Pimpri Chinchwad Education Trust's

PIMPRI CHINCHWAD COLLEGE OF ENGINEERING

SECTOR NO. 26, PRADHIKARAN, NIGDI, PUNE 411044

An Autonomous Institute Approved by AICTE and Affiliated to SPPU, Pune

DEPARTMENT OF MECHANICAL ENGINEERING

Curriculum Structure of
SY B Tech Mechanical Engineering
and
Syllabus of SY B Tech Courses
Approved by BoS Mechanical
(Course 2020)

Effective from Academic Year 2021-22

Institute Vision

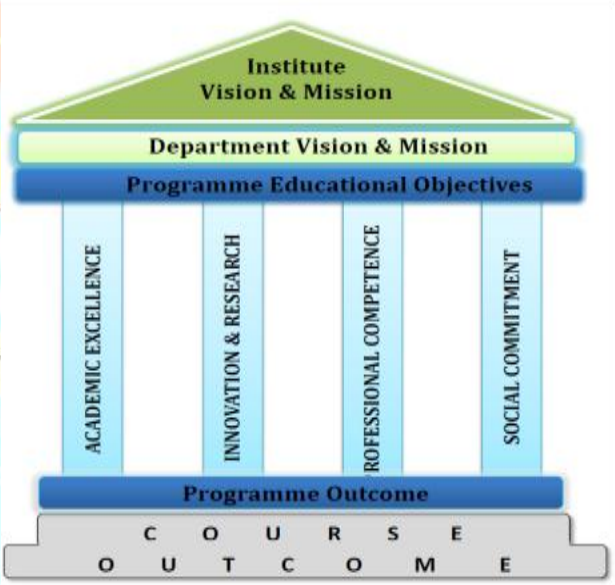
To Serve the Society, Industry and all the Stakeholders through the **Value-Added Quality Education.**

Institute Mission

To serve the needs of society at large by establishing State-of-the-Art Engineering, Management and Research Institute and impart attitude, knowledge and skills with quality education to develop individuals and teams with ability to think and analyze right values and self-reliance.

Quality Policy

We at PCCOE are committed to impart Value Added Quality Education to satisfy the applicable requirements, needs and expectations of the Students and Stakeholders. We shall strive for academic excellence, professional competence and social commitment in fine blend with innovation and research. We shall achieve this by establishing and strengthening state-of-the-art Engineering and Management Institute through continual improvement in effective implementation of Quality Management System.



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CURRICULUM FRAMEWORK

(2020-2021; 2021-2022; 2022-2023; 2023-2024)

❖ The B. Tech. Program is based on the following type of course: B. Tech. Mechanical

Sr. No.	Type of Courses	Abbreviation
1.	Basic Science Course	BSC
2.	Engineering Core Course	ECC
3.	Humanities, Social Sciences And Management Course	HSMC
4.	Professional Core Course	PCC
5.	Professional Elective Course	PEC
6.	Open Elective Course	OEC
7.	Project	PROJ
8.	Internship	INTR
9.	Audit Course	Audit
10.	Mandatory Course	MC
11.	Life Skill	LS
12.	Proficiency Course	PFC
13.	Massive Open Online Course (MOOC)	MOOC

❖ **The Course and Credit Distribution is as under**

Sr. No.	Type of Courses	No of Courses	Total Credits	
			No	%
1.	Basic Science Course (BSC)	8	23	14.28
2.	Engineering Core/ Science Course (ECC)	13	22	13.66
3.	Humanities, Social Sciences And Management Course (HSMC)	6	13	8.07
4.	Professional Core Course (PCC)	17	48	29.81
5.	Professional Elective Course (PEC)	6	18	11.18
6.	Open Elective Course (OEC)	6	18	11.18
7.	Project (PROJ)	2	16	9.93
8.	Internship (INTR)	1	3	1.86
9.	Audit Course (Audit)	3	-	-
10.	Mandatory Course (MC)	2	-	-
11.	Life Skill (LS)	4	-	-
12.	Proficiency Course (PFC)	4	-	-
13.	Massive Open Online Course (MOOC)	1	-	-
Total		**73**	**161**	**100**

COURSE DISTRIBUTION : SEMESTER WISE										
Sr. No.	**Type of Course**	**No of Courses/ Semester**								**Total**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
1.	Basic Science Course (BSC)	3	3	2	-	-	-	-	-	8
2.	Engineering Core Course (ECC)	6	5	1	1	-	-	-	-	13
3.	Humanities, Social Sciences And Management Course (HSMC)	1	1	1	1	1	1	-	-	6
4.	Professional Core Course (PCC)	-	-	5	4	3	3	2	-	17
5.	Professional Elective Course (PEC)	-	-	-	-	2	2	2	-	6
6.	Open Elective Course (OEC)	-	-	-	1	1	2	2	-	6
7.	Project (PROJ)	-	1	-	-	-	-	-	1	2
8.	Internship (INTR)	-	-	-	-	-	-	-	1	1
9.	Audit Course (Audit)	-	-	-	1	1	1	-	-	3
10.	Mandatory Course (MC)	-	-	-	-	1	1	-	-	2
11.	Life Skill (LS)	1	1	1	1	-	-	-	-	4
12.	Proficiency Course (PFC)	-	-	1	1	1	1	-	-	4
13.	MOOCs								1	1
	Total	**11**	**11**	**11**	**10**	**10**	**11**	**6**	**3**	**73**

CREDIT DISTRIBUTION : SEMESTER WISE										
1 Lecture hour = 1 Credit 2 Lab Hours = 1 Credit 1 Tutorial Hour = 1 Credit										
Sr. No.	**Type of Courses**	**No of Credits /Semester**								**Total**
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
1.	Basic Science Course (BSC)	9	9	5	-	-	-	-	-	23
2.	Engineering Core Course (ECC)	9	7	3	3	-	-	-	-	22
3.	Humanities, Social Sciences And Management Course (HSMC)	2	2	3	2	2	2	-	-	13
4.	Professional Core Course (PCC)	-	-	11	12	9	8	8	-	48
5.	Professional Elective Course (PEC)	-	-	-	-	6	6	6	-	18
6.	Open Elective Course (OEC)	-	-	-	3	3	6	6	-	18
7.	Project (PROJ)	-	2	-	-	-	-	-	14	16
8.	Internship (INTR)	-	-	-	-	-	-	-	3	3
9.	Audit Course (Audit)	-	-	-	-	-	-	-	-	-
10.	Mandatory Course (MC)	-	-	-	-	-	-	-	-	-
11.	Life Skill (LS)	-	-	-	-	-	-	-	-	-
12.	Proficiency Course (PFC)	-	-	-	-	-	-	-	-	-
13.	MOOCs	-	-	-	-	-	-	-	-	-
	Total	**20**	**20**	**22**	**20**	**20**	**22**	**20**	**17**	**161**

Curriculum structure

SY B Tech

Mechanical Engineering

FOR 2ND YEAR B. TECH. MECHANICAL ENGINEERING

SEMESTER – III

Course Code	Course Type	Course Name	Teaching Scheme					Evaluation Scheme						
			L	P	T	H	CR	IE	MTE	ETE	TW	PR	OR	Total
BAS3201	BSC	Applied Mathematics	3	-	-	3	3	20	30	50	-	-	-	100
BAS3202	BSC	Statistics and Probability	2	-	-	2	2	--	20	30	-	-	-	50
BME3301	ECC	Manufacturing Science	3	-	-	3	3	20	30	50	--	-	-	100
BME3401	PCC	Engineering Thermodynamics	3	-	-	3	3	20	30	50	-	-	-	100
BME3402	PCC	Strength of Materials	3	-	-	3	3	20	30	50	-	-	-	100
BME3403	PCC	Materials Engineering	3	-	-	3	3	20	30	50	-	-	-	100
BME3404	PCC	Material Testing Lab	-	2	-	2	1	-	-	-	50	-	50	100
BME3405	PCC	Manufacturing Practices	-	2	-	2	1	-	-	-	50	-	--	50
BHM3101	HSMC	Universal Human Values	3	-	-	3	3	30	-	20	-	-	-	50
BME3911	PFC	Computer Aided Machine Drawing-I	-	2	-	2	-	GRADE						
BHM3939	LS	Life Skill-III	-	2	-	2	-							
Total			20	8	-	28	**22**	130	170	300	100	-	50	**750**

Abbreviations are: L-Lecture, P-Practical, T-Tutorial, H- Hours, IE- Internal Evaluation, MTE- Mid Term Evaluation, ETE- End Term Evaluation, TW –Termwork, OR - Oral

FOR 2ND YEAR B. TECH. MECHANICAL ENGINEERING

SEMESTER – IV

Course Code	Course Type	Course Name	Teaching Scheme					Evaluation Scheme						
			L	P	T	H	CR	IE	MTE	ETE	TW	PR	OR	Total
BME4302	ECC	Metrology and Mechanical Measurement	3	-	-	3	3	20	30	50	-	-	-	100
BME4406	PCC	Applied Thermodynamics	3	2	-	5	4	20	30	50	25	50	-	175
BME4407	PCC	Fluid Mechanics	3	-	-	3	3	20	30	50	-	-	-	100
BME4408	PCC	Kinematics and Theory of Machines	3	2	-	5	4	20	30	50	25	-	50	175
BME4409	PCC	Metrology and Mechanical Measurement Lab	-	2	-	2	1	-	-	-	25	-	25	50
BAS4601 to BAS4606	OEC	Open Elective –I	3	-	-	3	3	20	30	50	-	-	-	100
BHM4101	HSMC	Professional Skills for Engineers	2	-	-	2	2	30	-	20	-	-	-	50
BME4912	PFC	Computer Aided Machine Drawing-II	-	2	-	2	-	GRADE						
BHM4940	LS	Life Skill –IV	-	2	-	2	-							
BHM9961 to BHM9965	AC	Audit Course-I	1	-	-	1	-							
		Total	18	10	-	28	**20**	130	150	270	75	50	75	**750**

Abbreviations are: L-Lecture, PR-Practical, T-Tutorial, H- Hours, IE- Internal Evaluation, MTE- Mid Term Evaluation, ETE- End Term Evaluation, TW –Term-work, OR - Oral

List of Open Electives

Semester- IV

Course Code	Course Name	
BAS4601	Numerical Methods	Choose any one
BAS4602	Mathematical Optimization	
BAS4603	Calculus of Variation	
BAS4604	Mathematical Modelling and Simulation	
BAS4605	Financial Mathematics	
BAS4606	Neural Network and fuzzy logic Control	

List of Life Skill Courses

Semester- III

Course Code	Course Name: Life Skills-III	
BHM3939	1. Practicing Meditation 2. Sports	Choose any one
	Performing Arts: Music, Singing, Poetry, Indian Conventional Dancing, Photography, Short Movie Making, Painting/ Sketching/ Drawing, Theatre Arts, Anchoring, Calligraphy etc.	Choose any one performing arts

Semester- IV

Course Code	Course Name: Life Skills-IV	
BHM4940	1. Social welfare and Cultural Awareness 2. Transactional Analysis	Choose any one
	Caring and service Hospital Caring, Personal Safety, First Aid, Disaster Management Gardening, Organic farming, Cooking etc.	Choose any one caring & service

List of Audit Courses

Semester -IV

Course Code	Name of Course	
BHM9961	Environmental Science	Choose any one
BHM9962	Constitution of India	
BHM9963	Emotional Intelligence	
BHM9964	Entrepreneurship Development	
BHM9965	Research Article Writing	

Course Syllabus

SY B Tech

Semester-III

Program:	B. Tech. (Mechanical)			Semester : III			
Course :	Applied Mathematics			Code : BAS3201			
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	IE	MTE	ETE	Total
3	-	-	3	20	30	50	100

Prior knowledge of

a. Univariate Calculus
b. Multivariate Calculus

is essential.

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of mathematical principles related to:

1. Ordinary and Partial differential equations applied to mechanical engineering problems such as mechanical vibrations and heat transfer.
2. Vector differentiation and integration applied to problems in fluid mechanics.
3. Laplace Transform and Inverse Laplace Transform applied to solve linear differential equations.

Course Outcomes:

After learning the course, the students will be able to:

1. **Apply** the concepts of higher order linear differential equations to **analyze** mass spring systems.
2. **Solve** initial and boundary value problems related to Partial differential equations of first and second order.
3. **Solve** partial differential equation using variable separation method to **analyze** wave, transport, one and two-dimensional heat flow equations.
4. **Perform** Vector differentiation and integration to **analyze** vector field and fluid flow problems.
5. **Evaluate** Laplace transform of basic functions, special functions, derivatives and integrals of functions.
6. **Apply** Laplace Transform to **solve** linear differential equations related to vibration theory and heat transfer.

Detailed Syllabus:

Unit	Description	Duration (H)
I	**Linear Differential Equations:** Introduction of Linear and Nonlinear differential equations, linear differential equation of nth order with constant coefficients, General method, Shortcut methods, Method of Variation of Parameters, Application of Linear differential equations in mass spring system.	6
II	**Partial Differential Equations:** Introduction, Types, Initial and Boundary value problems, First order Partial differential equations, Homogeneous and nonhomogeneous linear Partial differential equations of second order.	6
III	**Applications of Partial Differential Equations:** Solution to One dimensional Wave, Heat and Transport equation, Two-dimensional heat flow equation using Method of separation of variables.	6
IV	**Vector Calculus:** **Vector Differentiation:** Vector Differentiation Calculus: Introduction, Vector differential operators, Gradient, Divergent, Curl, Physical Interpretation of Vector Differentiation, Directional Derivatives, Solenoidal, Irrotational and conservative fields, Scalar Potential. **Vector Integration:** Line, Surface, and Volume Integrals, Work-done, Statement of Green's lemma, Stoke's theorem, Gauss divergence theorem, Application to problems in Electro-Magnetic fields.	8
V	**Laplace Transform:** Introduction, Laplace Transform of some standard and special functions, Region of convergence and Properties, properties and theorems of Laplace Transformation.	5
VI	**Inverse Laplace Transform:** Introduction, Inverse Laplace transform of basic functions, Properties of Inverse Laplace transform, Convolution Theorem, Applications of Laplace transform to solve Linear differential equations in mass spring system.	5
	Total	**36**

Text Books:

1. B.V. Ramana , “Higher Engineering Mathematics”, Tata McGraw-Hill, 34 edition, ISBN 13:9780070634190.
2. Erwin Kreyszig, “Advanced Engineering Mathematics” Wiley Eastern Ltd.,10 Edition, ISBN 13: 9780470458365

Reference Books:

1. Peter V. Neil, “Advanced Engineering Mathematics”, Thomson Learning ,7 Edition, ISBN 13:9781337274524.
2. M. D. Greenberg , “Advanced Engineering Mathematics”, Pearson Education, 2 Edition, ISBN 13:9780486492797.
3. B. S. Grewal , “Higher Engineering Mathematics”, Khanna Publication, 42 Edition, ISBN 13:9788174091955.
4. N. P. Bali, Manish Goyal, “ A textbook of Engineering Mathematics”, 9th Edition, ISBN 16:978-8131808320

e-sources:

1. **NPTEL Course lectures links:**
   https://nptel.ac.in/courses/111/105/111105038/ (P.D.E)
   https://onlinecourses.nptel.ac.in/noc20_ma13/ (Advanced Engineering Mathematics)

Program:	B. Tech. (Mechanical)				Semester :III		
Course :	Statistics and Probability				Code : BAS3202		
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	IE	MTE	ETE	Total
2	-	--	2	--	20	30	50

Prior knowledge: NIL

Course Objectives:

This course aims at enabling the students to

1. Present, analyze and interpret data.
2. Develop a statistical model and apply for the specific perspective data in an appropriate manner.
3. Understand uncertain occurrences in data through logical manner.

