: The design process, applications of computer for design, creating the Manufacturing, Database, The design workstation, Graphical Terminal, Operator input Devices, Plotters and other devices, the CPU secondary storage.

Module – II(8 Hours)

Computer graphics Software and Database: Configuration, Graphics Packages, Constructing the Geometry, transformations, Database structure and content, wire frame versus solid modeling.

Module – III (8 Hours)

CAM – Introduction, Numerical Control and NC Part Programming: NC Coordinate system, NC motion control system, Economics of NC, Manual and Computer Aid Programming, the APT language, NC programming with interactive graphics.

Module – IV(8 Hours)

Problems with conventional NC, NC technology: CNC, DNC combined DNC/CNC system, Adopter control manufacturing systems.

Module –V (8 Hours)

Computer Integrated manufacturing system, Machine Tools and related Equipment, Materials Handling and Storage system, computer system.

Text Book(s):

1. Computer Aided design and Manufacture, Grover M.P.Simmers, E.W. Prentice Hall
2. CAD/CAM/CIM, P.Radhakrishnan&Subramanyam, Willey Eastern Limited.
3. Principles of Computer Aided Design and Manufacturing / FaridAmirouche / Pearson.

Course outcomes:

Upon completion of the subject the students willbe able to:

CO1	Describe and identify the parts, to choose the functions and operations of a CAD / CAM system and draw up specifications.
CO2	Describe the mathematical basis in the technique of representation of geometric entities including points, lines, and parametric curves, surfaces and solid, and the technique of transformation of geometric entities using transformation matrix.
CO3	Generate NC part programs to run the system for machining works
CO4	Explain the operation of a CAD / CAM system to assess its performance and describe the use of GT and CAPP for the product development.
CO5	Identify the various elements and their activities in the Computer Integrated Manufacturing Systems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	1	1	-	1	-	-	-	1	1	3	1
CO2	3	2	-	-	2	-	1	-	1	1	2	1
CO3	2	3	2	1	3	-	-	-	-	-	2	2
CO4	3	3	2	3	-	-	-	-	-	-	2	1
CO5	3	3	2	1	3	-	-	-	-	-	2	1

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	3	3	-	1	-	1	1	3	2

SESSIONALS

MACHINE DESIGN SESSIONAL-I

Course content:

Design and drawing of:

1. Design of riveted joint
2. Design of Bolted joint.
3. Design of Welded joint.
4. Design of Cotter joint.
5. Design of Knuckle joint.
6. Design of Flexible coupling.
7. Design of Screw jack.

Reference

1. Bhandari, V B., Design of Machine Elements, 3/e, Tata McGraw Hill Book Company, New Delhi, 2009.
2. Norton, R. L., Machine Design: An Integrated Approach, 3/e, Pearson, 2004. 3. Shigley, J.E and
3. Mischke, C. R. Mechanical Engineering Design, 6/e, Tata McGraw Hill, 2005.
4. Paul H Black and O. E. Adams, P., Machine Design, 3/e, McGraw Hill Book Company, Inc., New York, USA., 2007.
5. Kannaiah, P., Machine Design, 2/e, Scitech Publication Pvt. Ltd., 2009.

Course Outcomes:

Upon completion of the course, the students will demonstrate the ability to:

CO1	Analyze the stress and strain on mechanical components; and understand, identify and quantify failure modes for mechanical parts
CO2	Analyze the stress and strain on mechanical components; and understand, identify and quantify failure modes for mechanical parts
CO3	Approaches a design problem successfully, taking decisions when there is not a unique answer and proficient in the use of software for analysis and design.
CO4	To work in teams to analyze and design various types of brakes and clutches and present their designs orally and in writing.
CO5	To identify the characteristics of their designs that have safety, societal, or environmental impact.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	-	1	1	-	-	1	1
CO2	3	3	2	3	3	-	1	1	-	-	1	1
CO3	3	3	2	3	3	-	1	1	-	-	1	1
CO4	3	3	2	3	3	-	1	1	-	-	1	1
CO5	3	3	2	3	3	-	1	1	-	-	1	1

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	3	3	-	1	1	-	-	1	1

METAL CUTTING AND METAL FORMING LAB

Course content

A. Metal Cutting Lab:

1. Determination of surface roughness of threedifferent specimen using Taylor Hobson's Talysurf.
2. Determination of cutting forces during turning operation using force dynamometer.
3. Determination of thrust and torque using drill tool dynamometer.
4. Demonstration of spinning operation.

B. Metal forming lab:

1. Comparison of loads in forward and backward extrusion processes.
2. Determination of load variations with different extrusion ratios.
3. Experiment on deep drawing.
4. Determination of friction factor in ring/disc compression test.

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	To able to measurement and understand the various elements of surface texture by using Taylor Hobson's Talysurf.
CO2	Understanding the relations of cutting forces during turning operation using force dynamometer and thrust and torque using drill tool dynamometer
CO3	Evaluate the loads in forward and backward extrusion processes and load variations with different extrusion ratios
CO4	Estimate formability limits for sheets and bulk metals
CO5	Estimate the friction factor in ring/disc compression test

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	2	-	-	2	-	-	-	-	-	-	1
CO2	2	3	-	-	2	-	-	-	-	-	-	1
CO3	2	3	-	-	2	-	-	-	-	-	-	1
CO4	1	2	-	-	2	-	-	-	-	-	-	1
CO5	2	3	-	-	2	-	-	-	-	-	-	1

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	2	3	-	-	2	-	-	-	-	-	-	1

HYDRAULIC MACHINES LAB

Contents

1. Model study of different Impellers and Runners of various Pumps and Turbines.
2. To obtainconstant speed characteristics of Francis Turbine.
3. Todetermine constant speed characteristics of Pelton Turbine.
4. To obtain variable speed characteristics of Kaplan Turbine.
5. Todetermine constant speed characteristics of Centrifugal Pump.
6. Determination of Slip and Efficiency of Double acting Reciprocating Pump.
7. Determination of Rankine Efficiency of Hydraulic Ram.
8. To obtain discharge characteristic of Vane pump.

Course Outcomes

Upon completion of the subject the students will be able to:

CO1	Develop idea about blade shapes of Runner and Impeller.
CO2	Develop sound knowledge about performance characteristics of Pelton turbine.
CO3	Develop practical knowledge about performance of Francis and Kaplan turbine.
CO4	Developknowledge aboutthe working of centrifugal and reciprocating pumps.
CO5	Develop practical knowledge about Hydraulic Ram and Vane pump.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	3	2	1	1	2	1	-	-	-	-	1

SIXTH SEMESTER

MACHINE DESIGN-II

Course Contents:

Module– I (8 Hours)

Theories of failure: Application of theories of failure to practical problems, dynamic stressesand stress concentration, design of machine members based on fatigue consideration, (Soderberg and Goodman criteria) notch sensitivity, S. C. F.

Module– II (8 Hours)

Design of engine components: Cylinders, piston, connecting rod, flywheel, crank shaft andvalve

Module– III (8 Hours)

Design of transmission components-: clutches(friction and centrifugal type), straight andhelical spur gears, bevel gears and worm gears

Module– IV (8 Hours)

Design of journal bearings based on hydrodynamic theory of lubrication, types of ball and roller bearing, dynamics and static load rating

Module–V (8 Hours)

Selection of ball and roller bearings, properties of lubricants, viscosity and oiliness

(DATA BOOKS ARE ALLOWED)

Text Books:

1. Machine design, P. C. Sharma and D. K. Agrawal, Kataria& Sons
2. Machine Design, P. Kannaiah; Scitech Publications
3. Any Machine Design data book

Course Outcomes:

At the end of the course, the student will be able to:

CO1	identify appropriate analytical models to describe and predict the behaviour of standard machine components and reduce the behaviour of a complex machine into appropriate sub- systems/elements and then analyse the behaviour of their elements.
CO2	apply stress analysis theory, fatigue theory and appropriate criteria of failure to the design of simple machine elements.
CO3	analyze and evaluate forces and stresses within a spur gear system and design simple power transmission systems.
CO4	select appropriate mechanical components from manufacturers' catalogues to design springs, bearings and fluid seals and apply codes and standards to machine component design.
CO5	communicate the results of a design assignment by means of drawings and a design report; and make appropriate use of available computer aided design software.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	3	2	3	3	2	2	-	3	1	2	2
CO2	3	3	2	3	3	2	2	-	2	1	2	2
CO3	3	3	2	3	3	2	2	-	2	1	2	2
CO4	3	3	2	3	2	2	2	-	2	2	2	2
CO5	2	2	1	2	2	2	1	-	2	3	2	2

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO	3	3	3	3	3	2	2	-	2	2	2	2

HEAT TRANSFER

Course Contents

Module-I (8 Hours)

I**ntroduction**: Modes of heat transfer, basic laws of heat transfer, combined heat transfer mechanism, analogy between flow of heat and electricity, Unit and dimension.

Conduction: Derivation of three dimensional Fourier conduction equation in Cartesian coordinates,transformation of Fourier equation into polar coordinates. One dimensional steady state conduction through slab, cylinder, sphere and composite medium, critical insulation thickness.Effect of variable thermal conductivity. Heat transfer through rectangular and pin fins. Fin effectiveness and fin efficiency. Solution of fin equation for different boundary condition.Effect of fin on heat flow, Fin arrangements.Solution of fin problems using numerical techniques. Introduction to two dimensional steady state heat conduction. Analytical method for solving two dimensional heat conduction problems.

Module-II (8 Hours)

Convection: Hydrodynamic and thermal boundary layer for laminar flow over a flat plate. Integralsolution of boundary layer equation for laminar flow over a plate. Heat transfer for laminar flow in tubes. Mechanism of heat transfer in turbulent flow, Reynolds analogy.Laminar free convection boundary layer equation for flow over a vertical plate and approximate solution of these equations. Dimensional analysis applied to forced and free convection.

Module-III (8 Hours)

Empirical correlation: Correlation for external flow – laminar and turbulent. Correlation for heattransfer to liquid metals. Correlation for free convection heat transfer

Boiling and Condensation: Film and drop wise condensation Nusselt's theory of laminar filmcondensation, pool boiling regimes, nucleate boiling, film boiling , peak heat flux, Rohsenow correlation for nucleate boiling

Module-IV (8 Hours)

Radiation: Basic theories of radiant heat transfer. Black body and monochromatic radiation, totalemissive power.Stephen Boltzmann law. Grey body. Kirchhoff's law.Wien's displacement law.Radiation between two black bodies, shape factors for simple geometries, radiation between two grey bodies, electrical network method for solving radiation problems, radiation shields.

Module-V (8Hours)

Heat exchangers: Types of heat exchangers, Overall heat transfer coefficient. Fouling factor, logarithmic mean temperature difference, effectiveness, Number of Transfer Units, heat exchanger design.

Text Book:

1. Heat transfer, J.P. Holman, TMH (P) Ltd.

Reference Book:

1. Fundaments of Heat and Mass Transfer, R. C. Sachdeva (New Age International (P)Ltd.
2. Heat transfer- A basic approach, M. Niyati, Ozisik, MC Graw Hills.

