SCHEME & SYLLABUS

(Choice Based Credit System)

for

B. TECH.

in

MECHANICAL ENGINEERING

(w.e.f. Session 2021-22)

Program Code: ME-301

DEPARTMENT OF MECHANICAL ENGINEERING

SCHOOL OF ENGINEERING

RIMT UNIVERSITY, MANDI GOBINDGARH, PUNJAB

TABLE OF CONTENTS

SECTION 1

Vision & Mission of the University

VISION

To become one of the most preferred learning places a centre of excellence to promote and nurture future leaders who would facilitate in desired change in the society

MISSION

M1: To impart teaching and learning through cutting edge technologies supported by the world class infrastructure

M2: To empower and transform young minds into capable leaders and responsible citizens of India instilled with high ethical and moral values

SECTION 2

Vision and Mission of the Department

VISION

To contribute to the society through excellence in scientific and technical education and research. To contribute the country by providing globally competent Mechanical Engineers capable of working in an inter-disciplinary environment which foster spirits of innovation, entrepreneurship and leadership. To support industry for growth, being the valuable resource for them, and remain a role model for others in the field of Mechanical Engineering.

MISSION

M1: To provide a high-quality educational experience for undergraduate and graduate students that enables them to become leaders in their chosen professions and to make them globally competitive mechanical engineers.

M2: To create, explore, and develop innovations in engineering and science through undergraduate and graduate research. To develop linkages with world class R&D organizations and educational institutions in India and abroad for excellence in teaching, research and consultancy practices.

SECTION 3

About the Program

Mechanical Engineering Department was established in 2003 with the inception of the institute to produce high quality engineers in the field of Mechanical Engineering. The programme involves application of principles of physics for analysis, design, manufacturing, and maintenance of mechanical systems. It requires a solid understanding of key concepts including Mechanics, Kinematics, Thermodynamics and Energy. Mechanical engineers use these principles and others in the design and analysis of automobiles, aircraft, heating and cooling systems, manufacturing plants, industrial equipment and machinery, medical devices and more.

SECTION 4

Program Educational Objectives (PEOs), Program Outcomes (POs) and Program Specific Outcomes (PSOs)

PROGRAMME EDUCATION OBJECTIVES (PEOs)

PEO1	To prepare learners with a solid foundation in mathematics, sciences, and technical skills needed to analyze and design in engineering problems.
PEO2	To be able to explore areas of research, application & innovation and make impact in different types of institutional settings such as corporate entities, government bodies, NGOs, inter-government organizations, & start-ups.
PEO3	To prepare learners to apply knowledge, strong reasoning, and quantitative skills to design and implement creative and sustainable solutions.
PEO4	To prepare learners to effectively use modern equipment's & programming tools to solve real life problems that are technically sound, economically feasible and socially acceptable.
PEO5	To prepare learners for successful professional career, to excel in higher studies and or to become entrepreneur.
PEO6	To be able to continuously learn and update one's knowledge, engage in lifelong learning habits and acquire latest knowledge to perform in current work settings.
PEO7	To prepare learners to become responsible citizens by serving the community locally, nationally, and internationally.

PROGRAMME OUTCOMES (POs)

PO 1	Apply the knowledge of mathematics, science, engineering fundamentals, and mechanical engineering to the solution of complex engineering problems.
PO 2	Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO 3	Design solutions for complex mechanical engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	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.
PO 5	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex mechanical engineering activities with an understanding of the limitations.
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.
PO 7	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	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.

PO 11	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.
PO 12	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 (PSOs)

PSO 1	Apply mechanical engineering and interdisciplinary knowledge for analyzing, designing and manufacturing products to address the needs of the society.
PSO 2	Apply state of the art tools and techniques to conceptualize, design and introduce new products, processes, systems and services.