Course Outcomes:

After learning the course, the students will be able to:

1. **Analyze** a set of data using standard procedure of statistical modeling and estimate the outcomes.
2. **Evaluate** Correlation, regression coefficients for the given data.
3. **Apply** regression analysis for demand forecasting and cost analysis.
4. **Analyze** numerical data, using standard procedures of probability theory to predict the performance.
5. **Examine** data using different hypothesis tests and make conclusions about acceptance or rejection of sample data.
6. **Choose and perform** tests of hypotheses for various population parameters.

Detailed Syllabus:

Unit	Description	Duration (H)
I.	**Descriptive Statistic** Measures of central tendency: Mean, Mode, Median, and Measures of Variability: Standard Deviation, Variance, Quartiles, and Interquartile Range, Coefficient of variation, Charts for data distribution, Moments, Skewness and Kurtosis	6
II.	**Regression Analysis** Coefficient of correlation, rank correlation, Standard error of estimation, Regression Analysis, application of regression analysis for demand forecasting and cost analysis.	6
III.	**Probability distribution** Probability, Discrete & Continuous random variable, Theorems on Probability: Bayes Theorem, Random variables, Mathematical Expectation, Probability density function, Probability distributions: Binomial, Poisson and Normal distributions.	6
IV.	**Hypothesis testing** Sampling Distribution, Hypothesis testing, Types of errors, level of significance, Critical value (p-test), Chi-Square test, z test, t-test, ANOVA, Application of hypothesis testing to production control.	6
	Total	**24**

Text Books:

1. Montgomery and Runger, "Applied Statistics and Probability for Engineers", Wiley, India, 6 Edition, ISBN: 9788126562947
2. R. Johnson, "Probability and Statistics for Engineers", Prentice India Ltd, 8 Edition, ISBN 13:978-8120342132

Reference Books

1. P. Newbold, W. Carlson, B. Thorne, "Statistics for Business and Economics", Pearson India, 6 Edition, ISBN 9788131719275
2. S. P. Gupta and M. P. Gupta, "Business Statistics", Sultan Chand & sons, 19 Edition, ISBN 13:978-9351610120.
3. Walpole, R. Myers and S. Myers "Probability and Statistics for Engineers and Scientists", Pearson Education India, 9 Edition, ISBN 13:9780321629111
4. S.P.Gupta, "Statistical Methods", Papperbook publication, 43 edition, ISBN: 9788180549892, 8180549895

e-sources:

1. **NPTEL Course lectures links:**
   https://nptel.ac.in/courses/111/105/111105090/ (Probability)
   https://nptel.ac.in/courses/111/105/111105077/ (Statistics)
2. **Coursera Corse**
   https://www.coursera.org/learn/probability-statistics (Statistics & Probability)
3. **V-lab (IIT-Bombay) link**: http://vlabs.iitb.ac.in/vlabs-dev/labs/numerical_lab/labs/explist.php

Program: B.Tech. (Mechanical)				Semester : III			
Course : Manufacturing Science				Code : BME3301			
Teaching Scheme/week				Evaluation Scheme			
Lecture	Tutorial	Credit	Hours	IE	MTE	ETE	Total
3	--	3	3	20	30	50	100

Prior knowledge of

a. Trigonometry
b. Hand tools and accessories
c. Basic manufacturing processes
d. Basic mechanical components

is essential

Objectives:

Students are expected to study,

1. A broad overview of various manufacturing processes and their relevance in current manufacturing industry.
2. The fundamental science behind the various manufacturing techniques.
3. The insights of manufacturing equipment, tools, operations, their capabilities and limitations.
4. The knowledge of different process parameters in manufacturing and their effect on final product.
5. Understanding of advanced manufacturing processes.

Outcomes:

The Students will be able to,

1. **Identify** the machine or process used in the product manufacturing, its operation and capabilities.
2. **Evaluate** the process variables by analyzing the process data.
3. **Identify** product defects, interpret their causes and suggest remedies.
4. **Choose** economical, effective and efficient manufacturing technique for the product under consideration.
5. **Write** part program for job under consideration
6. **Design** required jig or fixture for job under consideration

Detailed Syllabus

Unit	Description	Duration (H)
1	**Casting Processes:** Introduction, Pattern and Mold, Pattern allowances, Types of pattern, Types of molds, Gating system and its design, Melting, Furnaces, Pouring (Top & Bottom Gating Design), Effects of aspiration, friction and velocity distribution, Cooling and Mechanism of Solidification, Cleaning and Finishing of casting, Inspection of casting, Defects in Casting, Fundamentals of Special Casting Processes: Shell molding, Investment casting, Die casting, Centrifugal casting, Continuous casting.	6
2	**Forming Processes:** Fundamentals of bulk and sheet metal forming processes, Plastic deformation and yield criteria, Relation between tensile and shear yield stresses, Types of metal forming processes, Mechanics of rolling processes, Analysis of open die forging a flat strip and circular disc, Defects in metal forming, Sheet metal forming analysis, Die design for sheet metals shearing and forming operation, strip layout, center of pressure, forces in sheet metal shearing and forming.	6
3	**Machining Processes:** Concept of Generatrix and Directrix with respect to surface generation, Orthogonal and oblique cutting, Mechanics of basic machining operation, Mechanism of chip formation, Mechanics of chip formation, Tool geometry, Tool materials, Failure of cutting tool, Tool life and machinability, Cutting fluids, Machining time and material removal rate for various machining processes.	6
4	**Joining Processes:** Introduction and classification of joining processes, Principles of solid phase welding, Principles of fusion welding and their types, Principles of solid/liquid state joining and their types, Weld defects.	6

5	**Unconventional Machining Processes:** Introduction, Mechanics, process parameters, effects on material, characteristics of: Abrasive Jet Machining, Ultrasonic Machining, Electrochemical Machining, Electric Discharge Machining, Electron Beam Machining, Laser Beam Machining and Plasma Arc Machining.	**6**
6	**Jigs and Fixtures, Computerized Numerical Control System:** Introduction to Jigs and Fixtures, Introduction to NC & CNC system, Machining Centers, Basics of Manual Part Programming.	**6**
	Total	**36**

Text Books:

1. P. C. Sharma, A Textbook of Production Engineering and production technology, S. Chand Publication (2018)
2. Serope Kalpak Jian, Steven Schmid, Manufacturing Engineering & Technology, 7th Edition, Pearson

Reference books:

1. P. N. Rao, Manufacturing Technology, Volume I & II, McGraw Hill Education (India) Private Limited. 4th Edition (2018)
2. D. K. Singh, Fundamentals of Manufacturing Engineering, Ane's Books. Pvt. Ltd.
3. Amitabha Ghosh, Ashok Kumar Mallik, Manufacturing Science, East-West Press Pvt. Ltd
4. Heine, Richard W., Principles of Metal Casting, Tata McGraw-Hill Education.
5. Avitzur B, Metals Forming: Processes and Analysis, McGraw Hill, New York
6. Boothroyd G., Fundamentals of Metal Machining and Machine Tools, Scripta Book Company, Washington
7. M. P. Grover, 'Introduction to manufacturing processes', Wiley.
8. P H Joshi, Jigs and Fixtures, Tata McGraw-Hill Education, 1998
9. P N Rao, CAD/CAM: Principles and Applications, Tata McGraw-Hill Education, 2017
10. Tschaetsch, Heinz, Metal Forming Practice Processes Machines Tools, Springer.
11. HMT handbook, production technology.

Miniature commitment or Assignments:

1. Sand casting: Design of product, Pattern making, Sand preparation, Mold and core making, Melting and Pouring, Cooling, Fettling, Cleaning and inspection, Report writing.
2. Effect of process parameters on chip formation during machining of ductile and brittle materials
3. Implementation of CNC part programming and Jig/Fixture Design for customized product.

Industrial Visit:

To provide awareness and understanding of the course, Industrial Visit must be arranged for the students. The Industrial Visit must be preferably to one of the following industry.

1. Casting
2. Forming
3. Sheet Metal

Program: B. Tech. (Mechanical)					Semester : III		
Course :Engineering Thermodynamics					Code: BME3401		
Teaching Scheme/week				Evaluation Scheme			
Lecture	Tutorial	Credit	Hours	IE	MTE	ETE	Total
3	-	3	3	20	30	50	100

Prior Knowledge of

a. Fundamental concepts of physics like Volume, Pressure, Velocity, Work ,Energy
b. Concepts of mathematics like derivative, integration , nature of curves , slope of curve
c. Construction and working of common mechanical devices / machines
is essential

Objectives:

1. To understand of the fundamental concepts and Laws of thermodynamics
2. To differentiate between energy and energy transfer , heat and work transfer
3. To be able to apply of the laws of thermodynamics
4. To understand the equations and processes governing the ideal gas behavior
5. To be able to use of seam tables/ Mollier chart for reading properties of steam.
6. To apprehend the concept of Exergy and its application to open and closed systems

Outcomes:

The Learners will be able---

1. **Identify** work transfer by using the operation definition
2. **Apply** the first law of Thermodynamics to various processes and systems and draw inferences.
3. **Identify** the Possibility /type of processes and cycles
4. **Evaluate** heat transfer, work transfer & other important thermodynamic entities for the processes undergone by ideal gas.
5. **Use** steam tables and Mollier Chart for solving problems related to steam processes
6. **Estimate** the exergy of simple thermodynamic systems

Detailed Syllabus

Unit	Description	Duration (H)
1.	**Basic Ideas and definitions**: Role of thermodynamics in mechanical Engineering, Thermodynamic System, Boundary, Types of system, State of system, Properties of system, Viewpoints, Classification of properties, Thermodynamic Equilibrium, State Postulate-1, Thermodynamic Process, Quasi-static Process, Thermodynamic cycle, The operational definition of work Interaction, types of work transfer, Complexity of system, State Postulate-2	4
2.	**The first Law of thermodynamics:** Analysis of Joule's Experiment for obtaining definition of Change of energy and Heat transfer, Closed system formulation of First law, Special case: closed system undergoing cycle, Open system formulation of First law of thermodynamics, Special case: Steady Flow Energy equation (SFEE), Application of SFEE to typical Engineering Devices , Application of first law to day-to -day life examples, concept of PMM-I, Zero'th Law of thermodynamics	**7**
3.	**The second Law and Entropy:** Limitations of First Law, Concept of H.E, H.P. and Refrigerator, Kelvin-Plank and Clausius Statements and their equivalence, Reversible process, cycle, Carnot Theorem and its corollaries, Efficiency of Reversible cycle, PMM-II, Criteria to check Possibility of a cycle , Entropy as property of system, Criteria to check Possibility of a process, Concept of Entropy Generation and its significance, Entropy change calculation : General case, Incompressible systems, T.E.R.s, Simple compressible system (Tds equations), How the second law overcomes the limitations of first law, Carnot cycle for Heat Engine. (T-v and T-s diagram), second law analysis for open systems and demonstration with h-s diagrams.	**7**

4.	**Ideal Gas Properties and Processes:** Definition, Laws pertaining to Ideal Gas, Specific Heat, Joules Experiment on Ideal Gases, Various process (Constant P/T/V/H and Polytropic, p-v and T-s diagrams): Evaluation of Work transfer, Heat transfer and Entropy change. P-v diagram of Carnot Cycle with Ideal Gas.	**6**
5.	**Properties of Pure Substance:** Definition, Formation of steam at constant pressure (T-v and T-s diagram), Formation of steam at constant temperature (p-v diagram), generation of h-s diagram from T-ds equation (Mollier Chart), Criteria for identification of phases of water substance, Deviation of steam from Ideal gas behavior , use of steam tables and Mollier Chart , Properties of Wet steam: dryness fraction, Separating, Throttling and Combined Separating-throttling Calorimeter, various processes with steam as a working substance.	**6**
6.	**Availability:** Concept of Dead state, Definition of Availability/Exergy, Exergy as a property of system, Exergy associated with K.E. and P.E., Exergy by Heat and work transfer, Exergy of Closed system and open system, Principle of Exergy Destruction, Irreversibility and second law efficiency.	**6**
	Total	**36**

Text Books:

1. Y. Cengel & Boles: Thermodynamics – An Engineering Approach, Tata McGraw-Hill
2. P. K. Nag, Engineering Thermodynamics, Tata McGraw Hill Publications
3. Mahesh M. Rathore, Thermal Engineering, Tata McGraw-Hill

Reference Books:

1. Michael Moran, Howard Shapiro, Fundamentals of Engineering Thermodynamics, John Wiley
2. Claus Borgnakke, Richard E. Sonntag, Fundamentals of Engineering Thermodynamics, John Wiley
3. M. Achuthan, Engineering Thermodynamics, PHI Learning Pvt. Ltd.
4. Rayner Joel, "Basic Engineering Thermodynamics", AWL-Addison Wesley
5. Holman J.P, "Thermodynamics", McGraw Hill
6. Robert T. Balmer, Modern Engineering Thermodynamics, Elsevier Inc.
7. Steam Tables and Mollier Chart

Program: B. Tech. (Mechanical)					Semester : III		
Course : Strength of Materials					Code : BME3402		
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Credit	Hours	IE	MTE	ETE	Total
3	--	3	3	20	30	50	100

Prior Knowledge of

a. Fundamentals of engineering mechanics
b. Analysis of forces and moments
c. Laws of motion, kinetics, kinematics
d. Centre of gravity and Moment of inertia

is essential.