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Evaluate heat transfer by conduction for practical situations.
CO2	Evaluate heat transfer problems involving convections.
CO3	Design and analyse the performance of heat exchangers.
CO4	Analyse Radiation problems for various geometries.
CO5	Implement different techniques for heat transfer enhancement.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	3	2	1	1	2	1	-	-	-	-	1

PROFESSIONAL ELECTIVE

INDUSTRIAL ENGINEERING AND OPERATION RESEARCH

Course Contents

Module-I (8 Hours)

Production Planning & Control: Definition & Objectives, Aggregate Planning, Materials Requirement Planning, Routing, Scheduling, Machine Loading using Johnson's Rule, Dispatching.

Module-II (8 Hours)

Inventory Control: Introduction, Relevant Costs, Basic EOQ Model, Models with QuantityDiscount, Economic Batch Quantity, Safety Stock, Re-Order Point and Order Quantity Calculation, ABC Analysis.

Module-III (8 Hours)

Project Management: Project Management through PERT / CPM, Network Construction, CPM,Network Calculation, Crashing of Project Network, Project Scheduling with Limited Resources.

Module-IV (8 Hours)

Simplex Method: Simplex method, introduction, computational procedure, concept of duality in simplex method, dual simplex algorithm, Big M Method

Module-V (8 Hours)

Transportation and Assignment Problem: Initial basic feasible solution, transportation table moving towardsoptimality, degeneracy in transportation problem, Assignment problem.

Text Books:

1. Industrial Engineering & Production Management, M Mahajan, DhanpatRai Publication.
2. Operation Research, KantiSwaroop, P K Gupta, Manmohan, S Chand & Sons.

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Ability to do the planning for production and control of production processes
CO2	Control the inventory in the plant so that right amount of inventory in right time is available for smooth production operation.
CO3	Manage a project economically with limited resources
CO4	Maximize the output with limited resources
CO5	Transport materials to required location and assign jobs to different facility with minimum costs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	1	1	-	1	-	-	-	1	1	3	1
CO2	3	2	-	-	2	-	1	-	1	1	2	1
CO3	2	3	2	1	3	-	-	-	-	-	2	2
CO4	3	3	2	3	-	-	-	-	-	-	2	1
CO5	3	3	2	1	3	-	-	-	-	-	2	1

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	3	3	-	1	-	1	1	3	2

TRIBOLOGY

Course Contents

Module– I (8 Hours)

Introduction: Lubricant and lubrication, Types of bearings, properties and testing of lubricants, equations of flow, Hagenpoiseulle flow, flow between two parallel plates.

Module–II (8 Hours)

Hydro dynamic lubrication : Petroffs equation for a lightly loaded bearing mechanism, pressure development in an oil film, Reynold's equation in two dimensions, load carrying capacity of journal bearing, Heat balance of lubricants.

Module – III (8 Hours)

Hydrostatic Bearing:Principles, Component of hydrostatic lubrication, Hydrostatic circular thrust bearing, calculation of required in pressure, load carrying capacity, flow rate, power loss in bearing due to friction, concept of gas lubricated bearing

Module – IV (8 Hours)

Design and selection of antifriction bearings

Module–V (8 Hours)

Friction and wear of metals: Theories of friction, surface contaminants, Effect of sliding speed on friction, classification and mechanism of water resistant materials.

Text Books:

1. Introduction to Tribology of Bearing, B.C. Majumdar, S. Chand Pub. 2nd edition, 2016.
2. Principles of Lubrication, A. CameronJohn Wiley & Sons, 3rd edition 1981

Reference Books:

1. Mechanism and machine Theory, J.S. Rao, R.V. Sukki Patti, New Age Int. Pub.. 2nd edition, 2015
2. Fundamentals of Machine Elements,B J, Hamrock, B O Jacobson & S R, Schmid, McGraw-Hill Inc.,2nd edition, 1998.

Course Outcomes:

Upon completion of the subject the students willbe able to:

CO1	Introduce students to the field of tribology. Students will demonstrate basic understanding of friction and lubrication.
CO2	Enhance students' awareness of tribological issues in the design of machine components, such as journal bearings, hydrostatic bearing and gas bearing.
CO3	Familiar with common anti-friction and anti-wear components and the lubricants used therein.
CO4	Familiar with adhesion, abrasion and erosion theories and the effect of adhesion, abrasion and erosion on friction and wear.
CO5	Design a tribological system for optimal performance.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	2	1				1				1
CO2	2	1	3	3	2							
CO3	1	1	2	2	3						1	
CO4		3	3	3	2							
CO5	1	2	1		3	2					2	2

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	1	3	2	3	2	2	-	1	-	-	1	1

CRYOGENIC ENGINEERING

Course Contents

Module-I(8 Hours)

Introduction; Low temperature properties, Mechanical, Thermal, Electrical and Magnetic Properties of Cryogenic fluids.

Module-II (8 Hours)

Gas liquefaction systems; Simple Linde – Hampson system, Pre-cooled LindeHampson systems for Neon, Hydrogen and Helium; Collins liquefaction systems, Critical components of liquefaction systems, Components and its efficiencies on system performance.

Module-III (8 Hours)

Gas separation and purification systems ; Properties of mixtures , Principle of gas separation i.e., Simple condensation and evaporation , Rectification, Air separation systems, Argon separation systems, Helium separation systems, Gas purification methods, Cryogenic refrigeration systems (Liquid and gas as refrigerant); Joule Thomson refrigeration systems, Cascade or pre-cooled Joule–Thomson refrigeration systems, Cold gas refrigeration system (solid as working media)

Module-IV (8 Hours)

Magnetic cooling, its thermodynamic aspects, Magnetic refrigeration system, thermal valves, nuclear demagnetization, Measurement system for low temperature; Cryogenic fluid storage and transfer systems, Thermal insulations for cryogenic applications in the order of increasing performance.

Module-V (8 Hours)

Low temperature properties of engineering materials, sPROFESSIONALELECTIVErconductivity and sPROFESSIONALELECTIVErconducting devices, Special phenomenon at very low temperatures, Applications: SPROFESSIONAL ELECTIVEr conducting bearings, motors, Cryotrons, Chemical rockets, Space Simulation, Nuclear rockets , Blood and tissue preservation.

Text Books:

1. Barron, R., Cryogenic Systems, SI version, Oxford university press, 1985
2. Scott, R. B., Cryogenic Engineering, D'Van- Nostrand, 1962.

Reference Books:

1. Timmerhaus, K. D. and Flynn, T. M., Cryogenic Process Engineering, Plenum Press, 1989.
2. Vance, R. W. and Duke, W. M., Applied Cryogenic Engineering, John Wiley, 1962.
3. Marshall Sittig, Cryogenics Research and Applications, D. Van Nostrand Company, 1963
4. B.A.Hands, Cryogenic engineering, Academic press, 1986 7.Thomas M. Flynn, Cryogenic Engineering, Marcel Dekker Inc., New York, 2005.

Course Outcomes

At the end of the course, the student will be able to:

CO1	Define low temperature properties of cryogenic fluids.
CO2	Analyzegas liquefaction system.
CO3	Analyse gas separation and purification system.
CO4	Demonstrate different refrigeration system.
CO5	Evaluate storage systems used in cryogenic applications.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	1	-	2	2	1	1	1	-	-	-	-	1
CO2	3	1	2	2	1	1	1	-	-	-	-	1
CO3	2	1	2	2	1	1	1	-	-	-	-	1
CO4	2	2	2	2	1	1	1	-	-	-	-	1
CO5	2	1	2	2	1	1	1	-	-	-	-	1

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	2	1	2	2	1	1	1	-	-	-	-	1

INTERNAL COMBUSTION ENGINE AND GAS TURBINE

Course Contents

Module– I (8 Hours)

Introduction:ClassificationofI.C engines, working cycles, comparison of Two stroke &four stroke engines, Comparison between SI & CI engines

Fuel combustion &Fuel injection: Structure & composition of I.C engine fuel, Fuel rating Properties of fuel, Fuel additives and non petroleum fuels .Fuel air requirement for ideal normal operation, maximum power & quick acceleration, simple carburetor& it's draw back. Practical carburetor, petrol injection. Requirements & type of diesel injection system, fuel pump, injectors &nozzles

Module– II (8 Hours)

Ignition &combustion in I.C Engines: Battery, Magneto & Electronic ignition systems, Ignition timing, spark advance mechanism. Stages of SI engine combustion, Effect of engine variables on ignition lag flame front propagation. Abnormal combustion, pre-ignition& detonation, Theory of detonation, Effect of engine variables on detonation, Control of detonation. Requirement of good combustion chambers for SI engines. Stages of CI engine combustion. Effect of engine variables on delay periods. Diesel Knock & methods of control in CI engine combustion chambers.

Module– III (8 Hours)

Testing and performance : Power ,Fuel and air measurement methods, performance of SI.and CI. Engines, Characteristic curve, Variables affecting performance and methods to improve engine performance.

Module– IV (8 Hours)

Cooling and Lubricating Systems, Engine Emission &Controls : Air cooling and Water cooling system,Effect of cooling on power output & efficiency, properties of lubricants &tyres of lubricating system engine emission & it's harmful effect. Methods of measuring pollutants and control of engine emission

Module–V (8 Hours)

Gas turbines: Introduction, open & closed cycle gas turbines, Constant volume &constant pressure cycles. Thermodynamic analysis of ideal basic cycle with regeneration reheat & intercooling, Analysis of ideal basic cycle considering actual losses. Application of gas turbine

Text Books:

1. A course in I.C. Engines, Mathur, Sharma DhanpatRai& Sons.
2. Gas Turbines, V.Ganesan, TMH

Reference Books:

1. A Text book of Internal Combustion Engines, R. K. Rajput, Lami Pub.(P) Ltd.
2. Internal Combustion Engine Fundamentals, J. B. Heywood, McGraw Hill

Course Outcomes

Upon completion of the subject the students willbe able to:

CO1	Differentiate the internal combustion engines based on the classification parameters.
CO2	Explain the combustion characteristics of internal combustion engines and identify the abnormalities in combustion.
CO3	Identify the exhaust pollutants.
CO4	Determine the engine performance and illustrate the measuring instruments appropriately while working on internal combustion engines.
CO5	Express the ideal basic cycles and calculations involved in the operation of gas turbines and its application.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	1	1	1	-	-	-	-	-	-	1	-
CO2	2	2	1	-	1	-	1	-	-	-	1	1
CO3	2	3	2	2	1	1	1	-	-	-	-	1
CO4	1	1	3	-	2	1	-	2	2	-	-	2
CO5	2	3	2	3	2	1	1	1	-	-	-	2

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	3	2	2	2	1	1	2	2	-	1	2

INTRODUCTION TO NANOTECHNOLOGY

Course Contents

Module-I(4 Hours)

Background and Definition of Nanotechnology, MEMS/NEMS, Microelectronics fabrication methods, Principles of MEMS, Mechanical MEMS, Thermal MEMS, Magnetic MEMS.