SECTION 5

Curriculum / Scheme with Examination Grading Scheme

SEMESTER WISE SUMMARY OF THE PROGRAMME: B.TECH. (MECHANICAL ENGINEERING)

S. No.	Semester	No. of Contact Hours	Marks	Credits
1.	I	31	900	25
2.	II	29	800	23
3	III	29	900	16
4	IV	25	800	22
5	V	31	1200	27
6	VI	27	900	16
7	VII	27	900	15
8	VIII	00	800	16
	Total	**172**	**7200**	**160**

EXAMINATION GRADING SCHEME

Marks Percentage Range	Grade	Grade Point	Qualitative Meaning
80-100	O	10	Outstanding
70-79	A^+	9	Excellent
60-69	A	8	Very Good

55-59	B^+	7	Good
50-54	B	6	Above Average
45-49	C	5	Average
40-44	P	4	Fail
0-39	F	0	Fail
ABSENT	AB	0	Fail

Percentage Calculation: CGPA *10

Program Name: B. Tech. Mechanical Engineering
Program Code: ME-301

FIRST SEMESTER

Course		Contact Hours/Week			Credit	Contact Hrs.	Evaluation Scheme (% of Total Marks)			Exam Duration (Hours)
Course Code	Course Title	L	T	P			Internal	External	Total	
BTPH 1101	Applied Physics	3	1	0	4	4	40	60	100	3 Hrs
BTMA 1101	Applied Mathematics-I	4	1	0	5	5	40	60	100	3 Hrs
BTHU 1101	Communicative English	3	0	0	3	3	40	60	100	3 Hrs
BEEE 1101	Basics of Electrical & Electronics Engg.	4	0	0	4	4	40	60	100	3 Hrs
BTES 1101	Environmental Science	2	0	0	2	2	40	60	100	3 Hrs
BTPH 1102	Applied Physics Lab	0	0	2	1	2	60	40	100	3 Hrs
BTHU 1102	Communicative English Lab	0	0	2	1	2	60	40	100	3Hrs
BEEE 1102	Basics of Electrical & Electronics Engg. Lab	0	0	2	1	2	60	40	100	3Hrs
BTMP 1101	Manufacturing Practice	1	0	6	4	7	40	60	100	3 Hrs
Total		**17**	**2**	**12**	**25**	**31**			**900**	**27 Hrs**

Program Name: B. Tech. Mechanical Engineering
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SECOND SEMESTER

Subject		Contact Hours/Week			Credit	ContactHrs.	Evaluation Scheme (% of Total Marks)			Exam Duration (Hours)
Code	Title	L	T	P			Internal	External	Total	
BTCH-1101	Applied Chemistry	3	1	0	4	4	40	60	100	3 Hrs
BTMA-1201	Applied Mathematics-II	4	1	0	5	5	40	60	100	3 Hrs
BTCS-1103	Programming for Problem Solving	3	0	0	3	3	40	60	100	3 Hrs
BTME-1101	Elements of Mechanical Engg.	3	1	0	4	4	40	60	100	3 Hrs
BTME-1102	Engineering Drawing	1	0	6	4	7	40	60	100	3 Hrs
BTCH-1102	Applied Chemistry Lab	0	0	2	1	2	60	40	100	3 Hrs
BTCS-1104	Programming for Problem Solving Lab	0	0	2	1	2	60	40	100	3 Hrs
BTPD-1101	Professional Communication in Practice	0	0	2	1	2	60	40	100	3 Hrs
Total		**14**	**3**	**12**	**23**	**29**			**800**	**24 Hrs**