Objectives:

1. To establish an understanding of the fundamental concepts of mechanics of deformable solids, material behavior and basic mechanical principles underlying modern approaches for design of various types of structural members subjected to axial load, torsion and bending.
2. To utilize the concepts of Strength of material for solving engineering problems.

Outcomes:

After learning the course, the students should be able to:

1. Understand and distinguish the Mechanical behavior of ferrous and nonferrous materials by determining the stresses, strains, deflections produced by the loads.
2. Analyze beams for variation of shear force and bending moment across length of beam and locate point of contra flexure for various end conditions and load conditions.
3. Evaluate stresses in beams for various end conditions, load conditions and materials.
4. Analyse the beam for slope & deflection.
5. Design shaft subjected to torque and column subjected to axial loading.
6. Understand principal stresses and able to apply the theories of failure.

Detailed Syllabus

Unit	Description	Duration (H)
1.	**Stress and Deformation of Solids:** Stress, strain, Hooke's law, Poisson's ratio, Modulus of Elasticity, Modulus of Rigidity, Bulk Modulus. Interrelation between elastic constants, Stresses and strains in determinate and indeterminate, homogeneous and composite bars under concentrated loads and self-weight. Temperature stresses in simple members.	**7**
2.	**Shear Force and Bending Moment Diagrams :** Shear force and bending moment diagrams for statically determinate beam due to concentrated load, uniformly distributed load, uniformly varying load and couple, Relationship between rate of loading, shear force and bending moment. Maximum bending moment and position of points of contra flexure.	**6**
3.	**Stresses in Beams:** **Bending stresses:** Theory of simple bending: Flexural formula, bending stress distribution diagrams for common cross sections (rectangular, I,T,C), moment of resistance and section modulus. **Shear stresses:** Shear stress distribution in beams, shear stress distribution diagrams for common symmetrical sections, maximum and average shears stresses.	**6**
4.	**Slope and deflection of beams:** Relation between bending moment and slope, slope and deflection of determinate beams for standard cases with double integration method (Macaulay's method). Strain energy (theoretical treatment only): Strain energy due to axial load (gradual, sudden and impact).	**5**
5.	**Torsion:** Stresses, strain and deformations in determinate shafts of solid and hollow subjected to twisting moment, torsion equation.	**6**

	Buckling of columns: Concept of buckling of columns, derivation of Euler's formula for buckling load for column with hinged ends, concept of equivalent length for various end conditions, limitations of Euler's formula, Rankine's formula(only theoretical treatment).	
6.	**Principal planes and stresses:** Principal planes and stresses on oblique planes, expression for principal stresses and maximum shear stress, orientation of principal planes and planes of maximum shear. Graphical solution using Mohr's circle. **Theories of elastic failure:** Maximum principal stress theory, maximum shear stress theory, maximum distortion energy theory their applications and limitations	**6**
	Total	**36**

Text Books:

1. R. K. Bansal, "Strength of Materials", Laxmi Publication
2. G. H. Ryder- Strength of Materials- 3rd Edition, Macmillan Pub, India
3. S.S. Rattan - Strength of Material – Tata McGraw Hill Publication Co. Ltd. S.
4. Ramamurtham - Strength of material - Dhanpat Rai Publication.
5. Timoshenko and Young - Strength of Materials - CBS Publication

Reference Books:

1. Beer and Johnston - Strength of materials - CBS Publication.
2. E.P. Popov - Introduction to Mechanics of Solids - Prentice Hall Publication.
3. Singer and Pytel - Strength of materials - Harper and row Publication.
4. B.K. Sarkar - Strength of Material - Tata McGraw Hill New Delhi
5. R. C. Hibbeler, "Mechanics of Materials", Prentice Hall Publication
6. Prof. S.K. Bhattacharyya, IIT Kharagpur , "NPTEL Web course material" https://drive.google.com/file/d/1N2Eyv9ofPimIT2OSMZeMrSxe68Ulclei/view?usp=sharing

Program:	B.Tech. (Mechanical)			Semester : III			
Course :	Materials Engineering			Code: BME3403			
Teaching Scheme/week				Evaluation Scheme			
Lecture	Practical	Credit	Hours	IE	MTE	ETE	Total
3	--	3	3	20	30	50	100

Prior knowledge of

a. Atomic arrangement
b. Crystal structures
c. Classification of materials
d. Thermal, electrical and optical properties of materials

is essential

Objectives:

Students are expected to study,

1. Structure of materials and their property relationship
2. Fundamentals of alloying.
3. Mechanical behavior of materials.
4. Ferrous metals and alloys.
5. Nonferrous metals and alloys.
6. Heat treatment of metals and alloys.
7. Material standards and material selection process.

Outcomes:

The Students will be able to,

1. **Correlate** crystal structures and imperfections in crystals with mechanical behavior of materials.
2. **Apply** fundamentals of alloying and equilibrium diagram to predict phases and their amounts.
3. **Correlate** microstructure and properties of various ferrous alloys.
4. **Correlate** microstructure and properties of various nonferrous alloys.
5. **Select** appropriate heat treatment based on desired applications.
6. **Use** various material standards and **select** appropriate material for given application.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Structure of Materials and their property relationship** Crystalline structure in metals. Ceramics and molecular arrangement of polymers. **Mechanical behavior of materials** Introduction to crystal imperfections, classification and its effect on properties of materials, Mechanism of elastic & plastic deformation (slip and twinning), Theory of dislocation, deformation of single crystal by slip, plastic deformation of polycrystalline materials, work hardening theory, Changes in properties due to cold working & hot working.	**6**
2.	**Fundamentals of alloying** Related terms and their definitions, Hume Rothery's rule of solid solubility, Allotropy and polymorphism, Concept of solidification of pure metals and alloys, Nucleation: homogeneous and heterogeneous, Grain growth. Cooling curves, Plotting of equilibrium diagrams, Lever rule, Coring, Types of equilibrium diagrams.	**6**
3.	**Ferrous metals and alloys** Iron-iron carbide equilibrium diagram, critical temperatures, solidification and microstructure of slowly cooled steels, structure & property relationship, classification and application of steels. Cast Irons: Classification, Manufacturing, Composition, Properties and applications of cast iron, effect of various parameters on structure and properties of cast irons. Classification of alloy steels and effect of alloying elements, examples of alloy steels, stainless steels, tool steels and special purpose steels with applications, super alloys.	**6**
4.	**Nonferrous metals and alloys** Classification of nonferrous metals. Importance of nonferrous metals in engineering applications & compositions, study of different mechanical properties: Cu & Cu based alloys, Al and Al based alloys, Ni and Ni based alloys, Co and Co based alloys, Titanium & its alloys, Tin & Lead base alloys, Bearing materials: important properties & applications.	**6**

5.	**Heat treatment of metals and alloys** Transformation products of Austenite, Time Temperature Transformation diagrams, continuous cooling transformation diagrams. Heat treatment of steels: Annealing, Normalizing, Hardening & Tempering, quenching media. Retention of austenite, effects of retained austenite. Elimination of retained austenite (Subzero treatment). Secondary hardening, temper embrittlement, quench cracks, Hardenability & hardenability testing, Defects due to heat treatment and remedial measures. Surface hardening heat treatments.	**6**
6.	**Material testing standards** Designation of ferrous and nonferrous alloys: IS, AISI, SAE, DIN etc. Process of material selection.	**6**
		36

Text Books:

1. Dr. V. D. Kodgire, Material Science and Engineering, Everest publishing house, 42nd Edition, 2017
2. W. D. Callister, Introduction to Material Science and Engineering, John Wiley, 10th Edition, 2018

Reference Books:

1. George E. Dieter, Mechanical Metallurgy, McGraw-Hill, 3rd Edition, 2017
2. Charles O. Smith, The Science of Engineering Material, Prentice Hall, 1977
3. Higgins R.A., Engineering Metallurgy, Viva Books Pvt. Ltd., 2004
4. Avener S.H., Introduction to Physical Metallurgy, Tata McGraw-Hill, 1997
5. V. Raghavan, Material Science and Engineering A First Course, Prentice Hall India, 6th Edition, 2015

Program: B.Tech. (Mechanical)				Semester : III			
Course : Material Testing Lab				Code: BME3404			
Teaching Scheme				Evaluation Scheme			
Practical	**Tutorial**	**Credit**	**Hours**	**TW**	**OR**	**PR**	**Total**
2	--	1	2	50	50	--	100

Prior knowledge of

a. Type of materials
b. Mechanical behavior of materials

is essential

Objectives:

Students are expected to study,

1. Significance of various material testing methods.
2. The use of various material testing methods.

Outcomes:

The Students will be able to,

1. **Perform** mechanical testing referring appropriate material testing standards and **analyze** the data.
2. **Prepare, observe** and **analyze** microstructure.
3. **Measure** and **analyze** effect of heat treatment on properties of materials.

Detailed Syllabus:

Experiment 1 is compulsory. Perform any 9 out of remaining.

List of Practical

1. Tension test for ductile material using extensometer on Universal Testing Machine. (Discussion on Stress-strain diagram for ductile and brittle materials, factor of safety).
2. Compression test for Brittle material on Universal Testing Machine.
3. Shear test of ductile material on Universal Testing Machine.
4. Experimental verification of flexural formula in bending by 3 point bending method.
5. Experimental verification of torsional formula.
6. Impact testing of materials
7. Non-destructive testing of materials: Dye penetrant, magnaflux, Ultrasonic, Eddy current.
8. Heat treatment: Annealing, Normalizing, Hardening and Tempering.
9. Specimen preparation for microscopic study.
10. Microstructure observation and analysis of ferrous and non-ferrous materials.
11. Hardness test: Brinell, Vickers. Rockwell, etc.
12. Jominy End Quench test

Reference book:

ASM Handbook: Mechanical Testing and Evaluation

Program: B.Tech. (Mechanical)						Semester : III	
Course : Manufacturing Practices						Code : BME3405	
Teaching Scheme				Evaluation Scheme			
Practical	Tutorial	Credit	Hours	TW	OR	PR	Total
2	--	1	2	50	--	--	50

Prior knowledge of

a. Hand tools and accessories
b. Basic measurement instruments (caliper, micrometer, dial gauge, etc.)
c. Machine tools
d. Safety practices on shop floor
is essential

Objectives:

Students are expected to,

1. Get hand on experience of working on various machine tools and welding machine.
2. Select appropriate machining parameters.
3. Experience dimensional and geometrical tolerances.
4. Get acquainted with automation in machining processes.

Outcomes:

The students should be able to,

1. **Select** appropriate machining parameters and handle machines.
2. **Analyze** product and select appropriate method, type of joint and joining parameters.
3. **Analyze** product and select appropriate machining process, tooling and process parameters.
4. **Design** jigs and fixtures.
5. **Execute** NC part program.

Detailed Syllabus

Unit	Description	Duration (H)
1.	Each student shall manufacture one useful component/part using various machining operations on lathe machine.	6
2.	Each student shall manufacture one component on milling machine using indexing mechanism.	6
3.	Welding operations and testing.	4
4.	Group of 3 to 4 students shall design manufacture one marketable assembly of 3 or more components using various machine tools, including CNC simulator, CNC Turning center and VMC.	8
5.	Assignment on design of jig and fixture.	-
	Total	24

Reference books:

1. Hajra Chaudhary, Elements of Workshop Technology, Vol. I and II, Media promoters and publishers Pvt. Ltd., 2013
2. Heinrich Grelling, All about machine tools, New Age publication, 2nd Edition, 2006
3. J. T. Black, Degormos Materials and process in manufacturing, John Willey and sons
4. M. P. Grover, Fundamentals of modern manufacturing: Materials and systems
5. Cryil Donaldson and George H LeCain, Tool Design, Tata McGraw Hill Education Pvt. Ltd.
6. Little, Richard L, Welding and welding technology, McGraw Hill Education Pvt. Ltd.
7. P N Rao, CAD/CAM: Principles and Applications, Tata McGraw-Hill Education.

Program:	B. Tech. (Mechanical)			Semester :III					
Course :	Universal Human Values			Code: BHM3101					
Teaching Scheme				Evaluation Scheme					
Lecture	Practical	Tutorial	Credit	IE	MTE	ETE	TW	PR	Total
3	-	-	3	30	-	20	-	-	50

Prior knowledge: Nil

Objectives:

1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.