Module-II(10 Hours)

Nanomaterial Synthesis and Applications: Introduction to Carbon Nanotubes, Structure, Synthesis, Growth, Properties and Application, Nanowires, Introduction to Micro/Nanofabrication, Stamping Techniques for Micro and Nanofabrication: Methods and Applications, Materials Aspects of Micro and Nanoelectromechanical Systems, MEMS/NEMS Devices and Applications, Introduction to Micro Fluids.

Module-III(10 Hours)

Micro/Nanotribology and Materials Characterization Studies Using Scanning Probe Microscopy, Friction and Wear on the Atomic Scale, Nanoscale Mechanical Properties-Measuring Techniques and Applications, Nanomechanical Properties of Solid Surfaces and Thin Films, Mechanical Properties of Nanostructures, Kinetics and Energetics in Nanolubrication.

Module-IV (6 Hours)

Application of Nanotechnology: Nano-Grating System, Nano Lithography, Nanotechnology for Data Storage Applications, Microactuators for Dual-Stage Servo Systems in Magnetic Disk Files,

Module-V (10 Hours)

Micro/Nanotribology of MEMS/NEMS Materials and Devices, Mechanical Properties of Micromachined Structures, Thermo and Electromechanics of Thin-Film Microstructures, High Volume Manufacturing and Field Stability of MEMS Products, MEMS Packaging and Thermal Issues in Reliability.

Books:

1. Nanotechnology: N. Taniguchi, Oxford University Press
2. Handbook of Nanotechnology: B. Bhushan, Springer Verlag
3. Micromanufacturing and Nanotechnology: N. P. Mahalik, Elsevier Science
4. Foundation of MEMS: C. Liu, Prentice Hall
5. Introduction to Nanotechnolgy: C. P. Poole, F. J. Owens, Wiley Interscience

Course Outcomes:

At the end of the course, the student will be able to:

CO1	Evolution of Nanotechnology and its field of applications
CO2	Techniques used for synthesis of Nanomaterials and its advancements
CO3	Nanotribology and its applications in surface engineering
CO4	Nanocharacterization of advanced materials
CO5	Applications in production of high technology materials

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	2	2	1	-	-	-	-	-	3
CO2	1	2	2	3	2	1	-	-	-	-	-	2
CO3	2	1	3	2	2	2	-	-	-	-	-	1
CO4	2	1	1	3	3	1	-	-	-	-	-	2
CO5	3	3	2	1	1	1	-	-	-	-	-	3

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	3	3	3	3	2	-	-	-	-	-	3

EXPERIMENTAL STRESS ANALYSIS

Course Contents

Module-I (8 Hours)

Electrical Wire Resistance Strain Gauges: Strain sensitivity, strain gauge construction, temperature effects in bonded strain gauges. Gauge factor and gauge sensitivities. Determination of actual strain. Measurement of stress by a strain gauge, stress gauge, strain gauge Rosette.

Measuring Circuits: The potentiometer circuit, circuit sensitivity of potentiometer, Wheatstone bridge circuit, Null-balance bridge, strain gauge applications.

Module-II(8 Hours)

Moiré Fringe Method: Moiré method, geometry of moiré fringe, advantages and limitations of moiré method.

Module-III(6 Hours)

Photoelasticity: Introduction, basic principle, stress and strain optic law, plane polariscope, circular polariscope, white light illumination.

Module-IV (8 Hours)

Analysis of Photoelastic Data: Materials and properties of material for photoelastic models, stress loci, fractional fringe orders, methods of compensation, calibration techniques, the frozen stress method, Reflection polariscope, separation of principal stresses.

Module-V (8 Hours)

Brittle Coating Method: Brittle coating, calibration of coating, application of failure theory to brittle coating, advantages and limitations.

Text Books:

1. J.W. Dally and W.F. Riley, "*Experimental stress Analysis"*, McGraw Hill, 1991.
2. Durelli, Augusto J., and William Franklin Riley. "Introduction to photomechanics. Prentice-Hall, 1965.

Course Outcomes

At the end of the course, the student will be able to:

CO1	Understand the Electrical Wire Resistance Strain Gauges and Measuring Circuits.
CO2	Understanding of Moiré Fringe method for strain measurement.
CO3	Analyze the mechanism of photo elasticity
CO4	Measure of strain using photo elasticity technique.
CO5	Measure of strain using brittle coating technique.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	3	3	1	-	-	-	-	-	1
CO2	3	3	2	3	3	1	-	-	-	-	-	1
CO3	3	3	2	3	3	1	-	-	-	-	-	1
CO4	3	3	2	3	3	1	-	-	-	-	-	1
CO5	3	3	2	3	3	1	-	-	-	-	-	1

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	3	3	1	-	-	-	-	-	1

OPEN ELECTIVE

ADVANCED MANUFACTURING TECHNOLOGY

Course Contents

Module-I (8 Hours)

Advanced Machining Processes: Classification, Electron discharge machining, Electrochemical machining, Ultrasonic machining, Abrasive jet machining, Laser Beam Machining, Electron beam machining, Plasma cutting, Electrolytic grinding

Module-II (8 Hours)

Advanced Fabrication Processes: Explosive welding, Ultrasonic welding, Diffusion bonding,Resistance Welding, Friction Stir welding, Laser Beam Welding, Electron Beam Welding, Joining of metals to ceramics

Module-III (8 Hours)

Processing of Plastic: Thermoplastic, Thermosetting, Injection moulding, Machining of plastics, Welding of plastics

Module-IV (8 Hours)

Surface Coating Technology: Use of Coating, Methods of Coatings, CVD, PVD, Physical andMechanical characterization of coatings.

Module-V (8 Hours)

Use of sensors in Manufacturing: Basic Fundamentals, Sensors for Workpieces, Sensors for Machine Tools and Robots, Sensors for Process Monitoring, Nanomanufacturing: Nanometric machining, Nanogrinding

Text Books:

1. Modern Machines Process: P. C. Pandey, H. S. Shan, Tata McGraw Hill Publication
2. Manufacturing Science: A. Ghosh, A. K. Mallick, East West Press

References Books:

1. Welding and Welding Technology: R. L. Little, Tata McGraw Hill Publication
2. Non-Conventional Machining: P. K. Mishra, Narosa Publication
3. Introduction to Manufacturing Processes, J. Schey, McGraw-Hill Publication
4. Handbook of Hard Coatings Deposition Technologies, Properties and Applications, R. F. Bunshah, Noyes Publication
5. Sensors in Manufacturing, H. K. Tönshoff, I. Inasaki, Wiley-VCH

Course Outcomes:

At the end of the course, the student will be able to:

CO1	List and describe the various types of high-end manufacturing processes and calculate appropriate process parameters
CO2	Develop and present a conceptual design solution to a manufacturing automation problem
CO3	Develop a process monitoring for a selected manufacturing monitoring application
CO4	Demonstrate awareness of the energy consumption in manufacturing processes. Undertake critical review of research papers related to the fields of manufacturing engineering
CO5	Automation in manufacturing by sensors and monitoring

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	2	2	1	-	-	-	-	-	3
CO2	1	2	2	2	2	1	-	-	-	-	-	2
CO3	2	1	3	2	2	2	-	-	-	-	-	1
CO4	2	1	1	3	3	1	-	-	-	-	-	2
CO5	2	3	2	1	1	1	-	-	-	-	-	3

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	3	3	3	3	2	-	-	-	-	-	3

COMPOSITE MATERIALS AND PROCESSING

Course contents

Module-I (8 Hours)

Introduction of Composites and their classifications: Based on reinforcement and Matrix with advantages, limitations and applications. Laminae and laminates. Interface in composites: Types of interface in composites, wettability and bonding. Test for measuring interfacial strength. Basic terminologies; volume fraction, weight fraction and Rule of mixtures, Density & void content.

Module-II (8 Hours)

Fabrication techniques: pultrusion, filament winding, prepreg technology, injection and compression moulding, bag moulding, resin transfer moulding, reaction injection moulding. Diffusion bonding and powder metallurgy methods, joining of composites.Other manufacturing processes; Processing of MMC- Diffusion bonding; Stir casting; Squeeze casting.Basic properties of GRP, CFRP, Al-B, Casting and Particulate composites.

Module-III (8 Hours)

Stress-strain relations for anisotropic materials; Generallized Hook's law; Stiffenesses, Compliances & engineering constants for orthotropic materials.Mechanical properties of unidirectional composite lamina.Longitudinal and transverse Young modulus, shear modulus, Poisson ratio.Empirical relationship of Halpin-Tsai.Longitudinal and transverse Strength.Composites under compressive loading. Properties of angle ply lamina. Transformation of Young moduli, shear modulus.Concept of coupling coefficients.

Module-IV(8 Hours)

General and special orthotropic materials.Psai Pagano invariants Strength of orthotropic lamina.Biaxial strength theories.Maximum strength, maximum strain theory.Tsia-Hill maximum work theory.Tsai Wu tensor theory.

Module-V (8 Hours)

Codes and engineering representation of Laminates.Macro mechanical behavior of a laminate.Laminate stiffness for different types; symmetric, anti-symmetric, cross ply laminates.Stresses in different laminae in a laminate.Configurations and design of laminates for special properties Strength and mechanism of failure in a composite laminate. Concept of FPF(First Ply Failure and total failure). Hygroscopic and thermal stresses.

Course Outcomes

At the end of the course, the student will be able to:

CO1	Explain concept of the composite materials and its terminologies used.
CO2	Understand and analyze the fabrication techniques of composite materials.
CO3	Students will also have sound understanding of theory of elasticity and mechanics of anisotropic materials.
CO4	Student will also able to understand behavior and specialties of orthotropic materials.
CO5	Students will understand and analyze the properties and performance of composites

CO1	Explain concept of the composite materials and its terminologies used.
CO2	Understand and analyze the fabrication techniques of composite materials.
CO3	Understand the behavior and specialties of orthotropic materials.
CO4	Comprehend the usage of theory of elasticity and theories of failure in mechanics of anisotropic materials.
CO5	Understand the composite laminates and analyze the properties of laminates.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	2	-	2	-	-	-	-	-	-	-	-
CO2	2	3	3	-	-		-	-		1	-	1
CO3	2	-	-	3	-	-	1	2	-	-	-	-
CO4	3	2	-	-	1	-		-	1	-	-	-
CO5	1	-	-	2	-	-	-	-	2	-	2	3

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	2	1	-	1	-	1	2	-	1	-	1

TURBOMACHINERY

Course Contents

Module-I (8 Hours)

Steam Turbines-Types of turbines, constructional details, application of turbines, typesofseals, and packing to reduce leakage, losses in turbines.Compounding of turbine, velocity diagrams, output efficiency, losses in turbines, reaction turbine, velocity, diagrams, degree of reaction, constructional features of blades.Governing of turbines.