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THIRD SEMESTER

Subject		Contact Hours/Week			Credit	ContactHrs.	Evaluation Scheme (% of Total Marks)			Exam Duration (Hours)
Code	Title	L	T	P			Internal	External	Total	
BTME-2301	Strength of Materials - I	3	1	-	4	4	40	60	100	3 Hrs
BTME-2302	Theory of Machines - I	3	1	-	4	4	40	60	100	3 Hrs
BTME-2303	Machine Drawing with AutoCAD	1	-	6	4	7	40	60	100	3 Hrs
BTME-2304	Applied Thermodynamics - I	3	1	-	4	4	40	60	100	3 Hrs
BTME -2305	Manufacturing Processes-I	3	-	-	3	3	40	60	100	3 Hrs
BTME-2307	Strength of Materials Lab.	-	-	2	1	2	60	40	100	3 Hrs
BTME-2308	Applied Thermodynamics Lab	-	-	2	1	2	60	40	100	3 Hrs
BTME-2310	Institutional Training	-	-	-	2	-	60	40	100	3 Hrs
Elective Courses (Any one)										
BTME-2306	Engineering Materials & Metallurgy	3	-	-	3	3	40	60	100	3 Hrs
BTME -2311	Non-Conventional Energy Resources	3	-	-	3	3	40	60	100	3 Hrs
BTME -2313	Digital Electronics	3	-	-	3	3	40	60	100	3 Hrs
BTME -2314	Object Oriented Programming using C++	3	-	-	3	3	40	60	100	3 Hrs
BTME -2315	Effective Writing Skills	3	-	-	3	3	40	60	100	3 Hrs
BTME -2316 Engine	Internal Combustion Engine	3	-	-	3	3	40	60	100	3 Hrs

Total	**16**	**3**	**-**	**26**	**29**			**900**	**27 Hrs**

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FOURTH SEMESTER

Subject		Contact Hours/Week			Credit	Contact Hrs.	Evaluation Scheme (% of Total Marks)			Exam Duration (Hours)
Code	Title	L	T	P			Internal	External	Total	
BTME-2401	Strength of Materials - II	3	1	-	4	4	40	60	100	3 Hrs
BTME-2402	Theory of Machines- II	3	1	-	4	4	40	60	100	3 Hrs
BTME-2403	Fluid Mechanics	3	1	-	4	4	40	60	100	3 Hrs
BTME-2404	Applied Thermodynamics -II	3	1	-	4	4	40	60	100	3 Hrs
BTME-2405	Manufacturing Processes - II	3	-	-	3	3	40	60	100	3 Hrs
BTME-2406	Theory of Machines Lab.	-	-	2	1	2	60	40	100	3 Hrs
BTME-2407	Fluid Mechanics Lab.	-	-	2	1	2	60	40	100	3 Hrs
BTME-2408	Manufacturing Practice Lab.	-	-	2	1	2	60	40	100	3 Hrs
Total		**15**	**4**	**6**	**22**	**25**			**800**	**24 Hrs**

Program Name: B. Tech. Mechanical Engineering
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FIFTH SEMESTER

Subject		Contact Hours/Week			Credit	ContactHrs.	Evaluation Scheme(% of Total Marks)			Exam Duration (Hours)
Code	Title	L	T	P			Internal	External	Total	
BTME-3500	Mathematics - III	3	1	-	4	4	40	60	100	3 Hrs
BTME-3501	Design of Machine Elements – I	4	1	-	5	5	40	60	100	3 Hrs
BTME-3502	Computer Aided Design & Manufacturing	3	-	-	3	3	40	60	100	3 Hrs
BTME-3503	Mechanical Measurements & Metrology	3	-	-	3	3	40	60	100	3 Hrs
BTME-3504	Automobile Engineering	3	-	-	3	3	40	60	100	3 Hrs
BTME-3505	Industrial Automation & Robotics	3	-	-	3	3	40	60	100	3 Hrs
BTME-3506	Computer Aided Design and Manufacturing Lab.	-	-	2	1	2	60	40	100	3 Hrs
BTME-3507	Mechanical Measurements and Metrology Lab.	-	-	2	1	2	60	40	100	3 Hrs
BTME-3508	Automobile Engineering Lab.	-	-	2	1	2	60	40	100	3 Hrs
BTME-3509	Industrial Automation & Robotics Lab.	-	-	2	1	2	60	40	100	3 Hrs
BTPD-3521	Personality Development-I	-	-	2	-	2	60	40	100	3 Hrs
BTME-3510	Industrial Training (at the end of 4th sem.)	-	-		2	-	60	40	100	3 Hrs
Total		**19**	**2**	**10**	**27**	**31**			**1200**	**36 Hrs**