Outcomes:

After learning the course, the students will be able to:

1. Develop more awareness of their surroundings, society, social problems and their sustainable solutions, while keeping human relationships and human nature in mind.
2. Develop better critical ability by developing the right understanding of reality
3. Understand and become sensitive to their commitment towards what they believe in (humane values. humane relationships and humane society).
4. Apply what they have learnt to their own self in differ

Detailed Syllabus:

Unit	Description	Duration (H)
1	**Introduction to Value Education:** Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Right Understanding, Relationship and Physical Facility, Happiness and Prosperity – Current Scenario, Method to fulfil the Basic Human Aspirations	06
	Practice Session: Sharing about Oneself, Exploring Human Consciousness, Exploring Natural Acceptance	02
2	**Harmony in the Human Being:** Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health	06
	Practice Session: Exploring the difference of Needs of Self and Body, Exploring Sources of Imagination in the Self, Exploring Harmony of Self with the Body	02
3	**Harmony in the Family:** Harmony in the Family – the Basic Unit of Human Interaction, Values in Human-to-Human Relationship, Nine universal values in relationships viz. Trust, Respect, Affection, Care, Guidance, Reverence, Glory, Gratitude, Love	04
	Practice Session: Exploring the Feeling of Trust, Exploring the Feeling of Respect	02
4	**Harmony in Society:** Understanding Harmony in the Society, Vision for the Universal Human Order**,** Human Order Five Dimensions	03
	Practice Session: Exploring Systems to fulfill Human Goal	01
5	**Harmony in the Nature/Existence:** Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfillment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence	03
	Practice Session: Exploring the Four Orders of Nature, Exploring Co-existence in Existence	01

6	**Implications of the Holistic Understanding – a Look at Professional Ethics:** Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics, Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession	04
	Practice Session: Exploring Ethical Human Conduct, Exploring Humanistic Models in Education, Exploring Steps of Transition towards Universal Human Order	02
	Total	**36**

Text Books

1. A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
2. Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

Reference Books

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
4. On Education - J Krishnamurthy
5. Rediscovering India - by Dharampal
6.Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi

Links for additional learning

http://madhyasth-darshan.info/postulations/knowledge/knowledge-of-humane-conduct/
https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw
https://youtu.be/OgdNx0X923I

Program: B. Tech. (Mechanical)				Semester :III			
Course : Computer Aided Machine Drawing-I				Code: BME3911			
Teaching Scheme/week				Evaluation Scheme			
Practical	**Tutorial**	**Credit**	**Hours**	**IE**	**MTE**	**ETE**	**Total**
2	--	-	2	--	--	--	--

Prior Knowledge of:

a. Engineering 2D drawings,
b. Machine elements used in Mechanical Engineering,
is essential

Objectives:

1. To understand conventions of standard machine components
2. To understand Geometric Dimensioning & Tolerancing.
3. To understand Parametric Modeling and "Shape before Size" Approach.
4. To exhibit ability to develop Parametric 2-D Sketches, and Edit Parametric Dimensions.
5. To build Solid Models of machine components.

Outcomes:

After learning the course, the students should be able to:

1. Understand the importance of CAD software and interpret various sign conventions, limit fits and tolerances.
2. Interpret dimensioning, tolerance, and surface finish symbols from production drawing
3. Apply the parametric feature-based modeling 2D Sketching and 3D machine components modeling

Detailed Syllabus

Unit	Description	Duration (H)
1	**Conventional Representation using CAD software** Introduction to Graphical User Interface (GUI) of any commercially used CAD software. Understand and draw the projection of standard conventions (SP-46) for. 1. Various materials. 2. Conventional representation of common features- shafts, Bearings, Joints, Valves, Gears assemblies, Threads, Springs, holes etc. 3. Conventions of Section 4. Limits, Fits, Tolerances 5. Surface Roughness	**08**
2	**Geometric Dimensioning & Tolerancing (GD&T)** Introduction to GD&T, ASME Y14.5-2018, Dimensioning System, GD&T Symbols, Form Tolerances, Datum, Orientation Tolerances, Location Tolerances: Position, Runout, Profile, Concentricity & Symmetry Tolerances**.** 3-2-1 Principle, Primary datum, Auxiliary datum, Unilateral tolerance, Maximum Material condition(MMC) / Least Material condition(LMC)	**08**
3	**Parametric Solid Modeling** 1. Parametric sketching - draw and modify 2D entities, apply/modify constraints and dimensions. 2. Parametric solid modeling – Transforming 2D sketches into 3D model of simple mechanical elements by feature based modeling approach. 3. Reverse engineering of 3D model. 4. Concept of model-based definition	**08**
	Total	**24**

Text Books:

1. Bhatt, N. D. and Panchal, V. M., "Machine Drawing", Charotar Publishing House Pvt. Ltd, Anand, India,
2. Ajeet Singh, " Machine Drawing", McGraw Hill Publications, New Delhi 2012
3. ASME Y14.5 -2018,

Reference Books:

1. Cogorno, G. R., (2020), "Geometric Dimensioning and Tolerancing for Mechanical Design", 3rd edition, McGraw-Hill Education
2. Blokdyk, Gerardus, (2019), "Geometric Dimensioning and Tolerancing: A Complete Guide - 2020 Edition", 5STARCooks
3. Standards: ISO/TR 23605:2018, ISO 1101:2017, SP 46, IS 15054(2001)
4. CATIA For Engineers & Designers V5R16, Sham Tickoo

List of Experiments:

1. Drawing various conventional representations (using CAD Software)
2. Assignment on reading of Industrial drawings.
3. Assignment on parametric solid modeling of a machine component
4. Understand Model based definition for 3D model.
5. Reverse engineering of 3D model

Program: B. Tech. (Mechanical)							Semester: III		
Course : Life Skills-III							Code : BHM3939		
Teaching Scheme				Evaluation Scheme					
Lecture	Practical	Tutorial	Credit	IE	MTE	ETE	TW	OR	Total
--	2	--	--	--	-	-	-		-

Prior knowledge: Nil

Objectives:

1. To attain mental, emotional balance and spiritually to achieve self-realization and enlightenment to help better understanding of the inner personality & its establishment of harmony with the external demands.
2. To learn to build team spirit and adapt to the various skills required in various sports activities.
3. To provide a platform to express their mind, body, and emotions through performing arts.

Outcomes:

After completing the course, the students should be able to:

1. Achieve a balanced state of mind and enjoy improved mental, physical, emotional, and spiritual wellbeing.
2. Apply sportsmanship skills in the context of leadership, sports management etc.
3. Demonstrate the ability to think critically about a variety of visual and performing arts.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Practicing Meditation** Pranayama and Breathing exercises, Meditation Technique, Thoughtless Awareness : Through Patanjali /Sahajayoga/Vipassana /Madhyastha Darshan/ Art of Living etc., or **Sports:** Indoor Games / Outdoor Games	**12**
2.	**Performing arts** Music, Singing, Poetry, Indian Conventional Dancing, Photography, Short Movie Making, Painting/ Sketching/ Drawing, Theatre Arts, Anchoring, Calligraphy etc.	**12**
	Total	**24**

Reference Books:

1. Vishnu Devananda, “Meditation and Mantras” ,1978.
2. Swami Vivekananda, “Patanjali’s Yoga Sutras”, 1 Jan 2012.
3. Shri Mataji Nirmala Devi, “Sahajayoga an Introduction”
4. William Hart , S. N. Goenka, “The Art of Living”, 4 August 2009.
5. Dennis Hill, “Meditation Deep Peace”, Trafford Publishing, 7 August 2014.
6. Boria Majumdar, Sachin Tendulakar, “Sachin Tendulkar – Playing It My Way”, Hodder & Stoughton, Hachette Livre publishing, 6 November 2014.
7. Milkha Singh, “The Race of My Life”, 2013.
8. Sfurti Sahare, “Think and Win like Dhoni”, 3 July 2016.
9. Dina Serto and Mary Kom, “Unbreakable”, 19 November 2013.
10. Ronojoy Sen, “Nation at Play: A History of Sport in India”, 2015.
11. Andre Agassi, “Open”, 2009.
12. Dr. Monica Hiten Shah, “Sangeet Aradhana”, Aradhana Sangeet Academy Ahmedabad, Edition 2018.
13. Kishori Amonkar , “Recreating A Dream”, Standard Edition .
14. Veejay Sai & foreward by Girish Karnad, “Drama Queens – Women who created history on Stage”, Roli Books publication.
15. Jiwan Pani, “Back to the roots – Essays on Performing Arts of India”, 1 January 2004.

Course Syllabus

SY B Tech

Semester-IV

Program: B. Tech. (Mechanical)						Semester : IV	
Course : Metrology and Mechanical Measurement						Code: BME4302	
Teaching Scheme/week				Evaluation Scheme			
Lecture	Tutorial	Credit	Hours	IE	MTE	ETE	Total
3	--	3	3	20	30	50	100

Prior knowledge of

a. Basic mechanical components
b. Optics
c. Trigonometry
d. Statistics
is essential

Objectives:

Students are expected to,

1. Use and apply various measurement methods, instruments, calibration and advanced measurement systems.
2. Understand and use of sensors and transducers for various measurements.

Outcomes:

The students will be able to,

1. **Design** limit gauges to meet desired needs within realistic constraints.
2. **Use** appropriate method of measurement/instruments/tools/techniques and experimental data to determine geometry and dimensions of parts in engineering applications.
3. **Select** appropriate advanced measurement/inspection techniques for different applications.
4. **Discuss** fundamentals of instrumentation for measurement applications and **interpret** static and dynamic characteristics of instruments.
5. **Identify** different sensors for position and temperature measurement.
6. **Select** different sensors for force, flow and speed measurement.

Detailed Syllabus

Unit	Description	Duration (H)
1.	**Fundamentals of Dimensional Metrology** • Engineering Metrology, Measurement Standard, Abbe's principle, Calibration and traceability • Geometric Form Measurement • Design of limit gauges	6
2.	**Comparators, Thread and Gear Metrology** • Comparators: Mechanical, Pneumatic, Optical, Electrical. • Measurement of Thread form: Thread form errors, Measurement of Minor, Major and Effective diameter (Three Wire Method), Best Wire Size, Flank angle and Pitch, Floating Carriage Micrometer • Gear Metrology: Introduction, Gear tooth Vernier, Constant chord, Base tangent, Gear Rolling Tester, Profile Projector	6
3.	**Surface Roughness Measurement and Advances in metrology** • Surface Roughness Measurement: Introduction to Surface texture, Parameters for measuring surface roughness, Surface roughness measuring instrument: TalySurf. • Coordinate Measuring Machine (CMM) • Interferometry: Principle, Optical Flat, NPL Interferometer, Laser Interferometry and Applications • Machine Vision Systems	6
4.	**Fundamentals of instrumentation** • Basic functional elements of measurement system and instrumentation, need of measurement • Methods and applications of measurements, performance characteristics • Errors in measurement, standards • Significance of IS standards of instruments • Storage and display devices, digital voltmeter and ammeter.	6

5.	**Position and Temperature Measurement** • Classification of sensor/transducers • Position sensors: Potentiometer, LVDT, RVDT, digital encoder, LIDAR (light detection and ranging), Linear scale • Proximity sensors: Optical, Inductive, Capacitive • Temperature sensor: RTD, Thermocouples, pyrometer, Infrared thermometer	**6**
6.	**Miscellaneous Measurement** • Force/Pressure Sensors: Piezoelectric, strain gauges • Flow sensors: Electromagnetic, Ultrasonic, hot-wire anemometer • Level Sensors: Capacitive, Optical, Conductive • Measurement of speed/velocity: Stroboscope, Noncontact type of tachometers • Vibration sensor: Accelerometer • Color sensor and its applications • Selection of sensor/transducers	**6**
	Total	**36**

Text Books:

1. Jain R.K., Engineering Metrology, Khanna Publication
2. Alan Morris, Reza Langari , Measurement and Instrumentation Theory and Application, Elsevier
3. Bewoor A. K. and Kulkarni V. A., Metrology and Measurements, Tata McGraw hill Publication

Reference Books:

1. K. J. Hume, Engineering metrology, TBS.
2. S. P. Venkateshan, Mechanical Measurements, , Ane Books Pvt. Ltd
3. Doebelin E. O, Measurement Systems-Application and Design, McGraw Hill Publication
4. J. P. Holman, Experimental Methods for Engineers, McGraw Hill International Editions, Mechanical Engineering Series. ISBN 0-07-113354-2
5. Alciatore & Histand, Introduction to Mechatronics and Measurement system, 4th Edition, McGraw Hill publication, 2011
6. I. C. Gupta, Engineering Metrology, Dhanpath Rai
7. Narayana K.L., Engineering Metrology.
8. Galyer J.F & Shotbolt C.R., Metrology for engineers
9. Judge A.W., Engineering Precision Measurements, Chapman and Hall
10. Francis T. Farago, Mark A. Curtis, Handbook of dimensional measurement.
11. ASTME, Handbook of Industrial Metrology, Prentice Hall of India Ltd.
12. Connie Dotson, Fundamentals of Dimensional Metrology, Thomson, 4th Edition.

Program: B. Tech. (Mechanical)				Semester : IV					
Course : Applied Thermodynamics				Code: BME4406					
Teaching Scheme/week				Evaluation Scheme					
Lecture	Practical	Credit	Hours	IE	MTE	ETE	TW	PR	Total
3	2	4	5	20	30	50	25	50	175

Prior Knowledge of

a. Fundamental concepts of thermodynamics
b. Laws of thermodynamics
c. Use of steam tables and Mollier chart
d. Ideal Gas Equations and processes

is essential

Objectives:

1. To understand the theory and performance calculations of reciprocating air compressors
2. To understand the performance evaluation of boilers
3. To study various thermodynamic cycles with gas and steam as working medium
4. To get familiar with the characteristics of compressible fluid flow
5. To understand the analysis of flue gases and calculation of Air fuel ratio.

Outcomes:

The learners will be able to

1. **Analyze** the performance of Reciprocating Air Compressor
2. **Evaluate** the performance parameters of boiler
3. **Analyze** the performance of various Thermodynamic cycles
4. **Analyze** steady one dimensional isentropic compressible fluid flow.
5. **Estimate** the Actual and Stoichiometric air fuel ratio of various fuels.