Module-II(8 Hours)

Gas Turbine-Theory and fundamentals of gas turbines, principles, classification, Joule' scycles, assumptions for simple gas turbines, cycle analysis, work ratio, concept of maximum and optimum pressure ratio, actual cycle, effect of operating variable on thermal efficiency. Regeneration, inter cooling, reheating, their effects on performance. Closed cycle and semi closed cycles gas turbine plant/ Applications of gas turbines

Module-III (8 Hours)

Jet Propulsion-Introduction, types of jet engine, application of jet engine. Theory ofjet propulsion, energy flow through jet engine, thrust, thrust power, and propulsive efficiency.

Turbo jet, turbo prop, turbo fan engine, pulse jet and ram jet engine, performance characteristics thrust segmentation. Concept of rocket propulsion.

Module-IV (8 Hours)

Rotary Compressor- Concepts of: Rotary compressors, Root blower and vane typecompressors, Centrifugal compressors. Velocity diagram construction and expression for work done, introduction to slip factor, power input factor.

Module-V (8 Hours)

Hydraulic Turbines- Classification of hydraulic turbines, Heads & various efficiencies.Impulse momentum principle, Fixed and moving flat plate and curve vanes, series of plates &vanes. Velocity triangles and their analysis, work done, efficiency etc. Impulse turbine: Maincomponents and constructional features of Pelton wheel, velocity diagrams & work done, condition for max. Hydraulic Efficiency, number of buckets, jets, Non-dimensional parameters (speed ratio, jet ratio) Governing mechanisms for Pelton wheel. Reaction turbine, main components &constructional features, types of reaction turbine (Francis, Kaplan) draft tube types, efficiency,cavitation, , Francis, Kaplan turbines, Types of characteristic curves, unit quantities, selection of turbine considering various factors, specific speed, Application of similarity as applied to turbines, scale effect.

Text Books:

1. S. M. Yahya, Turbines compressors and fans: Tata McGraw-Hill.
2. R. S. R. Gorla, A. A. Khan, Turbomachinery: Design and Theory: Marcel Dekker, Inc.

Reference Books:

1. S. L. Dixon, Fluid mechanics and thermodynamics of turbo machinery: Butterworth-Heinemann.
2. W. W. Peng, Fundamentals of turbomachinery, J. Wiley.
3. E. A.Baskharone, Principles of turbomachinery in air-breathing engines: Cambridge University Press.
4. BU Pai, Turbo Machines, Willey Publication
5. R.K.Turton, Principles of Turbomachinery, E & F N Spon Publishers, London & New York.

Course Outcomes

Upon completion of the subject the students will be able to:

CO1	Analyze the working principles of turbo-machines and apply it to basic problems
CO2	Implement the concept of matching of a pump to a system
CO3	Analyze the working principle of various types of hydro turbines and describe their application range.
CO4	Apply the preliminary design concept of turbo-machines (pumps, compressors, turbines)
CO5	Analyze the off-design behavior of turbines and compressors

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	3	2	1	1	2	1	-	-	-	-	1

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SESSIONALS

ADVANCED PRODUCTION AND THERMAL ENGG. LAB:

PRODUCTION ENGG. LAB:

1. Experiment on EDM
2. Experiment on USM.
3. Experiment on AJM
4. Experiment on ECM

THERMAL ENGINEERING LAB:

1. Heat balance in Rusten Diesel Engine (single cyl.)
2. Morse test on BMC Petrol Engine
3. Load test on variable compression ratio engine
4. Load test on variable injection pressure

Course Outcomes

At the end of the course, the student will be able to:

CO1	List and describe the various types of high-end machining processes and calculate appropriate process parameters
CO2	Develop and present a conceptual design solution to the non-conventional machining processes
CO3	Develop process monitoring of selected machining and monitoring application
CO4	Acquire the knowledge of heat balance diesel engine.
CO5	Acquire the knowledge of performance characteristics of diesel engines.

Mapping of course outcomes with program outcomes:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	3	2	-	-	-	-	3
CO2	3	3	3	3	3	2	2	-	-	-	-	2
CO3	3	3	3	2	2	2	1	-	-	-	-	1
CO4	3	3	2	3	3	1	2	-	-	-	-	2
CO5	3	3	2	3	3	2	1	-	-	-	-	3

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	3	2	3	3	2	2	-	-	-	-	3

M/C DESIGN SESSIONAL -II

1. Problems for practice on theories of failure.
2. Problems for practice on fatigue failure.
3. Design of clutches.
4. Design of spur gear.
5. Design of spiral and bevel gear.
6. Design of crank piston and cylinder.
7. Design of connecting rod and shaft.
8. Design of journal bearing.

Course Outcomes:

At the end of the course, the student will be able:

CO1	to apply knowledge of engineering fundamentals and failure criteria for design procedures of Mechanical components use in Industries.
CO2	to apply the design and development procedure of different transmission components such as clutches and gears.
CO3	acquire the knowledge of design of different IC engine parts.
CO4	understand the standard geometry, applications, failures of Ball bearing and Sliding contact bearings.
CO5	gain the overall knowledge of design of various machine components using modern engineering tools in order to meet societal and environmental needs.

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	3	1	2	3	2	2	-	2	1	2	-
CO2	3	3	1	2	3	2	2	-	2	1	2	-
CO3	3	3	1	2	3	2	2	-	2	1	2	-
CO4	3	3	1	2	3	2	2	-	2	1	2	-
CO5	3	3	2	1	3	2	3	-	2	2	2	-

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO	3	3	1	2	3	2	2	-	2	1	2	-

PRODUCT DESIGN AND PRODUCTION TOOLING (PDPT) LAB

1. Design of single point cutting tool
2. Design of broach tool
3. Design of press tool
4. Design of limit gauges
5. Design of forging dies
   a. Design of press tool
   b. Design of deep drawing dies
   c. Design of drilling jig
6. Production Process planning

Course Outcomes

At the end of the course, the student will be able to:

CO1	Analyze in the design of single point cutting tool and broach..Evaluate the role of each process parameter during machining of various advanced materials
CO2	Determine major process/processes of manufacturing used for given application and explain why metal forming is chosen compared to other compatible methods
CO3	Solve the various problems for the given profiles to be imparted on the work specimens and design of fixtures and jigs for proper adaptability in the manufacturing system
CO4	Estimate formability limits for sheets and bulk metals. Select the suitable equipment for every forming process as well as design of forming tools and dies
CO5	Application of process planning in the industries

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	1	1	1	-	2	2	-	1
CO2	3	2	3	1	1	3	1	-	2	2	-	1
CO3	3	1	3	1	1	3	1	-	2	2	-	1
CO4	3	3	3	1	1	3	1	-	2	2	-	1
CO5	3	3	3	1	1	3	1	-	2	2	-	1

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	2	3	1	1	3	1	-	2	2	-	1

SEVENTH SEMESTER

ADVANCED MECHANICS OF SOLID

Course Contents

Module – I (8 Hours)

Elementary concept of elasticity: stresses in three dimension, equation of equilibrium & compatibility

Thick walled cylinder: Thick cylinders subjected to internal and external pressures, compound thick cylinder

Module – II (8 Hours)

Energy method based on strain energy due to bending: Strain energy due to axial load, bending moment & twisting moment, principle of virtual work, castiglianos theorem

Maxwell's theorem of reciprocal relations. Unit load and unit couple method for determining deflection and slope.

Module – III (8 Hours)

Curved beam: Bending of beam with large initial curvature, stess distribution in beam with rectangular, circular, trapezoidal cross section, stresses in crane hooks, ring & chain links

Module – IV (8 Hours)

Unsymmetrical bending: Properties of beam cross section , slope of neutral axis, stresses & deflection in unsymmetrical bending, shear centre

Module – V (8 Hours)

Advanced topics in strength of materials: Repeated stresses & fatigue in metals, concept of stress, concentration, notch & stress concentration factor, concept of creep.

Text Books:

1. Advanced Mechanics of Materials by Seely& Smith , John Wiley, New york
2. Advanced Mechanics of Solids by L.S.Srinath,TMH.

Reference Book:

1. Advanced mechanics of materials, Kumar and Ghai, Khanna pub.
2. Advanced strength and applied stress analysis , Richard G Budynas, McGraw Hill, ND.
3. Boresi A P and Sidebottom O M –Advanced mechanics of materials , John Willey Andsons

Course Outcomes

At the end of the course, the student will be able to:

CO1	Understand the three dimensional concept of stress-strain behaviour of materials.
CO2	Comprehend the usage of energy methods for solving structural problems.
CO3	Compute the hoop stress, radial stress and radial displacement for thick cylinders subjected to internal and external pressure.
CO4	Compute the stresses in curved beams subjected to bending, beams subjected to unsymmetrical bending and locate the shear center.
CO5	Analyze Repeated stresses & fatigue in metals.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	2	-	-	-	-	-	1	-	-	3
CO2	-	-	3	-	-		1	2		1	-	1
CO3	-	2	-	-	-	2	3	2	-	-	-	2
CO4	-	-	-	-	1	-		-	-	-	-	2
CO5	-	-	-	1	-	-	-	2	-	-	2	3

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	2	2	1	-	1	-	-	1	-	-	2	3

REFRIGERATION AND AIR-COINDITIONING ENGINEERING

Course Contents

UNIT –I (Refrigeration):

Module– I (8 Hours)

Air Refrigeration Cycles:Introduction, Units of Refrigeration, Coefficient of performance of arefrigerator, Open-air refrigeration cycle, Closed or Dense air Refrigeration cycle. Air Refrigerator Working on Reversed Carnot cycle.Air Refrigerator working on Belt Coleman cycle.

Vapour Compression Refrigeration System:Analyis of Theoretical vapour Compression cycle,Representation of the cycle on P-H, T-S and P-V diagrams, Simple Saturation Cycle, Sub-cooled cycles and SPROFESSIONAL ELECTIVErheated cycle. Effect of suction and discharge pressure on performance.Actual Vapour compression Cycle.

Module– II (8 Hours)

Compound Vapour Compression Refrigeration Cycle: Introduction, Methods of improving C.O.P – Optimum Interstage Pressure for Two-Stages Refrigeration System. Single load systems, Multi load systems with single Compressor, Multiple Evaporator and Compressor systems. Dual Compression systems.

Module– III (8 Hours)

Vapour Absorption Refrigeration Systems: Introduction, simple vapour Absorption system. Practical Vapour Absorption System. Advantages of Vapour Absorption sytem over vapour compression system. Coefficient of Performance of an Ideal Vapour Absorption Ref. System. Electrolux (Ammonia-Hydrogen) Refrigerator, Lithium Bromide Absorption Refrigeration System.

Module– IV (8 Hours)

Refrigerants: Introduction, Desirable properties of an Ideal Refrigerant. Classification of Refrigerants, Designation System of Refrigerants, Properties of Refrigerants, Uses of Important Refrigerants, Secondary Refrigerants – Brine

UNIT-II (Air Conditioning)

Module–V (8 Hours)

Psychrometry and Psychrometric properties, psychrometric Relations, Psychrometric chart, Psychrometricprocesses.Adiabatic mixing of two air streams. Requirements of Comfort Air-Conditioning : Requirements of comfort Air-Conditioning, Thermodynamics of Human Body, The body defence, Effect of heat on work performance, Comfort and Comfort chart, Effective Temperature.