Program Name: B. Tech. Mechanical Engineering
Program Code: ME-301

SIXTH SEMESTER

Subject		Contact Hours/Week			Credit	Contact Hrs.	Evaluation Scheme (% of Total Marks)			Exam Duration (Hours)
Code	Title	L	T	P			Internal	External	Total	
BTME-3601	Design of Machine Elements - II	4	1	-	5	5	40	60	100	3 Hrs
BTME-3602	Heat Transfer	3	1	-	4	4	40	60	100	3 Hrs
BTME-3603	Fluid Machinery	3	1	-	4	4	40	60	100	3 Hrs
BTME-3604	Heat Transfer Lab.	-	-	2	1	2	60	40	100	3 Hrs
BTME-3605	Fluid Machinery Lab.	-	-	2	1	2	60	40	100	3 Hrs
BTPD-3621	Personality Development - II	-	-	2	-	2	60	40	100	3 Hrs
BTME-3606	Minor Project	-	-	2	1	2	60	40	100	3 Hrs
Open Elective Courses (Any one)										
BTME-3600	Statistical & Numerical Methods in Engineering	3	-	-	3	3	40	60	100	3 Hrs
BTME-3600	Enterprise Resource Planning	3	-	-	3	3	40	60	100	3 Hrs
BTME-3600	Electrical Measuring Instrument	3	-	-	3	3	40	60	100	3 Hrs
BTME-3600	Wireless and Mobile Communication	3	-	-	3	3	40	60	100	3 Hrs
Department Elective Courses (Any one)										
BTME-3611	Automotive Chassis System	3	-	-	3	3	40	60	100	3 Hrs

BTME-3612	Non Destructive Testing	3	-	-	3	3	40	60	100	3 Hrs
BTME-3613	Product Design and Development	3	-	-	3	3	40	60	100	3 Hrs
BTME-3614	Mechatronics	3	-	-	3	3	40	60	100	3 Hrs
BTME-3615	Tool Design	3	-	-	3	3	40	60	100	3 Hrs
Total		**16**	**3**	**8**	**22**	**27**			**900**	**27 Hrs**

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SEVENTH SEMESTER

Subject		Contact Hours/Week			Credit	Contact Hrs.	Evaluation Scheme (% of Total Marks)			Exam Duration (Hours)
Code	Title	L	T	P			Internal	External	Total	
BTME-4701	Industrial Engineering	3	-	-	3	3	40	60	100	3 Hrs
BTME-4702	Refrigeration & Air Conditioning	3	1	-	4	4	40	60	100	3 Hrs
BTME-4703	Mechanical Vibrations	3	1	-	4	4	40	60	100	3 Hrs
BTMC-4701	Constitution of India	3	-	-	3	-	40	60	100	3 Hrs
BTME-4704	Refrigeration & Air Conditioning Lab.	-	-	2	1	2	60	40	100	3 Hrs
BTME-4705	Mechanical Vibrations Lab.	-	-	2	1	2	60	40	100	3 Hrs
BTME-4706	Major Project	-	-	6	3	6	60	40	100	3 Hrs
Department Elective Courses (Any one)										
BTME-4711	Automotive Control	3	-	-	3	3	40	60	100	3 Hrs
BTME-4712	Non Traditional Machining	3	-	-	3	3	40	60	100	3 Hrs
BTME-4713	Industrial Tribology	3	-	-	3	3	40	60	100	3 Hrs
BTME-4714	Finite Element Methods	3	-	-	3	3	40	60	100	3 Hrs
BTME-4715	Statistical Quality Control	3	-	-	3	3	40	60	100	3 Hrs
BTME-4716	Human Resource Management	3	-	-	3	3	40	60	100	3 Hrs
BTME-4717	Automotive Aerodynamics	3	-	-	3	3	40	60	100	3 Hrs
BTME-4718	Electric & Hybrid Vehicles	3	-	-	3	3	40	60	100	3 Hrs
BTME-4719	Additive Manufacturing	3	-	-	3	3	40	60	100	3 Hrs
BTME-4721	Total Quality Management	3	-	-	3	3	40	60	100	3 Hrs
BTME-4721	Operation Research	3	-	-	3	3	40	60	100	3 Hrs