Detailed Syllabus

Unit	Description	Duration (H)
1.	**Positive Displacement Compressors**: Reciprocating Compressor - Single stage compressor – computation of work of compression, isothermal efficiency, effect of clearance volume, volumetric efficiency, Free air delivery, Theoretical and actual indicator diagram, Multistage compressor, Computation of work of compression, Volumetric efficiency, Ideal Intermediate pressure, Inter-cooling and after cooling, Rotary Compressor – Introduction, vane compressors, roots blower	7
2.	**Steam Generation:** Boilers, Classification, Mounting, Accessories, Applications, Introduction to IBR , Boiler performance calculations-Equivalent evaporation, Boiler efficiency(direct & indirect), Heat balance, Boiler draught (natural and artificial draught)	7
3.	**Vapour Power Cycle:** Carnot cycle, Rankine cycle, Comparison, Efficiency of Rankine cycle, Relative efficiency, Effect of superheat, boiler and condenser pressure on performance of Rankine cycle, Deciding maximum pressure of boiler	6
4.	**Gas Power Cycles:** Air Standard assumptions, Otto Cycle, Diesel cycle, Dual cycle, Comparison of cycles, Brayton cycle, Efficiency, Work output, Effect of pressure ratio, Reheat and regeneration and intercooling.	6

5.	**Compressible Fluid Flow:** Definition, Speed of sound and Mach No. , Sonic, Subsonic and Supersonic flow, Effect of Area variation on one dimensional Steady isentropic compressible flow, Convergent -Divergent Nozzle, Effect of friction and heat transfer on steady one dimensional compressible fluid flow, Fanno Lines, Reyleigh lines.	**5**
6.	**Fuels & Combustion:** Fuel properties, Higher and Lower Calorific value, Determination of Air Fuel Ratio (Actual and Stoichiometric), Analysis of exhaust gases, Adiabatic Flame temperature, Dew point temperature of products of combustion.	**5**
	Total	**36**

Text Books:

1. Y. Cengel & Boles: Thermodynamics – An Engineering Approach, Tata McGraw-Hill
2. P. K. Nag, Engineering Thermodynamics, Tata McGraw Hill Publications
3. Mahesh M. Rathore, Thermal Engineering, Tata McGraw-Hill

Reference Books:

1. Michael Moran, Howard Shapiro, Fundamentals of Engineering Thermodynamics, John Wiley
2. Claus Borgnakke, Richard E. Sonntag, Fundamentals of Engineering Thermodynamics, John Wiley
3. M. Achuthan, Engineering Thermodynamics, PHI Learning Pvt. Ltd.
4. V. Ganesan, "Internal Combustion Engines", Tata McGraw-Hill
5. M. L. Mathur and R.P. Sharma, "A course in Internal combustion engines", Dhanpat Rai & Co.
6. Introduction to Fluid Mechanics, Robert W. Fox, Alan T. McDonald, John W. Mitchell, John Wiley

List of Laboratory Experiments

Total Eight experiments of the following are to be performed (Expt. 3, 4, 5 and 13 are compulsory, any one of Expt . 1 and 2, any one of Expt. 6 and 7, any three of Expt. 8 to 11)

1. Determination of Calorific Value of Solid/ Gaseous Fuel
2. Determination of Cp and Cv of Ideal Gas
3. Trail on Boiler to determine Efficiency, Equivalent Evaporation Rate, Heat Balance Sheet etc
4. Determination of Dryness fraction of steam by using Combined separating & Throttling Calorimeter
5. Trail on reciprocating Air compressor to determine volumetric efficiency, Isothermal Efficiency, Heat rejected in intercooler.
6. Analysis of compressible fluid flow by using Engineering Equation Solver (EES) software.
7. Demonstration of Compressible fluid flow through convergent- Divergent Nozzle
8. Variable load test on single cylinder C.I. engine to determine various performance parameters
9. Variable speed teat on Multi cylinder S.I. engine to determine various performance parameters
10. Morse test on Multi cylinder S.I. engine
11. Generation of P-theta diagram of C.I. / S. I. Engine
12. Analysis of exhaust gases of S.I. and C.I. Engines.
13. Visit to Industry utilizing Boiler

Program: B. Tech. (Mechanical)						Semester : IV	
Course : Fluid Mechanics						Code : BME4407	
Teaching Scheme/week				Evaluation Scheme			
Lecture	**Tutorial**	**Credit**	**Hours**	**IE**	**MTE**	**ETE**	**Total**
3	-	3	3	20	30	50	100

Prior Knowledge of

a. Fundamental concepts of physics like force, pressure, velocity, area, volume etc
b. Mathematical concepts like vector, differential equation

is essential

Objectives:

1. Understand & analyze various properties of fluid & fluid conditions such as static and dynamic.
2. Understand the importance of flow measurement devices and its industrial applications.
3. Understand Bernoulli's theorem and its applications.
4. Understand losses occurred in a pipe when there is a flow between two places.
5. Understand boundary layer phenomenon, drag and lift

Outcomes:

The student should be able to:

1. **Apply** the laws of fluid statics to determine various fluid properties
2. **Analyze** fluid flow behavior in different systems.
3. **Apply** Bernoulli's equation for different fluid system
4. **Evaluate** the losses in internal flow systems
5. **Evaluate** the properties of fluids related to external fluid flow.
6. **Identify** dimensionless numbers related to fluid flow and apprehend their significance

Detailed Syllabus

Unit	Description	Duration (H)
1.	**Fluid Properties and Hydrostatics** Definition of fluid, Concept of continuum, Properties of fluid (Density, Specific Weight, Specific Gravity, Viscosity, Newton's law of viscosity, Surface Tension, Capillarity, Compressibility, Vapour pressure, Cavitation.) Types of fluid & Rheological diagram. Hydrostatic forces on vertical & horizontal plate, Buoyancy, metacenter and floatation.	**6**
2.	**Fluid Dynamics** A. Fluid Kinematics Continuity equation, types of flows (One, two, three dimensional, steady, unsteady, uniform, non-uniform, laminar, turbulent, compressible, incompressible, rotational, Irrotational flow), Mass conservation equation (Continuity equation) – 1D, 2D & 3D equation, Visualization of flow field (Path line, Streamlines and streak lines), Introduction to flow visualization devices:- PIV (Particle image velocity meter), LDA (Laser doppler anemometer), Stream function & velocity potential function, flow net Velocity of fluid particle, local & convective acceleration. B. Fluid Kinetics Euler equation of motion, Bernoulli's equation of motion along stream line Modified Bernoulli's equation.	**7**

3.	**Applied Fluid Dynamics** Application of Bernoulli's principle:-Medical field, Engineering field, Hydraulic coefficient, Venturi meter, Orifice and Orifice meter, Notch, Pitot tube.	**5**
4.	**Internal Flows** Velocity and shear Stress distribution for laminar flow in a pipe & fixed parallel plates, Velocity and shear Stress distribution for Couette flow, Introduction to velocity profile for turbulent flow, Energy losses through pipe:-Major and Minor losses (no derivation of major and minor losses), Pipes in series, pipes in parallel and concept of equivalent pipe, Moody's diagram, Siphons, Transmission of power.	**6**
5.	**External Flows** Boundary layer formation for flow over flat plate, Boundary layer thickness - displacement, momentum and energy, Separation of boundary layer and methods of controlling, Introduction to drag and lift & its applications, Drag on a flat plate:-Bluff body & Stream line body	**6**
6.	**Dimensional Analysis** Significance of dimensional analysis, Dimensional homogeneity & methods – Raleigh and Buckingham π theorems, Similitude (Types of similarities), Dimensionless numbers – Reynolds, Froude, Euler, Weber, Mach, Unit quantities-Specific quantities, Model laws - Reynolds, Froude, Euler, Mach	**6**
	Total	**36**

Text Books:

1. Fluid Mechanics, - Dr. R.K. Bansal - Laxmi Publication (P) Ltd. New Delhi
2. Hydraulics and Fluid Mechanics - Modi P. N. and Seth S. M - Standard Book House.
3. Introduction to Fluid Mechanics and Fluid Machines – S K Som and G Biswas - TATA McGraw –Hill

Reference Books:

1. Mechanics of Fluids - Merle C. Potter, David C. Wiggert and Bassem Ramadan–Cengage Learning
2. Fluid Mechanics - Kundu, Cohen, Dowling - Elsevier India
3. Fundamentals of Fluid Mechanics - Munson, Young and Okiishi - Wiley India
4. Fluid Mechanics, - Cengel & Cimbla - TATA McGraw –Hill
5. Fluid Mechanics –F.M. White - TATA McGraw-Hill
6. Introduction to Fluid Mechanics, Robert W. Fox, Alan T. McDonald, John W. Mitchell, John Wiley

Program: B. Tech. (Mechanical)							Semester: IV		
Course: Kinematics and Theory of Machines							Code: BME4408		
Teaching Scheme				Evaluation Scheme					
Lecture	**Practical**	**Credit**	**Hours**	**IE**	**MTE**	**ETE**	**TW**	**OR**	**Total**
3	2	4	5	20	30	50	25	50	175

Prior Knowledge of

a. Fundamentals of mechanics
b. Power transmission elements used in mechanical engineering
c. Types of Motion

is essential

Objectives:

1. To make the students conversant with kinematic analysis of mechanisms applied to real life and industrial applications.
2. To develop the competency to analyze the velocity and acceleration in mechanisms using analytical and graphical approach
3. To develop the skill to propose and synthesize the linkages and cams
4. To develop the competency to understand & apply the principles of gear theory to design various applications.
5. To develop the competency to predict friction in clutches and brakes

Outcomes: After learning the course, the students should be able to:

1. Identify mechanisms in real life applications.
2. Analyze velocity & acceleration of mechanism by analytical method and graphical method
3. Synthesize linkages and cam
4. Understand fundamentals of gear theory and analyze Epicyclic gear train for speed and torque
5. Select appropriate clutch or brake for given application
6. Analyze and Synthesize the mechanisms using simulation tools

Detailed Syllabus

Unit	Description	Duration (H)
1.	**Introduction** Kinematic link, Kinematic Pair, Kinematic Chain, Mechanisms, Grashof's law, Degree of freedom, mobility, Kutzbach equation, Grubler's equation Kinematic inversions of four bar chain, slider and double slider crank chain, Introduction to spatial mechanisms	**6**
2.	**Kinematic analysis** Kinematic analysis of simple planar mechanisms using relative velocity and acceleration method (limitations to 6 links), Coriolis component of acceleration (limitations to 4 links). Kinematic analysis using complex algebra method.	**6**
3.	**Synthesis of linkages** Steps in synthesis, Tasks of Kinematic synthesis, Precision Positions, Chebychev spacing, Mechanical and structural errors, Angle relationship for function generation, Analytical synthesis using Freudenstein's equation, Bloch's synthesis (limited to three position synthesis)	**6**
4.	**Cam and Followers** Classification of cams and followers- Terminology and definitions Displacement programs - Uniform velocity, parabolic, simple harmonic and cycloidal motions, cam profile for given follower motion, 3-4-5 Polynomial Cams, Cam jump phenomenon	**6**
5.	**Gears and Gear Trains** Gear tooth terminology, fundamental law of gearing and conjugate action Involute and cycloidal gear profiles, Spur gear contact ratio and interference/undercutting, methods to avoid interference, Kinematics of simple, Compound and Epicyclic gear train (limited to spur gear trains only)	**6**

6.	**Clutch and brake** Pivot and collar friction, uniform pressure and uniform wear theory, Friction clutches: single plate, multi plate and centrifugal: friction torque transmission capacity. Brakes Internal expanding shoe (drum) brake and disc brake: braking torque analysis.	**6**
	Total	**36**

Text Books:

1. S. S. Rattan, "Theory of Machines", Third Edition, McGraw Hill Education (India) Pvt. Ltd., New Delhi.
2. Bevan T, "Theory of Machines", Third Edition, Longman Publication
3. G. Ambekar, "Mechanism and Machine Theory", PHI
4. J. J. Uicker, G. R. Pennock, J. E. Shigley, "Theory of Machines and Mechanisms", Fifth Edition, International Student Edition, Oxford

Reference Books:

1. Paul E. Sandin, "Robot Mechanisms and Mechanical Devices Illustrated", Tata McGraw Hill Publication
2. Stephen J. Derby, "Design of Automatic Machinery", 2005, Marcel Dekker, New York
3. Neil Sclater, "Mechanisms and Mechanical Devices Sourcebook", Fifth Edition, Tata McGraw Hill Publication
4. Ghosh Malik, "Theory of Mechanism and Machines", East-West Pvt. Ltd.
5. Hannah and Stephans, "Mechanics of Machines", Edward Arnolde Publication
6. R. L. Norton, "Kinematics and Dynamics of Machinery", First Edition, McGraw Hill Education (India) P Ltd. New Delhi
7. Sadhu Singh, "Theory of Machines", Pearson
8. Dr. V. P. Singh, "Theory of Machine", Dhanpatrai and Sons
9. C. S. Sharma & Kamlesh Purohit, "Theory of Machine and Mechanism", PHI

List of Practicals

A. Laboratory Experiments (Any 4):

1. Identify real life mechanism for types of links, joint and mobility (Presentation)
2. To study manufacturing of gear using gear generation with rack as a cutter and to generate an involute profile.
3. Speed and torque analysis of Epicyclic gear train to determine holding torque.
4. Kinematic analysis of Constant mesh, Sliding mesh and Synchromesh Gearbox
5. Determination of range ratio of axially displaceable conical variator
6. To determine friction torque capacity of a clutch.

B. Drawing Assignments (A3 size sheet) (Any 3):

1. Velocity and acceleration analysis of planar mechanism (limited to 6 links) using relative velocity and relative acceleration method
2. Velocity and acceleration analysis of planar mechanism involving coincident points with relative motion (limited to 4 links)
3. Synthesize the four bar and slider crank mechanism by inversion and relative pole method for three precision positions
4. To generate conjugate profile for a given tooth profile
5. To draw Cam profiles for given follower motions

C. Computer Aided Assignments (Any 2):

1. To determine the angular displacements/velocity/acceleration of input and output shafts of single Hooke's joint for different shaft angles and verification of the results using computer program.
2. To simulate Cam profiles for various follower motion and comparison for different performance parameters
3. Velocity and acceleration analysis of planar mechanism using any simulation software
4. Analysis of slider crank mechanism and validating the same with any programming software
5. Analytical synthesis of four bar mechanism and validating the same with any programming software

Program: B.Tech. (Mechanical)				Semester : IV			
Course : Metrology and Mechanical Measurement Lab				Code: BME4409			
Teaching Scheme/week				Evaluation Scheme			
Lecture	**Practical**	**Credit**	**Hours**	**TW**	**OR**	**PR**	**Total**
--	2	1	2	25	25	--	50

Prior knowledge of:

a. Basic mechanical components
b. Optics
c. Trigonometry
d. Statistics

is essential

Objectives:

Students are expected to,

1. Select and use of suitable measuring and inspection instruments for different geometrical and dimensional measurements.
2. Understand and use of sensors and transducers for various measurements.

Outcomes:

The Students will be able to,

1. **Use** appropriate method of measurement/instruments/tools/techniques and experimental data to determine geometry & dimensions of parts in engineering applications.
2. **Demonstrate** calibration process for various measuring instruments.
3. **Use** modern tools for measurement, gauging and analysis.
4. **Apply** fundamentals of instrumentation for measurement of flow/temperature/level/ proximity/speed.