Air Conditioning Systems: Process in Air-Conditioning, Summer, Winter and Year Round Air Conditioning,Cooling Load Calculations, Design of Air-Conditioning Systems

Text Book:

1. A course in Refrigeration and Air-Conditioning By S.C. Arora and S. Domkundwar, DhanpatRai Sons.

Reference Books:

1. Refrigeration and Air Conditioning, P.L. Balany, Khanna Pub.
2. A text book of Refrigeration and Air-conditioning, R.S. Khurmi, J.K. Jai, S.Chand& Co.

Course Outcomes:

Upon completion of the subject the studentswillbe able to:

CO1	Understand the basic concepts of refrigeration system.
CO2	Understand the vapour compression cycle and interpret the usage of refrigerants.
CO3	Explain the components of vapour compression system and vapour absorption systems.
CO4	Demonstrate the use of psychrometry and psychromtric properties in analyzing Air conditioning systems.
CO5	Discuss the theory and concept of comfort air-conditioning systems.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	3	3	1	-	1	2	1	1	-	-	2
CO2	2	3	1	1	2	-	-	-	2	-	-	2
CO3	1	3	1	2	2	-	-	-	3	-	-	2
CO4	2	3	-	1	2	-	-	-	2	-	-	2
CO5	-	2	1	1	2	1	-	1	1	-	-	1

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	2	3	1	1	2	-	1	-	2	-	-	2

PROFESSIONAL ELECTIVE

METROLOGY QUALITY CONTROL AND RELIABILITY

Course Contents

Module – I (8 Hours)

Introduction: Need of Inspection, Sources of errors, Basic types of errors, precision and accuracy. Method of estimating accuracy and precision, standard and their evolutions.

Simple measurement tools: Rules, Callipers, Height gauges, Micrometers, Depth gauge, Dial indicator, slip gauges, sine bar, Comparators: Allignment tests.

Module– II (8 Hours)

Limit, fits tolerance and Gauge Design: Basic concepts of limit fits and tolerance,Interchangeability and selective assembly, ISO system of tolerance, Taylor's principle of gauge design, Gauge design– Basic design rules for plug and ring gauges

Interferometers: Types of light sources and interferometers, Types of scale and grading, Optical flats

Module– III (8 Hours)

Screw Thread Measurement: Standard thread profiles, Effective diameter, Measurement of effective diameter by 2 wires and 3 wires methods. Best wire size.

Surface Roughness: Source of surface Irregularities in manufacturing. Roughness and waviness RMS and CLA values, Measurement of surface roughness using Taylor Hobson's Talysurf, CMM

Module– IV (8 Hours)

Statistical Quality Control: Frequency distribution, Process capability, Variables and Attributes. Control charts ($\bar{X}$& R charts) for variables, Control chart for attributes (p, np and C charts). OC curve, Single and Double sampling plan

Module–V (8 Hours)

Reliability: Definition, Relationship of Reliability with maintainability and availability, Failure data analysis –Bath tub curve, System reliability, Reliability improvement

Text Books:

1. Engg. Metrology, R. K. Jain, Khanna Publication
2. A text book of Metrology, M. Mahajan, DhanpatRai and co Pvt Ltd.

Reference Books:

1. Statistical Quality Control, M. Mahajan, DhanpatRai and co Pvt Ltd.
2. Reliability Engg. L. S. Srinath, East West press

Course Outcomes:

At the end of the syllabus students will be able to:

CO1	Apply the principles of measurement, types of standards and types of errors caused during measurement for practical usage.
CO2	Evaluate the various elements of surface texture and gain the ability to measure the diverse elements of surface texture, screw threads and gears.
CO3	Implement the major probability distributions in the engineering field and compute the control limits, tolerance limits/ specifications limits and the errors involved.
CO4	Implement the concept of different types of sampling plans, O-C Curve and calculation of AOQL.
CO5	Express the different forms of failure in Reliability system and apply system reliability concept in real life problems followed by improvement of reliability, maintainability and availability of systems

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	1	2	2	-	3	3	2
CO2	3	3	3	3	3	1	2	2	-	3	3	1
CO3	3	3	3	3	3	1	1	2	-	3	3	1
CO4	3	3	3	3	3	1	1	2	-	3	3	2
CO5	3	3	3	3	3	1	1	2	-	3	3	2

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	3	3	3	3	1	2	2	-	3	3	2

SOLAR ENERGY

Course Contents

Module-I: Solar passive heating and cooling (8 Hours)

Thermal comfort - Heat transmission in buildings - Bioclimatic classification. Passive heating concepts - Direct heat gain, indirect heat gain, isolated gain and sunspaces. Passive cooling concepts - Evaporative cooling, radiative cooling, application of wind, water and earth for cooling, roof cooling, earth air-tunnel.Energy efficient landscape design - Concept of solar temperature and its significance, calculation of instantaneous heat gain through building envelope.

Module-II: Solar liquid and air heating system(8 Hours)

Flat plate collector – Liquid and air heating - Evacuated tubular collectors - Overall heat loss coefficient, heat capacity effect - Thermal analysis. Design of solar water heating systems, with natural and pump circulation. Solar dryers and applications.Thermal energy storage systems.

Module-III: Solar cooling and dehumidification (8 Hours)

Solar thermo-mechanical refrigeration system – Carnot refrigeration cycle, solar electric compression air conditioning, simple Rankine cycle air conditioning system.

Module-IV: Dehumidification (8 Hours)

Absorption refrigeration – Thermodynamic analysis –Energy and mass balance of Lithium bromide-water absorption system, Aqua-ammonia absorption system, Calculations of HCOP and second law efficiency.Solar desiccant dehumidification.

Module-V: Solar thermal applications (8 Hours)

Solar systems for process heat production - Solar cooking – Performance and testing of solar cookers.Seawater desalination – Methods, solar still and performance calculations.Solar pond - Solar greenhouse.

Text Books:

1. Kalogirou S.A., “Solar Energy Engineering: Processes and Systems”, Academic Press, 2009.
2. Goswami D.Y., Kreith F., Kreider J.F., “Principles of Solar Engineering”, 2nd ed., Taylor and Francis, 2000, Indian reprint, 2003.

Reference books:

1. Duffie J. A, Beckman W. A., “Solar Engineering of Thermal Process”, Wiley, 3rd ed. 2006.
2. Khartchenko N.V., “Green Power: Eco-Friendly Energy Engineering”, Tech Books, Delhi, 2004.
3. Garg H.P., Prakash J., “Solar Energy Fundamentals and Applications”, Tata McGraw-Hill, 2005.

Course Outcomes

Upon completion of the subject the students will be able to:

CO1	Recognize the need of solar energy for the present day energycrisis.
CO2	Employ solar energy technology in real time situations.
CO3	Work for the future development of solar energy technologies.
CO4	Describe the use of Solar dehumidification process.
CO5	Designsystems using solar thermal applications.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	1	3	3	1	-	-	-	1
CO2	3	3	3	2	1	3	3	2	2	2	2	1
CO3	3	3	3	2	3	2	2	1	2	2	2	2
CO4	2	2	2	2	1	1	1	1	-	-	-	1
CO5	3	3	3	3	2	3	3	3	2	2	2	2

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	3	2	1	3	3	1	2	2	2	1

INDUSTRIAL NOISE CONTROL

Course Contents

Module-I (8 Hours)

Principle of sound generation and propagation, Sound attenuation, sound absorption.

Module- II (8 Hours)

Sources of industrial noise, effect of noise, noise measurement units and instruments, identification of source of noise.

Module-III (8 Hours)

Noise evaluation procedures, acoustical enclosures

Module-IV (8 Hours)

Design of reactive and absorptive mufflers, active noise control.

Module-V (8 Hours)

Designing for quieter machines and processes, various case studies.

Text Books:

1. L.N.Beraneck, Noise and Vibration control, McGraw Hill.
2. Baxa, Noise Contro of IC engine, Willey.

Reference Books:

1. H. Lord, Gately and Eversen, Noise control for Engineers, McGraw Hill.
2. R.H. Lyon, Machinery Noise Diagnostics, Butterworths.
3. C. H. Harris, Handbook of Noise Control, McGraw Hill
4. J. D. Irwin, E. R. Graf, Industrial Noise and vibration control, Prentice Hall.

Course Outcomes

Upon completion of the subject the students will be able to:

CO1	Understanding the basic concepts of sound propagation and absorption.
CO2	Identifying the sources of industrial noise and noise measurements.
CO3	Evaluation of industrial noise and methods of minimizing the noise.
CO4	Designing of mufflers to lowering the spreading of noise level.
CO5	Designing for quieter machines and processes.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	3	3	1	-	-	-	-	-	1
CO2	3	3	2	3	3	1	-	-	-	-	-	1
CO3	3	3	2	3	3	1	-	-	-	-	-	1
CO4	3	3	2	3	3	1	-	-	-	-	-	1
CO5	3	3	2	3	3	1	-	-	-	-	-	1

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	3	2	3	3	1	-	-	-	-	-	1

OPEN ELECTIVE

MECHANICAL VIBRATION

Course Contents

Module – I (8 Hours)

Damped System with Single degree of freedom: Equilibrium method , Viscous damping :Law of damping , Logarithmic decrement , Steady state solution with viscous damping , Reciprocating and Rotating unbalance , Base excitation Vibration Isolation, Energy dissipated by damping , Equivalent viscous damping . Sharpness of resonance, Vibration measuring instruments, Whirling of rotating shafts, Rigid shaft supported by flexible bearings

Module – II (8 Hours)

Two degree of freedom system: Generalised derivation of equation of motion, co-ordinatecoupling, Langrange's equation. Application of dynamic vibration absorbed.

Module – III (8 Hours)

Multi-degree of system: Derivation of equation, Calculation of natural frequencies, Maxwell'sreciprocal theorem, Rayleigh,Stodala,matrix iteration &Holzer methods

Module – IV (8 Hours)

Torsional Vibration: Single & multi rotor system, Geared system and Branched system

Module – V (8 Hours)

Vibration of continuous system: Euler equation for beam, Transverse vibration of beams withdifferentend conditions (cantilever beam, simple supported beam and fixed beam).

Text Books:

1. Mechanical Vibration, Tse , Morse, Hinkle, Prentice Hall of India
2. Mechanical Vibration with application –W. T. Thomas, CPC Publication

Reference Books:

1. Mechanical Vibrations, G. K. Grover, Nem Chand & Bros. Publication
2. Mechanical Vibrations V.P. Singh, DhanpatRai& Co.