BTME-4722	Material Management	3	-	-	3	3	40	60	100	3 Hrs
BTME-4723	Solar Energy	3	-	-	3	3	40	60	100	3 Hrs
BTME-4724	Optimization Techniques	3	-	-	3	3	40	60	100	3 Hrs
Total		**15**	**2**	**10**	**22**	**27**			**800**	**24Hrs**

Program Name: B. Tech. Mechanical Engineering
Program Code: ME-301

EIGHT SEMESTER

Subject		Contact Hours/Week			Credit	ContactHrs.	Evaluation Scheme (% of Total Marks)			Exam Duration (Hours)
Code	Title	L	T	P			Internal	External	Total	
Core Courses										
BTME-4801	Software Training	-	-	-	6	-	100	200	300	3 Hrs
BTME-4802	Industrial Training				10		200	300	500	3 Hrs
Total		**-**	**-**	**-**	**16**	**-**		**500**	**800**	**6 Hrs**

SECTION 6

Detailed Syllabus with Course Outcomes

SYLLABUS

SEMESTER-III

SUBJECT TITLE: STRENGTH OF MATERIALS – I
SUBJECT CODE: BTME-2301
SEMESTER: 3
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks.

Contents of Syllabus

S. No.	Content	Contact Hrs
1	**Unit –I** **Simple, Compound Stresses and Strains**: Stress and Strain and their types, Hook's law, longitudinal and lateral strain, Poisson's ratio, stress-strain diagram for ductile and brittle materials, extension of a bar due to without and with self weight, bar of uniform strength, stress in a bar, elastic constants and their significance, relation between elastic constants, Young's modulus of elasticity, modulus of rigidity and bulk modulus. Temperature stress and strain calculation due to axial load and variation of temperature in single and compound bars. Two dimensional stress system, stress at a point on a plane, principal stresses and principal planes, Mohr's circle of stress ellipse of stress and their applications. Generalized Hook's law, principal stresses related to principal strains.	**12 Hrs**
2	**Unit –II** **Bending Moment (B.M) and Shear Force (S.F) Diagrams**: S.F and B.M definitions; relation between load, shear force and bending moment; B.M and S.F diagrams for cantilevers, simply supported beams with or without overhangs, and calculation of maximum B.M and S.F and the point of contra flexure under the following loads: a) Concentrated loads b) Uniformity distributed loads over the whole span or part of span c) Combination of concentrated and uniformly distributed load d) Uniformly varying loads Application of moments **Unit –III**	**18 Hrs**

	Bending Stresses In Beams: Assumptions in the simple bending theory; derivation of formula and its application to beams of rectangular, circular and channel, I and T- sections. Combined direct and bending stresses in afore-mentioned sections, composite / flitched beams.	
3	**Unit –IV** **Torsion:** Derivation of torsion equation and its assumptions and its application to the hollow and solid circular shafts. Torsional rigidity, combined torsion and bending of circular shafts; principal stress and maximum shear stresses under combined loading of bending and torsion.	**10 Hrs**
4	**Unit –V** **Columns and struts**: Introduction, failure of columns, Euler's formula, Rankine-Gordon's formula, Johnson's empirical formula for axially loaded columns and their applications. **Unit –VI** **Slope and deflection**: Relationship between moment, slope and deflection; method of integration, Macaulay's method, moment area method and use of these methods to calculate slope and deflection for the following: a) Cantilevers b) Simply supported beams with or without overhang c) Under concentrated loads, uniformly distributed loads or combination of concentrated &uniformly distributed loads.	**10 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2301.1	Able to understand the theory of elasticity including strain/displacement and Hooke's law relationships
CO2	BTME-2301.2	Determine the resistance and deformation in machine members subjected to axial, flexural and tensional loads
CO3	BTME-2301.3	Able to analyze the stresses and deflections of beams under various loading conditions
C04	BTME-2301.4	Able to obtain solutions to column buckling and plate problems

Suggested Readings / Books:

1. D.S. Bedi, ***Strength of Materials,*** Khanna Book Publishing Company,1998, Reprint-2016
2. E.P. Popov, ***Mechanics of Materials-(SI Version),*** Prentice Hall India.,2006
3. R.S Lehri and A.S. Lehri***, Strength of Materials,*** Kataria and Sons.,1998
4. S.S.Rattan, ***Strength of Materials,*** Tata McGraw Hill.,1996
5. Timoshenko and Young, ***Elements of Strength of Materials,*** East West Press (EWP), 2014.
6. James M Gere and Barry J. Goodno, ***Strength of Materials,*** Cengage Learning.,2006

SUBJECT TITLE: THEORY OF MACHINES-I
SUBJECT CODE: BTME-2302
SEMESTER: 3
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks.