Detailed Syllabus:

Industrial Visit is compulsory, any 8 from remaining

List of Practical

1. Demonstration of linear and angular measuring instruments, slip gauges and their applications.
2. Calibration of measuring instrument, like Pressure gauge, Dial gauge, Micrometer, Vernier (any one) (Refer ISO 17025).
3. Verification of dimensions and geometry of given components using Mechanical /Pneumatic/Electrical comparator.
4. Measurement of complex components such as thread, gear, etc.
5. Demonstration of surface inspection using optical flat and surface roughness measurement using surface roughness tester.
6. To measure temperature using any temperature sensor/transducer.
7. To measure the load by using load cell and its comparison with mechanical load.
8. Case study on sensor/transducer selection for any one real life application and prepare detailed report for the same.
9. Flow/Level measurement using suitable sensor/transducer.
10. Demonstration and use of various proximity sensors in mechanical industry.
11. Speed measurement of mechanical system/application using instruments based on non-contact and contact type principles and its comparison.
12. Industrial Visit.

Program: B. Tech. (All branches)				Semester : IV					
Course : Professional Skills for Engineers				Code : BHM4101					
Teaching Scheme				Evaluation Scheme					
Lecture	**Practical**	**Tutorial**	**Credit**	**IE**	**MTE**	**ETE**	**TW**	**PR**	**Total**
2	-		2	30	-	20	-	-	50

Pre-requisite: Nil

Objectives:

1. To introduce to students the fundamentals of effective communication and barriers in communication.
2. To introduce them to the concept of verbal and non-verbal communication and importance of Body language
3. To introduce to students the skills to prepare and deliver effective presentations and learn tricks of mastering group discussions.
4. To sensitize students to their behavior in corporates by allowing them to understand the basics of corporate etiquettes.

Outcomes:

After learning the course, the students will be able to:

1. Evaluate the barriers in communication and accordingly master the skills of communication across culture at workplace.
2. Demonstrate effective verbal as well as non-verbal communication skills in both social and professional contexts
3. Develop practically deployable skill set involving effective presentations and handling group discussions to hone the opportunities of employability and excel in the professional environment.
4. Demonstrate skills for effectively handling the interviews and and ability to handle casual and formal situations in terms of personal grooming, dining and other corporate etiquettes

Detailed Syllabus

Unit	Description	Duration (H)
1	**Introduction and Fundamentals of Communication**: Need for effective communication, Functions of Communication, Communication Cycle, Levels of communication; Flow of communication **Barriers to Effective Communication:** Miscommunication; Noise; Types of barriers; Communication across Culture	**06**
2	**Verbal, Nonverbal communication and Body language:** Forms of Communication- Verbal and Non-verbal, their role and composition in overall communication; Effective use of body language, Listening Vs Hearing	**06**
3	**Presentation Skills:** 4Ps (Planning, Preparation, Practice, Presentation), Outlining; Effective use of A/V aids and Modes of Delivery **Mastering Group Discussion skills:** Skills evaluated in Group discussion, Types of Group discussion, Do's and Don'ts in Group Discussion	**06**
4	**Interview Skills:** Self Introduction, Do's and Don'ts during Interview **Corporate Etiquettes:** Definition and importance of Etiquette, Dressing Etiquettes, Dining Etiquettes, Telephonic etiquette, Business card Etiquette, Email etiquette	**06**
	Total	**24**

Text Book:

1. R.Gajendra Singh Chauhan and Sangeeta Sharma, "Soft Skills-An integrated approach to maximize personality", Wiley Publication, ISBN: 987-81-265-5639-7

Reference Books:

1. Muralikrishna C., Sunita Mishra "Communication Skills for Engineers" 2nd edition, Pearson, New Delhi 2010
2. Indrajit Bhattacharya, "An Approach to Communication Skills", Dhanpat Rai, Delhi, 2008
3. Simon Sweeney, "English for Business Communication", Cambridge University Press.
4. Sanjay Kumar and Pushpa Lata, "Communication Skills", Oxford University Press.

Program: B. Tech. (Mechanical)				Semester: IV			
Course: Computer Aided Machine Drawing-II				Code: BME4912			
Teaching Scheme				Evaluation Scheme			
Lecture	**Practical**	**Credit**	**Hours**	**IE**	**MTE**	**ETE**	**Total**
-	2	-	2	--	--	--	--

Prior knowledge of

- **a.** 2D, 3D drafting
- **b.** Various manufacturing processes
- **c.** Dimensional tolerances, geometric tolerances **is essential.**

Objectives:

1. To develop an ability to create assembly models of simple machines
2. To develop an ability to create 2D drawings from 3D models
3. To learn how effectively tolerance parts in engineering drawing.
4. To apply various kinematic constraints for assembly
5. To develop ability to create surface models for mechanical components.

Outcomes:

After learning the course, the students should be able to:

1. CREATE 3D assemblies that represent mechanical applications.
2. INTERPRET dimensioning, tolerance, and surface finish symbols from production drawing
3. APPLY geometric and dimensional tolerance, surface finish symbols in drawings
4. CREATE Kinematic simulation for motion study.
5. CREATE surface models for mechanical components

Detailed Syllabus

Unit	Description	Duration (H)
1	**Assembly Modeling** 1. Top-down and Bottom-Up Assembly approaches 2. Defining relationship between various parts of machine. 3. Apply constraints. 4. Generation of exploded view. 5. Design for manufacturing and assembly concept with suitable examples. 6. Assembly modeling by importing parts from free online resources.	**06**
2	**Production drawing** **1.** Generation of 2-D sketches from parts and assembly 3-D model, Placing Dimensions to Views, Tolerances, Notes, **2.** Drafting Tools, Bill of Material, Balloon Creation **3.** APPLY geometric and dimensional tolerance, surface finish symbols in drawing. Case studies of Industrial drawing of mechanical components.	**08**
3	**Kinematics Simulations** Creating a Mechanism, modifying a Mechanism, completing a Macro Mechanism, Master Exercise: Create Motorbike Suspension Mechanism, Creating Kinematics Simulations, Recording and Editing a Kinematics Scenario, Modifying and Plotting Excitations.	**06**
4.	**Introduction to surface modeling** Introduction to Surface Design, Creating Wireframe Geometry, Shape Design Common Tools, Creating Surfaces, Understanding operations toolbar.	**04**
	Total	**24**

Text Books:

1. Bhatt, N. D. and Panchal, V. M., (2014), “Machine Drawing”, Charotar Publishing House Pvt. Ltd, Anand, India, ISBN-13: 978-9385039232
2. ASME Y14.5 -2018, ASME, 2018
3. CATIA For Engineers & Designers V5R16, Sham Tickoo

Reference Books:

1. Cogorno, G. R., (2020), "Geometric Dimensioning and Tolerancing for Mechanical Design", 3rd edition, McGraw-Hill Education
2. Blokdyk, Gerardus, (2019), "Geometric Dimensioning and Tolerancing: A Complete Guide - 2020 Edition", 5STARCooks
3. Standards: ISO/TR 23605:2018, ISO 1101:2017, SP 46, IS 15054(2001)

List of Experiments:

1. Assignment on assembly of the parts using proper constrained conditions and generation of exploded view.
2. Assignment on Assembly modeling for a product by importing parts from free online resources
3. Study, reading and generation of production drawing for given parts and assembly by applying required GD &T symbol
4. Create Kinematic simulation for assembly.
5. Assignment on surface modeling of a machine components

Program: B. Tech. (All branches)							Semester: IV			
Course : Life Skills-IV							Code : BHM4940			
Teaching Scheme				Evaluation Scheme						
Lecture	Practical	Credit	Hours	IE	MTE	ETE	TW	PR	OR	Total
-	2	0	0	-	-	-	-	-	-	-

Prior knowledge: Nil

Objectives:

1. To learn about the social functioning and diverse culture in the country.
2. To be aware and improve interpersonal behavioural patterns.
3. To inculcate caring and serving qualities towards family, society and environment at large.

Outcomes:

After Successfully completing the course the students should be able to:

1. Apply social work practices in the context of diverse cultures.
2. Develop a broad understanding of Indian culture through various art forms.
3. Apply effective ways of interpersonal behavioural patterns eliminating their unhelpful thoughts, feelings and actions.
4. Develop skills which are necessary to initiate ideas and pursue them for holistic development of the individual.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Social Welfare** Environment awareness such as Tree Plantation, Natural resources awareness etc, Donation Camp, Visit to Orphanage, Old Age home and Villages, Contribution in social activity like Pani Foundation, Swaccha Bharat Abhiyan, Save Girl Child/Animals/Birds/Trees etc., Activity based on societal projects / Project Exhibitions etc. **Cultural Awareness** Divisions of Indian classical music: Hindustani and Carnatic, Dances of India, Various Dance forms: Classical and Regional, Rise of modern theatre and Indian cinema. **or** **Transaction Analysis** Introduction to TA, Basic Assumptions of TA, Theory of Personality Ego States, Strucural and Functional, Ego States Diagnosis, Egogram, Structural Pathology, Contamination, Theory of Communication, Types of Transactions, Strokes, Stroke Economy, Theory of Life Positions, Injunctions	**12**
2.	**Caring and service** Hospital Caring, Personal Safety, First Aid, Disaster Management Gardening, Organic farming, Cooking, etc	**12**
	Total	**24**

Reference Books:

1. K. Singh, “An introduction to Social Work”, 14 April 2011.
2. Bishnu Mohan Dash, Mithilesh Kumar, D. P. Singh, Siddheshwar Shukla, “Indian Social Work”, 1 October 2020.
3. Martin Davies, “Social work with Children and Families”, 20 March 2012.
4. Anita Kainthla, “Baba Amte – A Biography”, 1 January 2006.
5. Aroup Chatterjee , “Mother Teresa – The untold story”, 1 January 2006.
6. Improving Behaviour and Raising Self-Esteem in the Classroom, A Practical Guide to Using Transactional Analysis, Giles Barrow, Emma Bradshaw, Trudi Newton, David Fulton Publishers, 1 October 2001.
7. Transactional Analysis, 100 Key Points and Techniques, Mark Widdowson, 8 September 2009.
8. Benjamin Colodzin, “Helping ourselves by Helping Others”, 3 August 2020.
9. Smith Mark K. “The Art of Helping Others”, Jessica Kingsley Publishers,15 April 2008.
10. Chip Heath, “Decisive: How to Make Better Choices in Life and Work”, March 26, 2013.

Annexture-I

Audit Course-I

Semester-IV

Program: B. Tech. (Mechanical)				Semester: IV		
Course: Environmental Sciences				Code : BHM9961		
Teaching Scheme				Evaluation Scheme		
Lecture	**Credit**	**Hours**	**IE**	**MTE**	**ETE**	**Total**
1	--	1	--	-	-	-

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Multidisciplinary nature of environmental studies**: Definition, scope and importance, Need for Public awareness, Natural Resources: Renewable and non-renewable resources: Natural resources and associated problems a) Forest b)Water c)Mineral d)Food e) Land f) Energy, Role of an individual in conservation of natural resources, Use of resources for sustainable lifestyle.	3
2	**Ecosystems**: Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumer and decomposer, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Characteristic features, Case study on Forest ecosystem, Aquatic ecosystem.	3
3.	**Biodiversity and its conservation: Introduction**: Definition: genetic, species and ecosystem diversity, Biogeographically classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic values, Biodiversity at global, national and local levels, India as a mega-diversity nation, Hotspots of biodiversity, Threats to biodiversity, Conservation of biodiversity, Case study on any one Hotspot of biodiversity.	3
4.	**Environmental Pollution:** Definition, Cause, effects and control measures of different pollution: a. Air b. Water c. Soil d. Noise e. Thermal f. Nuclear hazards, Solid waste management, Relevance of environmental ethics for environmental protection, Social Issues and the Environment :From Unsustainable to Sustainable development ,Urban problems related to energy ,Water conservation, Impact of Climate change, Innovative ideas for creating public environmental awareness.	3
	Total	**12**

Text Books:

1. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T., "Environmental Encyclopedia", Jaico Publications House, 1st edition, 2000, ISBN-13: 978-8172247867
2. 2.Agarwal, K.C, "Environmental Biology", Nidhi Publishers, 2nd edition ,2008, ISBN-13978-8189153021

Reference Books:

1.BharuchaErach, "The Biodiversity of India", Mapin Publishing Pvt. Ltd., 1st edition, 20021, ISBN-108188204064

Program: B. Tech. (Mechanical)					Semester: IV	
Course: Constitution of India					Code: BHM9962	
Teaching Scheme				Evaluation Scheme		
Lecture	**Credit**	**Hours**	**IE**	**MTE**	**ETE**	**Total**
1	-	1	-	-	-	-

Detailed Syllabus:

Unit	Description	Duration (H)
1.	Introduction to Constitution: Meaning of the constitution law and constitutionalism, making of constitution, Salient features and characteristics of the Constitution of India, Preamble, Fundamental Rights, Directive Principles of State Policy, Fundamental Duties and it's legal status, Citizenship.	3
2.	System of Government- Centre & State level **and local level** Structure and Function of Central GovernmentPresident, Vice President, Prime Minister, Cabinet, Parliament, Supreme Court of India, Judicial Review, Federal structure and distribution of legislative and financial powers between the Union and the States, local self-government	3
3.	Judiciary: Governor, Chief Minister, Cabinet, State Legislature Judicial System in States, High Courts and other Subordinate Courts,Parliamentary Form of Government in India.	3
4.	Constitution Functions: Indian Federal System and it's characteristics, Center& State Relations, President's Rule, ConstitutionalAmendmentsandpowers, Constitutional Functionaries,Emergency Provisions, Assessment of working of the Parliamentary System in India	3
	Total	**12**

Text Books:

1. Durga Das Basu, "Introduction to the Constitution of India ", Prentice Hall of India, New Delhi,24th edition, 2020, ISBN-109388548868
2. Clarendon Press, Subhash C, Kashyap, "Our Constitution: An Introduction to India's Constitution and constitutional Law", NBT, 5th edition, 2014, ISBN-9781107034624

Reference Books:

1. Maciver and Page, "Society: An Introduction Analysis ", Laxmi Publications, 4th edition, 2007, ISBN-100333916166
2. PM Bhakshi, "The constitution of India", Universal Law Publishing - An imprint of Lexis Nexis, 14th edition, 2017, ISBN-108131262375