Course Outcomes

At the end of the course, the student will be able to:

CO1	Understand the causes and effects of vibration in mechanical systems and analyse the mathematical modelling of the single-degree of freedom systems.
CO2	Analyse the mathematical modelling of the two degrees of freedom systemsand explain about the working principle of vibration absorber.
CO3	Compute the natural frequencies and mode shapes of a multi degree of freedom system and explain the modal analysis of a vibrating system.
CO4	Obtain the natural frequencies and mode shapes of rotor systems.
CO5	Select the numerical methods to determine natural frequencies of continuous system

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	3	3	2	-	2	1	-	-	1	1
CO2	3	3	3	3	2	-	2	1	-	-	1	1
CO3	3	3	3	3	2	-	2	1	-	-	1	1
CO4	3	3	3	3	2	-	2	1	-	-	1	1
CO5	3	3	3	3	2	-	2	1	-	-	1	1

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO	3	3	3	3	2	-	2	1	-	-	1	1

COMPUTATIONAL FLUID DYNAMICS

Course Contents

Module-I (8 Hours)

Governing Differential Equations and Finite Difference Method- Classification of PDEs-Initial and Boundary conditions - Initial and Boundary value problems - Finite difference method,-Central, Forward, Backward difference for a uniform grid – Central difference expressions for a non-uniform grid - Numerical error - Accuracy of solution – Grid independence test

Module-II (8 Hours)

Conduction Heat Transfer- Applications of Heat conduction - Steady and Unsteadyconductions - One dimensional steady state problems - Two dimensional steady state problems - Three dimensional steady state problems - Transient one dimensional problem

Module-III (8 Hours)

Convection Heat Transfer- Introduction - Steady one dimensional Convection-Diffusion - Unsteady one. Dimensional Convection – Diffusion – Unsteady two dimensional Convection - Diffusion.

Module-IV (8 Hours)

Incompressible Fluid Flow- Introduction - Governing equations - Difficulties in solvingNavier- Stokes equation - Stream function - Vorticity method - In viscid flow (steady) -Determination of pressure for viscous flow

Module-V (8 Hours)

Applications of Computational Fluid Dynamics- Computer graphics in CFD - Future of CFD-Enhancing the design process - understanding - Applications - Automobile, Engine, Industrial, Civil, Environmental

Text Books:

1. S. V. Patankar, Numerical Heat Transfer and Fluid Flow, Taylor and Francis.
2. K. Muralidhar, T. Sundararajan,Computational Fluid flow and Heat Transfer,Narosa Publishing House

Reference Books:

1. P. S. Ghoshdasdidar, Computer simulation of flow and heat transfer, Tata McGraw – Hill, New Delhi
2. D. A. Anderson, J. L. Tannehill,R. H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Hemisphere Publishing Corporation,
3. J. D. Anderson, Computational Fluid Dynamics: The Basics with Applications, McGraw Hill, New York.

Course Outcomes

Upon completion of the subject the students will be able to:

CO1	Develop mathematical models for flow phenomena
CO2	Analyze mathematical and computational methods for fluid flow and heat transfer simulations.
CO3	Solve computational problems related to fluid flows and heat transfer.
CO4	Evaluate the grid sensitivity and analyze the accuracy of a numerical solution.
CO5	Develop flow simulation code for fluid flow and heat transfer problems

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	3	2	2	-	3	-	-	2
CO2	3	3	2	1	3	2	2	-	2	-	-	2
CO3	2	3	2	1	3	2	2	-	3	-	-	2
CO4	3	1	2	1	3	3	3	-	3	-	-	2
CO5	3	3	3	2	3	3	3	-	3	-	-	2

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	3	2	1	3	2	2	-	3	-	-	2

EMERGING TRENDS IN MANUFACTURING TECHNOLOGY

Course Contents

Module-I (12 Hours)

Surface engineering and High speed grinding: Application of advanced coatings in high performance cutting tools and high performance sPROFESSIONALELECTIVEr-abrasive grinding wheels. Application of surface coating in metal-ceramic joining.Ultra high speed grinding with monolayer CBN grinding wheel. Machining and grinding under cryogenic environment. Micro and nano machining of glasses and ceramics in ductile regime using diamond cutting tool and diamond grinding wheel.

Module-II (8 Hours):

Rapid prototyping: Need for Rapid Prototyping, Basic Principles and advantages of RP, Classifications of different RP techniques with examples, Introduction to three Representative RP techniques: Fused deposition modeling, Laminated Object Manufacturing and Stereo-lithography

Module-III (8 Hours):

MEMS: Introduction, history, development and need of micro-electro-mechanical systems. IC fabrication processes used for MEMS; MEMS sensors and actuators

Module-IV (6 Hours):

Mechanical process techniques and process models for micro-machining; Fabrication processes and design of the process sequences

Module-V (6 Hours):

Agile prototyping; Reliability and process control of micro manufacturing processes. Introduction to nano-technology processes.

Text Books:

1. T. Burakowski, T. Wierzchon, Surface Engineering of Metals, Principles, Equipment, Technologies, CRC Press
2. H Prasad, K S Badrinarayanan, Rapid Prototyping and Tooling, SPI-Pageturners, Bangalore, India, 2013.
3. N. Maluf, K. Williams, An Introduction to Microelectromechanical Systems Engineering, Artech House, Inc.
4. Introduction to Nanotechnolgy: C. P. Poole, F. J. Owens, Wiley Interscience

Reference Books:

1. J. A. Venables, Introduction to Surface and Thin Film Processes, Cambridge University Press
2. D. T. Pham, S. S. Dimov, Rapid Manufacturing, Verlag, 2001.
3. Handbook of Hard Coatings Deposition Technologies, Properties and Applications, Rointan F. Bunshah, Noyes Publication
4. S. Beeby, G. Ensell, M. Kraft, N. White, MEMS Mechanical Sensors, Artech House, Inc.
5. C. Liu, Foundation of MEMS, Prentice Hall
6. Nanotechnology: N. Taniguchi, Oxford University Press
7. Handbook of Nanotechnology: B. Bhushan, Springer Verlag
8. Micromanufacturing and Nanotechnology: N. P. Mahalik, Elsevier Science

Course Outcomes

At the end of the course the student will be able to:

CO1	Extensive use of surface coatings in the development of advanced high speed cutting tools and grinding wheels
CO2	Manufacturing of complex shapes by Stereo-lithography process
CO3	Development of MEMS sensors and actuators for electronic applications
CO4	Models used in micro-machining and methods of fabrication
CO5	Agile prototyping, Reliability and process control in micro manufacturing

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	2	1	1	1	-	-	-	-	3
CO2	2	2	2	2	1	1	3	-	-	-	-	2
CO3	3	3	3	2	1	2	1	-	-	-	-	1
CO4	2	3	2	3	1	1	2	-	-	-	-	2
CO5	2	2	2	1	1	1	1	-	-	-	-	2

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	2	3	2	2	1	1	2	-	-	-	-	2

SESSIONALS

HEAT TRANSFER AND REFRIGERATION AND AIR CONDITIONING LAB:

Course contents

1. Determination of COP of vapor compression refrigeration tutor.
2. Determination of COP of vapor absorption refrigeration tutor.
3. Study of different psychrometric process ofair using AC tutor.
4. Study of domestic refrigerator.
5. Determination of thermal conductivity of composite slab.
6. Determination of heat transfer coefficient of natural convection of vertical cylinder.
7. Determination of heat transfer coefficient of forced convection of vertical cylinder.
8. Determination of surface emissivity.
9. Determination of thermal conductivity for insulating powder.
10. Determination of effectiveness of Parallel flow and counter flow heat exchanger.
11. Determination of effectiveness shell and tube heat exchanger.
12. Temperature measurement in a heat pipe Demonstrator.
13. Determination of critical heat flux and temperature in pool boiling apparatus.
14. Determination of heat transfer coefficient in film and dropwise condensation apparatus.

Course Outcomes:

Upon completion of the subject the students willbe able to:

CO1	Develop practical knowledge about Refrigeration and Psychrometric process.
CO2	Develop knowledge about measuring thermal conductivity of composite slab.
CO3	Develop practical knowledge about heat transfer measurement process.
CO4	Develop knowledge about determination of effectiveness of heat exchangers.
CO5	Demonstrate the measurement of surface emissivity.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	2	1	-	-	-	-	1
CO2	3	3	2	1	1	2	1	-	-	-	-	1
CO3	3	3	2	1	1	2	1	-	-	-	-	1
CO4	3	3	2	1	1	2	1	-	-	-	-	1
CO5	3	3	2	1	1	2	1	-	-	-	-	1

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	1	1	2	1	-	-	-	-	1

EIGHTH SEMESTER

PROFESSIONAL ELECTIVE

AUTOMOBILE ENGINEERING

Course Contents

Module – I (8 Hours)

Introduction: Main units of an automobile , Classification of automobiles, chassis and body , Automobile Frames and its types, descriptions of main parts of the engine: cylinder head , cylinder block, cylinder liner, crank-case, piston , piston rings, piston-pin, connecting-rod, crankshaft, bearing, valve, valve driving mechanism, Materials used for fabrication of engine parts, Impulse and mechanical balancing of engine.

Power Propulsion: Resistance to motion, rolling resistance, air-resistance, gradient resistance,calculation of power required for propulsion, tractive effort and traction, Vehicle performance characteristics and requirements, Numerical problems on tractive effort, power and efficiency, road performance curves.

Module – II (8 Hours)

Transmission system: Introductionto transmission system, Requirements, Types of transmission, Units of transmission system, Clutch unit, transmission unit, Drive-line unit, Driving axle unit

Clutch: Types of clutches, Positive clutches & Gradual engagement clutches, Single plate, Multiplate& Cone clutch, Material and construction of clutch, Design & Calculation of main dimension ofdry friction clutch, Automatic Transmission devices: Fluid coupling and its characteristics, Hydraulic Torque Converter.

Gearbox: Transmission and drive units**,** Types of Transmission: Selective Transmission, Progressive Gearbox and Epicyclic or Planetary gearbox, Sliding mesh, Constant mesh and synchromesh gearboxes, Design of three speed and fourspeed gear boxes, Torque convertor and its characteristics, Principle of Automatic transmission, Overdrive, Transfer case.

Module – III (8 Hours)

Hooke's joint: Propeller shaft, Hot-kiss type & Torque tube type propeller shaft, Final drive and Differential, Construction & Operation of a differential, Rear axle, Types of rear axle, half-floating, threequarter floating and fully floating type, Different types of rear axle drives , Hotch kiss and torque tube drive

Braking System: Classification of Brakes: Mechanical Brakes**,** Hydraulic Brakes, Power Brakes, Braking of Vehicle when applied to rear, front and allfour wheels, Theory of internal shoe brake , Working of Servo and power brakes

Module-IV (8 Hours)

Front wheel geometry and steering system: Purpose of Steering System, Functions of Steering System, General arrangement, Steering gears, Steering ratio, Torque Ratio, Reversibility, Camber , Castor ,King-pin inclination, Toe-in, Toe-Out, Centre-pointsteering, condition for true rolling , Steering

Mechanisms: Akerman and Davis steering, components of steering mechanism, Understeering and Oversteering, Power steering

Suspension System: Introduction, functions and requirement of suspension system, elements ofasuspension system. Springs, Dampers, types of suspension system, wheels and tyres.