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	**Unit –I** **Basic Concept of machines:** Link, Mechanism, Kinematic Pair and Kinematic Chain, Principles of Inversion, Inversion of a Four Bar Chain, Slider-Crank-Chain and Double Slider-Crank-Chain. Graphical and Analytical methods for finding: Displacement, Velocity, and Acceleration of mechanisms (including Corliolis Components). **Unit –II** **Lower and higher Pairs:** Universal Joint, Calculation of maximum Torque, Steering Mechanisms including Ackerman and Davis approximate steering mechanism, Engine Indicator, Pentograph, Straight Line Mechanisms, Introduction to Higher Pairs With Examples	**18 Hrs**
2	**Unit –III** **Belts, Ropes and Chains:** Material & Types of belt, Flat and V-belts, Rope & Chain Drives, Idle Pulley, Intermediate or Counter Shaft Pulley, Angle and Right Angle Drive, Quarter Turn Drive, Velocity Ratio, Crowning of Pulley, Loose and fast pulley, stepped or cone pulleys, ratio of tension on tight and slack side of belts, Length of belt, Power transmitted by belts including consideration of Creep and Slip, Centrifugal Tensions and its effect on power transmission	**6 Hrs**

3	**Unit –IV** **Cams:** Types of cams and follower, definitions of terms connected with cams. Displacement, velocity and acceleration diagrams for cam followers. Analytical and Graphical design of cam profiles with various motions (SHM, uniform velocity, uniform acceleration and retardation, cycloidal Motion). Analysis of follower motion for circular, convex and tangent cam profiles. **Unit –V** **Friction Devices**: Concepts of friction and wear related to bearing and clutches. Types of brakes function of brakes. Braking of front and rear tyres of a vehicle. Determination of braking capacity, Types of dynamometers, (absorption, and transmission).	**16 Hrs**
4	**Unit –VI** **Flywheels:** Turning moment and crank effort diagrams for reciprocating machines' Fluctuations of speed, coefficient of fluctuation of speed and energy, Determination of mass and dimensions of flywheel used for engines and punching machines. **Unit –VII** **Governors:** Function, types and characteristics of governors. Watt, Porter and Proell governors. Hartnell and Willson-Hartnell spring loaded governors. Numerical problems related to these governors. Sensitivity, stability, isochronisms and hunting of governors. Governor effort and power, controlling force curve, effect of sleeve friction.	**10 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2302.1	Students will be able to analyze planer mechanisms terms of DoF, Gross Motion, Velocity and Acceleration of Points on Link / Links, Forces acting on links and joints
CO2	BTME-2302.2	Synthesize simple mechanisms
CO3	BTME-2302.3	Analyze and synthesis cams, clutches, and flywheel
C04	BTME-2302.4	Analyze and determine key kinematic parameters for friction mechanisms

Suggested Readings / Books:

1. S. S. Rattan, Theory of Machines, Tata McGraw Hill, New Delhi. 2010
2. JagdishLal, Theory of Mechanisms & Machines, Metropolitan Book Co. 2006
3. Thomas Beven, Theory of Machines, Longman's Green & Co., London. 2010
4. W. G. Green, Theory of Machines, Blackie & Sons, London 2012
5. V.P. Singh, Theory of Machines DhanpatRai. 2008

SUBJECT TITLE: MACHINE DRAWING WITH AUTO CAD
SUBJECT CODE: BTME-2303
SEMESTER: 3
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
1	0	6	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3Hrs

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Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks.