Program: B. Tech. (Mechanical)					Semester: IV	
Course: Emotional Intelligence					Code: BHM9963	
Teaching Scheme					Evaluation Scheme	
Lecture	**Credit**	**Hours**	**IE**	**MTE**	**ETE**	**Total**
1	**-**	**1**	**-**	**-**	**-**	**-**

Detailed Syllabus:

Unit	Description	Duration (H)
1.	Introduction to Emotional Intelligence (EI): What is Emotional Intelligence, Emotional Intelligence and various EI models, The EQ competencies of self-regulation, motivation, empathy and interpersonal skills, Understand EQ and its importance in life.	3
2.	Self-awareness (SA): Seeing the other side, giving in without giving up. Tools : Think, Feel, Act Cards, Plutchik's Wheel of Emotions& Emotional intelligence test Self-Regulation/Managing Emotions: The science of Emotions, Self-emotional quotient	3
3.	Gaining Control: Use of Coping Thoughts and Relaxation Techniques to manage emotions, Activities: Be the Fog, Temperament Analysis. Emotion recognition in others: The universality of emotional expression, perceiving emotions accurately in others to build empathy Activities : Mindful Listening, Perceptual Positions	3
4.	Emotional Intelligence at Work place: Importance of Emotional Intelligence at Work place, role of empathy and trust in relationships, building effective work relationships, conflict resolution strategy, Cohesive team building, Tests : My Colored Hat, "I Am" Circle, Empathy Cards	3
	Total	**12**

Text Books:

1. Daniel Goleman, "Emotional Intelligence – Why It Matters More Than IQ,", Bantam, 10th Anniversary edition, 2005, ISBN: 978-0553383713
2. Steven C. Hayes, Spencer Smith, "Get Out Of Your Mind And Into Your Life: The New Acceptance and Commitment Therapy", Read How You Want, [Large Print] edition, 2009, ISBN-13 : 978-1458717108

Reference Books:

1. Steven Stein, "The EQ Edge", Jossey-Bass, 3rd edition, 2011, ISBN-13: 978-0470681619
2. Drew Bird , "The Leader's Guide to Emotional Intelligence", Createspace Independent Pub, Kindle Edition, 2016, ISBN-13 : 978-1535176002

Program: B. Tech. (All branches)				Semester : IV		
Course: Entrepreneurship Development				Code : BHM9964		
Teaching Scheme				Evaluation Scheme		
Lecture	**Credit**	**Hours**	**IE**	**MTE**	**ETE**	**Total**
1	**---**	**1**	**-**	**-**	**-**	**-**

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Concept and Scope:** Entrepreneurship as a career, Traits of Successful Intrapreneur/ Entrepreneur, Why to become entrepreneur, Entrepreneurship Development Phases, Problem Solving and Ideation Process, Design Validation, Types of Start-ups	**3**
2.	**Creating Entrepreneurial Venture** : Sources of Innovation, methods of generating ideas, Prototype preparation and validation, Legal Issue,Private/Public Limited Company formation requirements, Intellectual Property Protection: Patents Trademarks and Copyrights, **Entrepreneurial Failure** : Case study of patterns, Early failures: Good idea bad planning, False start , False positive, Late-stage failures: Speed trap, Cascading miracle , False confidence	**3**
3.	**Business Plan Preparation:** Sources of product for business: Feasible study, Ownership, capital, budgeting, Marketing plan for the new venture, steps in preparing marketing plan, Business Model Canvas (BMC), Financial plan- proforma income statements, Ratio Analysis.	**3**
4.	**Financial Modelling and Metrics:** Spreadsheets, Benchmarks, Revenue assumptions, expense assumptions, Metrics customer Acquisition cost and life time model, Metrics viral coefficient, Funnel Analysis, **Entrepreneurial Finance:** venture capital, financial institutions supporting entrepreneurs, Lease Financing; Funding opportunities for Start-ups in India, Crowdfunding, Angel investing	**3**
	Total	**12**

Text Books:

1. Kumar Arya, "Entrepreneurship: Creating and Leading an Entrepreneurial Organization", Pearson Education India, First edition, 2012, ISBN-10: 8131765784; ISBN-13: 978-8131765784
2. S.S.Khanka, "Entrepreneurial Development", S Chand and Company Limited, Revised 2012th edition, 2012, ISBN : 81-219-1801-4

Reference Books:

1. Taneja, Gupta, Entrepreneur Development New Venture Creation", Galgotia Publishing Company, 2nd edition. 2017, ISBN: 9788185989594
2. Charantimath, Poornima, "Entrepreneurship Development and Small Business Enterprises" Pearson Education, 3rd edition, 2018, ISBN: 8177582607, 9788177582604
3. Blake Masters and Peter Thiel, "Zero to One", Plata Publishing, 2nd edition, 2014, ISBN-10 : 9780804139298 - ISBN-13 : 978-0804139298

Program: B. Tech. (Mechanical)			Semester: IV			
Course: Research Article Writing			Code: BHM9965			
Teaching Scheme			Evaluation Scheme			
Lecture	**Credit**	**Hours**	**IE**	**MTE**	**ETE**	**Total**
1	**--**	**1**	**-**	**-**	**-**	**-**

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Introduction to Research Writing:** What is a research article? Understanding what is 'Research Writing', Qualities and skills required in a Research writer, Types of Research writing, choosing a suitable journal/conference/book chapter, How to conduct an effective Research, Abstract Writing, Selection of keywords, defining problem statement.	**3**
2.	**Sources of citations**: Understanding of giving citation to other works, Identifying relevant citations, Understanding impact factor, Importance of Indexing and Indexed articles, learning to scan research articles quickly and effortlessly, Using Your Sources Wisely**:** what to cite, where to find good sources and how to use them, avoiding plagiarism **Plagiarism tools**: iThenticate, Grammarly **Citation Tools :**Mendeley, ,BibMe, Citefast, APA, MLA	**3**
3.	**Drafting**: Structure of a basic research paper, stages of writing and research, learn to write the first draft, Understanding the components of an article: Abstract, Introduction, Preliminary concepts, proposed system, Experimental section, result analysis and discussion, Conclusion, Reference.	**3**
4.	**Revising and Editing:** Importance of revision, Understanding the comments of reviewer, Point-to-Point address of reviewer comments, What/Whatnot to revise, Emphasis on Journal formats, Proper usage of Grammar and sentence formatting, Steps for submitting the revised manuscript/article	**3**
	Total	**12**

Text Books:

1. Charles A. MacArthur , "Handbook of Writing Research", The Guilford Press; 2nd edition, 2016, ISBN-10: 1462529313, ISBN-13: 978-1462529315
2. Margaret Cargill, Patrick O'Connor, "Writing Scientific Research Articles", Wiley-Blackwell, 2nd Edition, 2013, ISBN: 978-1-118-57070-8

Reference Books:

1. Booth W., Colomb G. and Williams J., "The Craft of Research", University of Chicago Press,4th edition, 2016, ISBN-13: 978-0226239736
2. Jennifer Peat, Elizabeth Elliott, Louise Baur, Victoria Keena ,"Scientific Writing Easy when you know how", Wiley & Sons, Inc, 2nd edition, 2013, ISBN:9780727916259

Annexure-II

Open Elective-I

Semester-IV

Program: B. Tech. (Mechanical)				Semester : IV			
Course : Numerical Methods				Code : BAS4601			
Teaching Scheme				Evaluation Scheme			
Lecture	**Practical**	**Tutorial**	**Credit**	**IE**	**MTE**	**ETE**	**Total**
3	**-**	**-**	**3**	**20**	**30**	**50**	**100**

Prior Knowledge of:

1. Univariate Calculus
2. Multivariate Calculus is essential.

Course Objectives:

This course aims at enabling students to get acquainted with,

1. Concepts and techniques of Numerical Methods to solve systems of linear equations.
2. Numerical techniques to solve integration, ordinary and partial differential equations, and their applications.
3. Open-source software to perform numerical techniques.

Course Outcomes:

After learning the course, the students will be able to:

1. Apply numerical methods to solve the systems of linear equations.
2. Perform different numerical methods to solve differentiation and integration.
3. Understand basic operators, packages, syntax of software to develop programs for systems of linear equatio differentiation and Integration.
4. Apply single & multistep numerical methods to ordinary differential equations of first order for analyz engineering problems.
5. Apply Explicit and Implicit methods to partial differential equations for analyzing heat, wave and Lapl equations.
6. Develop programs for Numerical Methods using open-source software.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**System of linear equations:** Gauss elimination method by pivoting, Gauss-Jordan method, LU decomposition, Cholesky method, Relaxation method: Jacobi and Gauss-Seidel iterative methods.	6
2.	**Numerical Integration**: Difference formulae for numerical differentiation, Boole's rule, Romberg integration and Gauss quadrature for double & triple integration.	6
3.	**Problem Solving-I:** Solutions of systems of linear equations, Differentiation and Integration using open source software.	6
4.	**Ordinary differential equations:** Euler's method, Modified Euler's method, Runge-Kutta 4^{th} order methods, predictor corrector method.	4
5.	**Partial Differential Equations:** Explicit and Implicit method, Stability of finite difference method, Applications of finite difference analysis in boundary value problems: one dimensional diffusion equation, Wave equation, Laplace equation.	8
6.	**Problem Solving-II:** Solutions of ordinary and partial differential equations using open source software.	**6**
	Total	**36**

Text Books:

1. S.S. Sastry, "Introductory Methods of Numerical Analysis", PHI learning Pvt Ltd, 5^{th} Edition, ISBN 10: 9788120345928
2. B. S. Grewal, "Numerical Methods in Engineering & Science", Khanna Publishers, 43rd Edition, ISBN 13: 9788174092489

Reference Books:

1. S.R.K. Iyengar, Rajendra K. Jain, "Advanced Engineering Mathematics", Alpha Science International, Ltd,4 Edition, ISBN 13: 9781842658468
2. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw-Hill, 34 edition, ISBN 13:9780070634190.
3. Abhishek K Gupta," Numerical Methods using MATLAB", Springer, First Edition, ISBN 13: 9781484201541
4. Victor A. Bloomfield, "Using R for Numerical Analysis in Science and Engineering", CRC Press, First Edition, ISBN: 9781315360492

e-sources:

1. **NPTEL Course lectures links:**
   https://nptel.ac.in/courses/127/106/127106019/ (Methods of root finding)
   https://nptel.ac.in/courses/115/103/115103114/ (NM & Simulation)
   https://nptel.ac.in/courses/122/106/122106033/ (N.M. with programming)

2. **V-lab (IIT-Bombay) link**: http://vlabs.iitb.ac.in/vlabs-dev/labs/numerical_lab/labs/explist.php

Program: B. Tech. (Mechanical)				Semester : IV			
Course : Mathematical Optimization				Code: BAS4602			
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	Internal Evaluation	MTE	ETE	Total
3	-	-	3	20	30	50	100

Prior Knowledge: NIL

Course Objectives: This course aims at enabling students to

1. Develop a practical approach to mathematical problem solving.
2. Get familiar with many commonly used tools and techniques in numerical work.
3. Understand the different mathematical approaches for optimization.

Course Outcomes:

After learning the course, the students will be able to:

1. **Apply** basic theoretical principles for formulation of optimization models and **solve** using graphical method.
2. **Apply** Simplex methods and duality to find optimal solutions for constrained and unconstrained problems.
3. **Understand** basic operators, packages, syntax of software to **develop** programs for Linear Programming Problems.
4. **Apply** optimization techniques to **solve** transportation and assignment problems.
5. **Apply** different optimization models for real time projects of transport problems to analyze networks.
6. **Develop** programs for transportation and assignment problems and Nonlinear Programming problems.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Linear Programming (LP)-I:** Introduction, formulation of Linear Programming problems, Graphical solution method, alternative or multiple optimal solutions, Unbounded solutions, Infeasible solutions, Maximization – Simplex Algorithm,	6
2.	**Linear Programming (LP)-II:** Minimization – Simplex method, Simplex Algorithm using Big-M method, Two phase method, Unrestricted variables, Degeneracy, Types of linear programming solutions, Duality in linear programming, Formulation of Dual Linear programming problems.	6
3.	**Problem Solving-I:** Solutions of LPP using open source software, use of solver in MS-Excel to solve Optimization problem.	6
4.	**Transportation Problems:** Introduction, Mathematical model of transportation problem, transportation algorithm, Methods of finding initial solutions: North-west Corner rule, Least cost method, VOGEL's approximation method, Variations in Transportation problems. **Assignment Problems:** Introduction, Mathematical model of Assignment problem and it's solutions, variations in Assignment problems.	6
5.	**Nonlinear programming:** Unconstrained optimization techniques, Constrained optimization techniques. **Network Analysis:** Network definition and Network diagram, probability in PERT analysis, project time cost trade off, introduction to resource smoothing and allocation.	6
6.	**Problem Solving-II:** Solutions of Assignments and Transportation problems and nonlinear optimization problems using open source software, use of solver in MS-Excel to solve Optimization problem.	6
	Total	**36**

Text Books:

1. Rao S S, Engineering Optimization theory and Practice, Willy Easter Ltd. 4th Edition, ISBN: 978-0-470-18352-6
2. Taha Hamdy, Operation Research: An Introduction, Pearson Education, 9th Edition, ISBN: 0134444019

Reference Books:

1. Sharma S. D. Operation Research, Kadar Nath Ram Nath & Co. Edition, ISBN: 9380803389
2. Matteo Fischetti, "Introduction to mathematical optimization", First Edition, ISBN: 9781692792022
3. Judith L. Gersting, "Mathematical Structures for Computer Science", Freeman Co, 4 Edition, ISBN: 9780716783060
4. Peter V. O'Neil, "Advanced Engineering Mathematics", Thomson Learning ,7 Edition, ISBN 13: 9781337274524
5. Hira and Gupta, "Operation research", S. Chand publication, ISBN (13): 9788121909686.
6. Abhishek K Gupta," Numerical Methods using MATLAB", Springer, First Edition, ISBN 13: 9781484201541
7. Victor A. Bloomfield, "Using R for Numerical Analysis in Science and Engineering", CRC Press, First Edition, ISBN: 9781315360492

e-sources:

1. **NPTEL Course lectures links:**
   https://nptel.ac.in/courses/111/102/111102012/ (LPP)
   https://nptel.ac.in/courses/110/106/110106059/ (Transportation & Assignments Problems)