Module-V (8 Hours)

Vehicle Electrical and Electronic system: Starting system and starting drive, Chargingsystem, Ignition system & recent developments, Lighting accessory system, Recent advances in automotive electronic such as multiplying, sensors and actuators engine and drive line controls, information systems, electronic display Relay, Switching and inter connector and Instrumentation

Vehicle Design: Safety & Comfort features, Vehicle design criteria and NVH considerations in vehicle design, Air pollution due to exhaust emissions, Control Measures and Euro-norms.

Text Books:

1. R.Stone and J.K.Ball , Automotive Engineering fundamentals, SAE International
2. Automobile Engineering by Dr.Kirpal Singh (Vol-I &Vol-II)
3. Automobile Engg., R.K. Rajput, S. Chand publications
4. Automobile Mechanics (through problem), Dr. N. K. Giri, Khanna Pub.

Reference Books:

1. The Motor Vehicle, Newton & Steed, London Liffee Books Ltd.
2. J.Heither, Automotive Mechanics, EWP Pvt. Ltd.
3. W.H.Crouse and D.L. Anglin, Automotive Mechanics, Tata McGraw Hill Education Pvt.Ltd

Course Outcomes

Upon completion of the subject the students will be able to:

CO1	Identify various automobile components and be conversant in calculating the power required for propulsion of automobiles.
CO2	Comprehend the working of various transmission systems.
CO3	Develop a practical know-how about different types of brakes.
CO4	Explaincorrect steering and suspension system used in different types of vehicles.
CO5	Establish a strong base in recent developments in vehicle design, safety, electrical and electronic system for accessing future prospects in automobile industry.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	1	1	2	1	1	-	-	-	1
CO2	3	3	3	2	1	1	1	1	-	-	-	1
CO3	3	3	3	1	2	2	2	1	-	-	-	1
CO4	3	3	3	2	2	1	1	1	-	-	-	1
CO5	2	2	2	1	1	2	3	3	-	-	-	1

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	3	3	1	1	2	1	1	-	-	-	1

OPERATION MANAGEMENT

Course Contents

Module-I (8 Hours)

Productivity: Definition, Importance, Difference between Efficiency and Productivity, Production and Productivity, Measurement of Productivity Index, Productivity Improvement Procedure

Module-II (8 Hours)

Forecasting: Definition, Relationship between Prediction and Forecasting, Objective of Forecasting, Basic Principle of Forecasting, Quantitative Method of Forecasting: Simple Average, Simple Moving Average, Weighted Moving Average, Simple exponential Smothing; Qualitative Methods of Forecasting: Delphi Method and Market Survey.

Module-III (8 Hours)

Facilities Location and Design: Introduction on Different Facilities, Factors Influencing Plant Location, Impact of Location on Cost and Revenues, Layout Types: Product, Process and Fixed Position, Workplace Design Using CRAFT, Working Conditions, Noise, Illumination.

Module-IV (8 Hours)

Design of Products and Services: Concept of Product Design, Product Life Cycle, Procedure of Product Development, Basic Idea on Ergonomic Consideration on Product Design, Product vs Services, Design of Services, Value Engineering and Value Analysis.

Module-V (8 Hours)

Work Design: Introduction, Job Design: Job Evaluation and Merit Rating; Method Study: Steps of Method Study, Work Measurement: Time Study using Stopwatch, Determination of Standard and Time.

Course Outcome:

Upon completion of the subject the students will be able to:

CO1	Determine the productivity of an organisation.
CO2	Accurately forecast the demand for the future time period.
CO3	Locate the different facilities for efficient use of resources.
CO4	Design products and services.
CO5	Design the job and its methods.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	-	-	1	-	-	2	1	2	3	3	1	1
CO2	-	-	2	-	-	1	1	2	1	1	1	1
CO3		1	1	-	-	1	2	1	1	1	1	2
CO4	1	1		-	-	-	-	1	2	1	1	1
CO5	1	2	1	1	1	-	-	1	2	1	3	1

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	-	2	-	-	1	3	3	3	3	3	3	3

FUNDAMENTALS OF PRODUCT DESIGN

Course contents

Module I:
Introduction: Design for manufacturing, Typical Case Studies, Innovative product and service designs.
Material Selection: Requirements for material selection, systematic selection of processes and materials, ASHBY charts
Design for Casting: Basic characteristics and Mould preparation, Sand casting alloys, Design rules for sand castings, Example calculations, Investment casting overview, Cost estimation, Number of parts per cluster, Ready to pour liquid metal cost, Design guidelines for investment casting, Die casting cycle, Determination of optimum number of cavities, appropriate machine size, Die cost estimation, Design principles.

Module II:
Design for Injection moulding: Injection moulding systems, Moulds, Moulding cycle time, Mould cost estimation, Estimation of optimum number of cavities, Assembly techniques, Design Guidelines.
Design for Hot Forging: Characterization of forging process, forging allowances, flash removal, Die cost estimation, Die life and tool replacement costs.

Module III:
Design for Sheet metal working: Press selection, press brake operations, Design rules.

Design for Powder Metal processing: Powder metallurgy, tooling and presses for compaction, Sintering materials, heat treatments, Design guidelines.

Module IV:
Design for machining: Machining using single point cutting tools, multipoint cutting tools, abrasive wheels, Assembly, cost estimation for machined components, Design guidelines.

Module V:
Design for Assembly: Design guidelines for manual assembly, large assemblies, analysis of an assembly, Rules for product design for automation, design for robot assembly, Design for manufacture and computer aided design.

Reference Books:

1. Product Design for Manufacturing and Assembly, G. Boothroyd, P. Dewhurst, W. Knight, CRC Press, 2002.
2. Engineering Design-A material processing approach. G. E. Dieter, McGraw Hill, 2003
3. ASM Handbook, Design for manufacture, 2000.

Course Outcomes

Upon completion of the subject the students will be able to:

CO1	Understand the design principles of design for manufacturing processes
CO2	Estimate the cost of dies, moulds and machined components based on die life
CO3	Understand the design for manual assembly and automated assembly
CO4	Design typical assemblies principles of design for X concepts
CO5	Understand the design rules for machining with single point and multi point cutting tools

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	1	1	-	-	-	-	1	-	1
CO2	3	3	1	2	2	1	-	-	-	1	-	1
CO3	3	2	2	2	2	2	2	2	-	1	-	1
CO4	3	3	1	2	2	-	-	-	-	-	-	1
CO5	3	3	1	1	1	1	1	-	-	1	-	1

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	3	2	2	2	2	2	-	1	-	1

MECHANICAL ENGINEERING INSTRUMENT AND CONTROL

Course Contents

Module – I (8 Hours)

Introduction: The significance of mechanical measurement, basic detector transducer elements:Electrical transducer , Sliding contact devices ,Variable-inductance transducer elements, the differential transformer, variable-reluctance transducer , capacitive transducer , The piezoelectric effect, Photo electric transducers . Intermediate modifying system : Electrical intermediate modifying devices , input circuitry , The simple current sensitive circuit, the ballast circuit , the voltage dividing potentiometer circuit , Resistance bridges. Terminating Devices and Methods: Introduction, Meter indicators, CRO, Oscillographs

Module – II (8 Hours)

Strain Measurement: The electrical resistance strain gauge, The metallic resistance strain gauge,circuitry, metallic strain gauge. The strain gauge ballast circuit,the strain gauge bridge circuit, Temperature compensation.

Module – III (8 Hours)

Pressure Measurement: Pressure measurement systems , Pressure measurement transducer,Gravitational transducer ,Electric transducers ,Elastic diaphragms , Secondary transducer used with diaphragms ,strain gauge pressure cells , measurement of high pressure , measurement of low pressures, calibration methods

Module – IV (8 Hours)

Temperature Measurement: Use of bimetals pressure thermometers, Thermocouples, Pyrometry,Calibration of temperature measuring devices.

Flow Measurement: Flow characteristic obstruction meters, obstruction meters forcompressiblefluids, the variable area meter and calibration of flow measurement devices.

Module – V (8 Hours)

Control System: Description of open and closed loop control system and their block diagrams use ofblock diagrams, Use of block diagram reduction and signal flow graph to find overall transfer function, 1st and 2nd order systems and their response to step and sinusoidal input , error analysis, Routh's stability criterion, Polar plot, Nyquist plot.

Text Books;

1. T. G. Beckwith, M. Lewis Buck, Mechanical Measurements, Oxford & IBH Publishing Co.
2. A. K. Sawhney, PuneetSawhney, A course in Mechanical Measurements and Instrumentation
3. K. K. Ogata, Modern control Engineering, Prentice Hall India

Course Outcomes

At the end of the course, the student will be able to:

CO1	Ability to understand the fundamentals of measurement.
CO2	Ability to gain knowledge of strain measurement and its application
CO3	Ability to gain knowledge of pressure measurement and its application.
CO4	Ability to gain knowledge of temperature and flow measurement and their application.
CO5	Ability to gain fundamental knowledge of control system.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3		3	3	1	1		2	1			2
CO2	3		2	3	3			2	1			
CO3	3		2	3	3			2	1			
CO4	3		2	3	3			2	1			
CO5	3		2	3	3			2	1			

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3		2	3	3	1		2	1			2

INDUSTRIAL MANAGEMENT

Course contents

Module - I (10 Hours)

Basic Management Theory: Evolution of Management Thought, Scientific Management, Organization as a System, Functions of Management, Principles of Management, Planning, Decision Making, Organizing Principle, Delegation Of Authority, Line and Staff Function, Leadership, Motivation, Communication, Controlling.

Module - II (8 Hours)

Personnel Management: Organization as Social System, Motivation and Behavior, Role of Personnel Management, Recruitment, Selection, Training, Performance Appraisal, Job Evaluation and Merit Rating, Wage Policy, Incentives, Group Dynamics, Job Satisfaction and Morale.

Module – III (6 Hours)

Materials Management: Purchasing, Selection of Vendor, Learning Curve Concept, MRP.

Module – IV (8 Hours)

Marketing Management: Selling and Marketing Concept, Role of Marketing Management in the Process of Marketing Management, Product Life Cycle, New Product Development Strategy, Market Research, Consumer Behavior, Sales Promotion, Advertising, Pricing Strategy, Break even analysis, Channel of Distribution.

Module - V (8 Hours)

Financial Management: Scope, Time Value of Money, Depreciation cost of a product, Financial Statement Analysis, Ratio Analysis, Working Capital, Sources of Finance.

Text Books:

1. Industrial Engineering & Production Management, M. Mahajan, DhanpatRai Publication.
2. Industrial Engineering & Management Science, T. R. Banga, N. K. Agarwal, S. C. Sharma, Khanna Publication.