Program: B. Tech. (Mechanical)				Semester : IV			
Course : Calculus of Variation				Code : BAS4603			
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	Internal Evaluation	MTE	ETE	Total
3	-	-	3	20	30	50	100

Prior knowledge of

1. Linear Algebra & Univariate Calculus
2. Multivariate Calculus is essential.

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of mathematical principles related to:

1. Formulation of variational problems and analysis of key properties of system behavior.
2. Construction of variational problem for multivariate functional and it's solution
3. Application of mathematical methods of calculus of variation to construct finite element structure for several engineering problems

Course Outcomes:

After learning the course, the students should be able to:

1. Construct variational problems to optimize constrained and unconstrained functional.
2. Apply Euler-Lagrange's equation to determine stationary paths of a multivariable functional.
3. Understand basic operators, packages, syntax of software to develop programs for optimization of functional.
4. Apply theory & techniques of calculus of variation to solve boundary value problems.
5. Analyze given problem to construct finite element structure and apply theory of calculus of variation to solve it
6. **Develop** programs for approximate and FEM models using open source software.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**The foundations of calculus of variations** Introduction, The Euler-Lagrange differential equation, Minimal path problems, opens boundary variational problems. **Constrained variational problems.** Algebraic boundary conditions, Lagrange's solution, Isoperimetric problems, Closed-loop integrals,	6
2.	**Multivariate functional** Variational problems in parametric form, Functional with two independent variables, Minimal surfaces, Functional with three independent variables (only conversion). **Higher order derivatives** The Euler-Poisson equation, The Euler-Poisson system of equations, Algebraic constraints on the derivative.	6
3.	**Problem Solving-I:** Solutions of constrained and unconstrained variational problems using open source software.	6
4.	**Approximate methods** Euler's method, Rayleigh-Ritz method, Galerkin's method	6
5.	**Finite Element Methods** Boundary integral method, Finite element method, Case Studies.	6
6.	**Problem Solving-II:** Solutions of Approximate and FEM models using open source software.	6
	Total	**36**

Text Books:

1. Mark Kot, "A First Course in the Calculus of Variations", AMS, ISBN: **978-1-4704-1495-5**
2. A.S. Gupta , "Calculus of Variation with applications" , PHI Learning PVT LTD, ISBN: 978-8120311206

Reference Books:

1. L.Elsgolts, "Differential equations and calculus of variations", MIR Publications, ISBN 13: 978-1410210678
2. B. S. Grewal , "Higher Engineering Mathematics", Khanna Publication, 42 Edition, ISBN 13: .9788174091955
3. Krishnamoorthy C. S., "Finite element analysis: theory and programming", Mcgraw hill education (india) pvt. Ltd., 2 Edition, ISBN 13: 9780074622100
4. Moaveni, Saeed, "Finite element analysis : theory and application with ansys" Pearson education pvt.. ltd, 2 Edition, ISBN: 0137850980

e-sources:

1. **NPTEL Course lectures links:**
   https://nptel.ac.in/courses/111/104/111104025/ (Functional)
   https://nptel.ac.in/courses/112/104/112104193/ (FEM)

Program: B. Tech. (Mechanical)				Semester : IV			
Course: Mathematical Modeling and Simulation				Code: BAS4604			
Teaching Scheme				Evaluation Scheme			
Lecture	**Practical**	**Tutorial**	**Credit**	**Internal Evaluation**	**MTE**	**ETE**	**Total**
3	**-**	**-**	**3**	**20**	**30**	**50**	**100**

Prior knowledge of

1. Linear Algebra & Univariate Calculus
2. Multivariate Calculus
3. Higher order of differential equations.

is essential.

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of mathematical principles related to:

1. Mathematical Modeling and its uses in different engineering disciplines.
2. Mathematical techniques that can be used to build a proper mathematical model for a given engineering problem.
3. Simulation of mathematical models using open source software.

Course Outcomes:

After learning the course, the students will be able to:

1. Identify the types of mathematical modeling according to the real life problem.
2. Build a simple mathematical model.
3. Understand basic operators, packages, syntax of software to develop programs for analytical solutions of ordinary and partial differential equations.
4. Apply Explicit and Implicit methods to partial differential equations for analyzing heat, wave and Laplace equations.
5. Predict the performance of the mathematical model.
6. Develop programs for Numerical Solutions of ordinary and partial differential equations using open-source software.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Basics of Mathematical Modeling:**: Introduction, open and closed systems, advantages and limitations, properties, needs and techniques used, discussion on non-uniqueness of models. Classification of mathematical models: Classical and Continuous models, Deterministic, Probabilistic and Stochastic models, Areas of applications.	6
2.	**Procedure and Techniques of Mathematical Modeling:** Procedure: Introduction, Identification of parameters, significant parameters, reduction of an open problem to a closed form, Techniques: Analytical Methods, Numerical Methods, Computer simulation, physical interpretation, case studies.	6
3.	**Problem Solving-I:** Analytical Solutions of ordinary and partial differential equations using open source software.	6
4.	**Numerical Methods:** Explicit and Implicit finite difference scheme, Stability of finite difference method, Applications of finite difference analysis in boundary value problems: one dimensional diffusion equation, Wave equation, Laplace equation.	6
5.	**Prediction of Performance:** Steps involved in a computer model, predict performance of an experimental system, Numerical Simulation and its Validation, Multiscale modeling, Sensitivity analysis.	6
6.	**Problem Solving-II:** Numerical Solutions of ordinary and partial differential equations using open source software.	6
	Total	**36**

Text Books:

1. Frank Severance, System Modeling and Simulation: An Introduction", John Wiley & Sons limited,2001, ISBN:978-8126519606
2. S.S. Sastry, "Introductory Methods of Numerical Analysis", PHI learning Pvt Ltd, 5th Edition, ISBN 10: 9788120345928
3. Erwin Kreyszig, "Advanced Engineering Mathematics" Wiley Eastern Ltd.,10 Edition, ISBN 13: 9780470458365

Reference Books:

1. Averill Law, "Simulation modeling and analysis" ,Mc-graw Hill Publication, 5 Edition, ISBN: 9780073294414
2. Abhishek K "Gupta, Numerical Methods using MATLAB", Springer, First Edition, ISBN 13: 9781484201541
3. John A Sokolowski and Catherine M Banks ,"Principles of Modeling and Simulation", John Wiley, First Edition, ISBN:9780470289433

e-sources:

1. **NPTEL Course lectures links:**
   https://nptel.ac.in/courses/111/107/111107113/ (Mathematical Modelling)
   https://nptel.ac.in/courses/115/103/115103114/ (NM & Simulation)
   https://nptel.ac.in/courses/122/106/122106033/ (N.M. with programming)

2. **V-lab (IIT-Bombay) link**: http://vlabs.iitb.ac.in/vlabs-dev/labs/numerical_lab/labs/explist.php

Program: B. Tech. (Mechanical)					Semester: III		
Course: Financial Mathematics					Code: BAS4605		
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	IE	MTE	ETE	Total
3	-		3	20	30	50	100

Prior knowledge of:

1. Basic Mathematics
2. Probability is essential.

Course Objectives:

The course aims at:

1. Address issues related to globalization of financial markets,
2. Development and Feasibility of financial transactions,
3. Provide the students with knowledge of a range of mathematical and computational techniques that are required for a wide range of quantitative positions in the financial sector
4. Forecasting market developments.

Course Outcomes:

After learning the course, the students will be able to:

1. **Demonstrate** knowledge of the fundamental concepts of financial mathematics
2. **Identify** various types of cash flow patterns, Compute the future value and the present value of different cash flow streams.
3. **Understand** types of Options and **apply** it to hedge against risks in existing investments.
4. Understand the characteristics of different financial assets such as money market instruments, bonds, and stocks, and how to buy and sell these assets in financial markets.
5. **Describe** and to analyze the investment environment, different types of investment vehicles;
6. **Analyze** the degree of risk for its effective management

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Fundamentals of Financial Mathematics I:** Introduction of Financial Mathematics and its application in real life, Sources of Finance; Short term finance and Long term Funds (basics), Rate of interest, simple interest, compound interest.	6
2.	**Fundamentals of Financial Mathematics II:** The time value of money, annuities and cash flows, loans, general cash flows and portfolios, derivatives, swaps, and hedging.	6
3.	**Basics of Options :**Options; (call option and put options), payoffs call and put options, speculation (call or put) and its application (option).	6
4.	**Stocks and bonds:** Stocks and bonds, Valuation of stocks and bonds, Mutual funds, Cost of capital and ratio analysis.	6
5.	**Basics of Investment:** Investment return. Uneven cash flows Compounding frequency of interest, Economic equivalence. Portfolio diversification	6
6.	**Risk & uncertainty:** Decision under risk & uncertainty, Risk premium, Portfolio diversification, Life Insurance, Endowment	6
	Total	**36**

Text Books:

1. Marek Capinski and Tomasz Zastawniak, “Mathematics for Finance”, Springer 2nd Edition, ISBN 13:978-0857290816.
2. Ambad Nazri Wahidudin, “Financial Mathematics and its Applications”, Ventus Publishing ApS, ISBN 978-8776819286

Reference Book:

3. Giuseppe Campolieti Roma M. Makarov “Financial mathematics a Comprehensive treatment”, CRC Press Taylor and francis Group, 1st Edition, ISBN 978-1439892428

e-sources:

1. **NPTEL Course lectures links:**
   https://nptel.ac.in/courses/112/107/112107260/

Program: B. Tech. (Mechanical)							Semester: IV
Course: Neural Network and Fuzzy Logic Control							Code: BAS4606
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	Internal Evaluation	MTE	ETE	Total
3	-	-	3	20	30	50	100

Prior Knowledge: Nil

Course Objectives:

This course aims at enabling students to get acquainted with,

1. Knowledge of Neural Networks and Fuzzy Logic Control and their use for controlling real time systems.
2. Knowledge about fuzzy set theory to solve various engineering problems.

Course Outcomes:

After learning the course, the students will be able to:

1. Model a Neuron and Express Neural Network.
2. Apply feedback networks to study Inverted Pendulum, Articulation Control.
3. Implement an artificial neural network using the NN simulation toolbox.
4. Apply concepts of fuzzy logics in Fuzzification and Defuzzification.
5. Appl fuzzy logic control in Pattern recognition and Home Heating system.
6. Implement Fuzzy Logic Toolbox in fuzzy logic control.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Architecture of Neural Network:** Introduction, Biological neuron, Artificial neuron, Neuron modeling, Basic learning rules, Single layer, Multi layer feed forward network, Back propagation, Learning factors.	6
2.	**Neural Networks For Control:** Feedback networks, Discrete time hop field networks, Schemes of neuro-control, Identification and control of dynamical systems, Case studies-Inverted Pendulum, Articulation Control.	6
3.	**Problem Solving-I:** Neural Network (NN) Toolbox, NN Simulink Demos, Neural Network (ANN) implementation, NN Tool Artificial Neural Network (ANN) implementation, Application of NN to Control System.	6
4.	**Fundamental of Fuzzy Logic:** Classical sets, Fuzzy Sets, Membership function, Cardinality of fuzzy set, Fuzzy complement, Fuzzy union & intersection, Fuzzy Relation, Fuzzification, Defuzzification, Fuzzy Rule.	6
5.	**Fuzzy Logic Control:** Introduction, Knowledge based system, Decision making Logic, Fuzzy optimization, Adaptive fuzzy systems, Introduction to generate a genetic algorithm, Applications to Pattern recognition, Home Heating system.	6
6.	**Problem Solving-II:** Fuzzy Logic Toolbox, Fuzzy Logic Simulink Demos, Fuzzy Logic Controller (FLC) implementation, Simulink Fuzzy Logic Controller (FLC) implementation, Applications of FLC to Control System.	**6**
	Total	**36**

Text Books:

1. Kosko, B, "Neural Networks and Fuzzy Systems: A Dynamical Approach to Machine Intelligence", PrenticeHall, NewDelhi, 2004.
2. Ross T. J. , "Fuzzy logic with engineering applications (Vol. 2)", New York: Wiley, 2004, ISBN: 9783030375478

Reference Books:

1. Jack M. Zurada, "Introduction to Artificial Neural Systems", PWS Publishing Co., Boston, 2002.
2. Zimmerman H.J., "Fuzzy set theory and its Applications", Kluwer Academic Publishers Dordrecht, 2001.
3. Driankov,Hellendroonb, "Introduction to fuzzy control", Narosa Publishers,2001.
4. G Klir, B Yuan, "Fuzzy sets and fuzzy logic : Theory and application", PHI, ISBN:
5. LauranceFausett, Englewood cliffs, N.J., "Fundamentals of Neural Networks", PearsonEducation, New Delhi, 2008.

E-source:

Online course "Fuzzy logic and Neural Network" by Prof. Dilip Kumar Pratihar, IIT Kharagpur.

https://nptel.ac.in/courses/127/105/127105006/

VISION AND MISSION OF MECHANICAL DEPARTMENT

Vision

- To recognize for an academic excellence through skill development, innovation fine blend with quality work culture

Mission

- To impart quality education, innovation culture, necessary skill sets and social commitment among the students to build professional carrier by establishing state-of-the-art Mechanical Engineering infrastructure and conducive learning environment

Program Outcomes

PO	PO Statements: Engineering Graduates will be able to:
1.	**Engineering knowledge**: **Apply the knowledge** of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
2.	**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
3.	**Design/development of solutions: Design solutions for complex engineering problem**s 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.
4.	**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.
5.	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and **modern engineering and IT tools** including prediction and modeling to complex engineering activities with an understanding of the limitations.
6.	**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.
7.	**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
8.	**Ethics**: Apply ethical principles and commit to **professional ethics and responsibilities** and norms of the engineering practice.
9.	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10.	**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.
11.	**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

12.	**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

Programme Specific Outcomes:
Mechanical Engineering graduates will be able to-

PSO 1	Conceptualize, design, model, simulate and analyze mechanical components, systems and processes by applying the principles of thermal engineering, machine design, manufacturing and automation.
PSO 2	Derive solutions to real life mechanical engineering problems in automobile industries and research organizations.
PSO 3	Apply industrial engineering and management principles and consider public health safety and environmental factors, cultural, societal, and to work professionally in the industry or as an entrepreneur.