Reference Books:

1. Personnel Management, A. Mannappa, M. S. Saiyadain.
2. Fundamentals of Financial Management, Prasanna Chandra, TMH.

Course outcomes

Upon completion of the subject the studentswillbe able to:

CO1	Understand how different functions of management works together for the development of any organization.
CO2	Know the basic functions of Personnel management.
CO3	Develop an ability to manage the activities of materials manager in an organization such as purchasing, inventory analysis, storage, etc.
CO4	Know the basic concept of selling and marketingof a product.
CO5	Interpret financial statements and other financial reports of industrial organization.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	3	-	1	2	1	-	1	3	3	2	2
CO2	-	1	1	-	-	3	1	3	3	2	2	1
CO3	-	1	-	-	2	-	-	2	1	2	1	2
CO4	1	2	1	1	2	-	1	3	2	2	1	1
CO5	1	2	1	1	2	-	2	1	-	-	2	2

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	1	3	1	1	2	3	2	3	3	3	2	2

TWO PHASE FLOW

Course Contents

Module – I (8 Hours)

Introduction, types and applications, common terminologies, flow regimes for single and two component vertical and horizontal flow patterns, flow regime mappings.

Module – II (8 Hours)

Conservation equations based on one-dimensional steady homogeneous flow model, drift flux model, separated flow model (multi-fluid model), two phase transportation. Brief discussion on critical flow conditions.

Module – III (8 Hours)

Introduction to Lockhart-Martinelli and other important correlations for pressure drop and correlations for void fraction.

Module – IV (8 Hours)

Hydrodynamics of solid-liquid and gas-solid flow, Measurement techniques for multiphase flow:

Module – V (8 Hours)

Flow regime identification, pressure drop, void fraction and flow rate measurement.

Text Books:

1. G. B. Wallis, One dimensional Two Phase Flow
2. Butterworth, Hewitt, Two Phase Flow
3. C. L. Kleinstreuer, Two-Phase Flow: Theory and Applications, CRC Press

Reference Books:

1. P. B. Whalley,Two-phase flow and heat transfer, Oxford University Press, USA.
2. D. Butterworth, G. F. Hewitt, Two-phase flow and heat transfer, Oxford University Press, USA.

Course Outcomes

At the end of the course, the student will be able to:

CO1	Analyze two phase flow patterns for thermal systems.
CO2	Apply analytical tools for design and performance assessment of two-phase devices.
CO3	Analyze hydrodynamics of solid-liquid and gas-solid flows.
CO4	Demonstrate Measurement techniques for multiphase flow.
CO5	Demonstrate flow rate measurement processes.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**
CO1	**3**	**3**	**2**	**1**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**1**
CO2	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**1**
CO3	**3**	**3**	**2**	**1**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**1**
CO4	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**1**
CO5	**3**	**3**	**2**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**1**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	**3**	**3**	**2**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**1**

OPEN ELECTIVE

ENTREPRENEURSHIP

Course Contents

Module – I (8 Hours)

Entrepreneurship: Concept, Historical background, Economic development and entrepreneurship,Role of Entrepreneurship in Industrialization, Entrepreneurship programmes (EDPS) in India, Indian middle class values.

Module – II (8 Hours)

Entrepreneurial Qualities: Achievement motivation, Creativity, perception, Risk taking,Entrepreneurial goal setting, Group activities

Environmental scanning, Business opportunity guidance, Product selection, Market research, marketing channels.

Module – III (8 Hours)

Assistance of Govt. agencies – Role of DIC, SFC, SISI, MSME and banks, Procedure in setting up an enterprise, Incentives and subsidies.

Module – IV (8 Hours)

Assessment of working capital, preparation of project report, project appraisal, Elementary knowledge on costing, Book keeping, Balance sheet preparation, Ratio analysis, Income tax

Management of small scale industry-Decision making, Leadership, Communication skill, Stress management.

Module – V (8 Hours)

Laws concerning entrepreneur viz, partnership laws, business ownership, sales and income taxes and workman compensation act.

Text Books:

1. Entrepreneurial Development, C. B. Gupta, S. Chand Publication.
2. Entrepreneurship of small industries by M. U. Deshpande – Deep and Deep Publication.

Course Outcomes:

Upon completion of the subject the students will be able to:

CO1	Apply sound business and economic principles to successfully launch and effectively manage a new venture
CO2	Exhibit financial and management skills necessary to succeed in increasingly challenging academic environments of further higher education.
CO3	Develop analytical and critical thinking skills necessary to make sound financial decisions in business and personal arenas.
CO4	Recognize the sources of their own attitudes and worldview and deal constructively with and contribute positively to issues that arise in workplaces and communities.
CO5	Understand the ethical implication of business decision making and recognize ethical dilemmas.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	1	-	-	3	-	-	3
CO2	-	-	-	-	-		1	2		1	-	1
CO3	-	-	-	-	-	2	3	2	2	2	1	2
CO4	-	-	-	1	-	-	-	-	-	2	2	2
CO5	-	-	-	-	-	-	-	2	2	2	2	3

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	-	-	-	-	1	3	3	1	3	3	3	1

FINITE ELEMENT METHOD

Course Contents

Module-I (8 Hours)

Introduction: Role of the Computer, General Steps of the Finite Element Method, Applications of the Finite Element Method, Advantages of the Finite Element Method.

Introduction to the Stiffness (Displacement) Method: Definition of the Stiffness Matrix, Derivation of the Stiffness Matrix for a Spring Element, Example of a Spring Assemblage, Assembling the Total Stiffness Matrix by SPROFESSIONAL ELECTIVErposition (Direct Stiffness Method),Boundary Conditions, Potential Energy Approach to Derive Spring Element Equations.

Module-II (8 Hours)

Development of Truss Equations: Derivation of the Stiffness Matrix for a Bar Element in Local Coordinates, Selecting Approximation Functions for Displacements, Transformation of Vectors in Two Dimensions, Global Stiffness Matrix, Computation of Stress for a Bar in the x-y Plane, Solution of a Plane Truss, Potential Energy Approach to Derive Bar Element Equations, Comparison of Finite Element Solution to Exact Solution for Bar

Development of Beam Equations: Derivation of the Beam Stiffness matrices, Distributed Loading, Potential Energy Approach to Derive Beam Element Equations

Module-III (8 Hours)

Development of the Plane Stress and Plane Strain Stiffness Equations: Basic Concepts of Plane Stress and Plane Strain, Derivation of the Constant-Strain Triangular Element Stiffness Matrix and Equations, Treatment of Body and Surface Forces.

Axisymmetric Elements: Derivation of the Stiffness Matrix, Solution of an Axisymmetric Pressure Vessel, Applications of Axisymmetric Elements.

Module-IV (8 Hours)

IsoparametricFormulation: Isoparametric Formulation of the Bar Element Stiffness Matrix, Rectangular Plane Stress Element

Three-Dimensional Stress Analysis: Three-Dimensional Stress and Strain, Tetrahedral Element.

Module-V (8 Hours)

Use of Computer: Computer methods and computer programmes, Data input, stiffness generations, Assembly and solution of equations and output of results.

Text Books:

1. A First Course in the Finite Element Method- Daryl L. Logan, Thomson
2. The Finite Element method in Engineering Science – O.C. Zienkiwiecs, TMH

References:

1. Introduction to finite element method – Abel and Desal, EWP
2. Introduction to the finite element method-J. N. Reddy, McGraw Hill

Course Outcomes

Upon completion of the subject the students will be able to:

CO1	Apply the types of approximation methods and use of finite element method
CO2	Analyzethe truss and beam problems
CO3	Analyze different types of two dimensional problems including axisymmetric problems
CO4	Developisoparametric formulations and basic knowledge about three dimensional problem
CO5	Write computer program of finite element method.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	2	-	-	-	-	-	1
CO2	3	3	3	3	3	2	-	-	-	-	-	1
CO3	3	3	3	3	3	2	-	-	-	-	-	1
CO4	3	3	3	3	3	2	-	-	-	-	-	1
CO5	3	3	3	3	3	2	-	-	-	-	-	1

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	3	3	3	3	2	-	-	-	-	-	1

NON-CONVENTIONAL ENERGY

Course Contents

Module – I (8 Hours)

Introduction to Energy Sources: Renewable and non-renewable energy sources, energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements Global and National scenarios, Prospects of renewable energy sources.

Module – II (8 Hours)

Solar Energy: Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length. flat plate collectors, concentrating collectors, Solar air heaters-types, solar driers, storage of solar energy-thermal storage, solar pond , solar water heaters, solar distillation, solar still, solar cooker, solar heating & cooling of buildings, photo voltaic - solar cells & its applications.

Module –III (8 Hours)

Wind Energy: Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations.

Module – IV (8 Hours)

Energy from Biomass: Biomass conversion technologies, Biogas generation plants, Classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of bio-gas, utilization of biogas.

Geothermal Energy: Estimation and nature of geothermal energy, geothermal sources and resourceslike hydrothermal, geo-pressured hot dry rock, magma. Advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India.

Energy from the ocean: Ocean Thermal Electric Conversion (OTEC) systems like open cycle, closedcycle, Hybrid cycle, prospects of OTEC in India. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy.

Magneto Hydro Dynamic (MHD) Power Generation: Principle of MHD power generation, MHDsystem, Design problems and developments, gas conductivity, materials for MHD generators and future prospects.

Module – V (8 Hours)

Fuel Cells: Introduction, Design principle and operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, application of fuel cells.

Hydrogen Energy: Introduction, Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles

Energy Management: Energy economics, energy conservation, energy audit, general concept of total energy system, scope of alternative energy system in India

Text Books:

1. Non-conventional energy sources by G.D. Rai, Khanna Publishers

2. Solar Energy: Fundamentals and Applications by H.P. Garg& Jai Prakash, Tata McGraw Hill

Reference Books:

1. Solar Energy: Principles of Thermal Collection and Storage by S,P Sukhatme, Tata McGraw Hill
2. Alternative Energy Sources by B.L. Singhal Tech Max Publication
3. Non Conventional Energy Resources by S.HasanSaeed and D.K.Sharma
4. Fuel Cells by Bockris and Srinivasan; McGraw Hill
5. Magneto Hydrodynamics by Kuliovsky and Lyubimov, Addison
6. Solar Engineering of Thermal Processes,Duffic and Beckman, John Wiley

Course Outcomes

Upon completion of the subject the students will be able to:

CO1	Understand the different non-conventional sources and the power generation techniques, to generate electrical energy.
CO2	Understand the basic concepts of solar radiation and analyze the working of solar PV and thermal systems.
CO3	Understand the basic principles of energy conversion from alternate sources including wind, geothermal, ocean, biomass, etc.
CO4	Understand the concepts and applications of fuel cells, thermoelectric convertor and MHD generator.
CO5	Understanding of energy management

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	3	3	2	1	2	1	2	-	-	2
CO2	3	3	2	3	3	1	2	-	2	-	-	2
CO3	3	2	1	2	1	1	1	-	2	-	-	2
CO4	3	2	3	1	1	1	1	-	2	-	-	2
CO5	3	2	1	3	1	1	2	-	2	-	-	2

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	2	2	3	1	1	2	-	2	-	-	2