Contents of Syllabus

S.No.	Contents	Contact Hrs
1	**Unit –I** **Introduction:** Principles of Drawing, Requirements of production drawing, Sectioning and conventional representation, Dimensioning, symbols of standard tolerances, Machining Symbols, introduction and Familiarization of Code IS: 296	10 Hrs
2	**Unit –II** **Fasteners:** Various types of screw threads, types of nuts and bolts, screwed fasteners, welding joints and riveted joints	10 Hrs
3	**Unit –III** **Assembly and Disassembly:** **a) Couplings:** Solid or Rigid Coupling, Protected Type Flange coupling, Pin type flexible coupling, muff coupling, Oldham, universal coupling, claw coupling, cone friction clutch, free hand sketch of single plate friction clutch. **b)** Knuckle and cotter joints **c) Pipe and Pipe Fittings:** flanged joints, spigot an socket joint, union joint, hydraulic an expansion joint **d) IC Engine Parts:** Piston, connecting rod **e) Boiler Mountings:** Steam stop valve, feed check valve, safety valve, blow off cock. **f) Bearings:** Swivel bearing, thrust bearing, Plummer block, angular plumber block g) **Miscellaneous:** Screw Jack, Drill Press Vice, Crane hook, Tool	40 Hrs

	Post, Tail Stock, Drilling Jig. Drafting of simple mechanical components on computer.	

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2303.1	To make students understand the principles and requirements of production drawings and learning how to assemble and disassemble important parts used in major mechanical engineering applications
CO2	BTME-2303.2	To understand the drawings of mechanical components and their assemblies along with their utility for design of components
CO3	BTME-2303.3	Draw the projections of various mechanical components in terms of top, side and front views
C04	BTME-2303.4	Draw the projections of various miscellaneous components in terms of top, side and front views

Suggested Readings / Books:

1. Ajit Singh, Machine Drawing (including Auto CAD), Tata McGraw Hill., 2006
2. A Text Book of Machine Drawing by R. K. Dhawan, S. Chand and Co. Ltd., 1998
3. N.D. Bhatt, Machine Drawing, Charotar publications., 1995
4. N. Sidheshwar, Machine Drawing, Tata McGraw Hill. 2002
5. P.S. Gill, Machine Drawing, BD Kataria and Sons.2000
6. V Lakshmi Narayanan and Mathur, Text-book of Machine Drawing. 2004

SUBJECT TITLE: APPLIED THERMODYNAMICS-I
SUBJECT CODE: BTME-2304
SEMESTER: 3
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	**Unit –I** **Combustion:** Combustion Equations **(**Stoichiometric and non-Stoichiometric**).** Combustion problems in Boilers and IC engines/Calculations of air fuel ratio, Analysis of products of combustion, Conversion of volumetric analysis into gravimetric analysis and vice-versa, Actual weight of air supplied, Use of mols, for solution of combustion problems, Heat of formation, Enthalpy of formation, Enthalpy of reaction, Adiabatic flame temperature. **Unit –II** **IC Engines Introduction:** Actual Engine Indicator diagrams and valve-timing diagrams for two stroke and four stroke S.I. and C.I. Engines; **Construction and Working Principle** of Wankel rotary engine; Principle of simple carburator, Injection systems in Diesel and Petrol Engines(Direct Injection, MPFI in SI and CI Engines, respectively). Essential requirements for Petrol and Diesel Fuels. Theory of combustion in SI and CI Engines; Various stages of combustion; Pressure-time/crank - Angle diagrams; Various phenomenon such as turbulence, squish and swirl, dissociation, pre-ignition/auto- ignition, and after burning etc.; Theory of knocking (ie,. detonation) in SI and CI Engines; Effect of engine variables on the Delay Period in SI and CI engines; Effect of various parameters on knock in SI and CI Engines; Methods employed to reduce knock in SI and CI Engines; Octane and Cetane rating of fuels; Knockmeter; Dopes and inhibitors; Performance curves/maps of SI and	**16 Hrs**

	CI Engines; Effect of knocking on engine performance; Effect of ***compression ratio*** and ***air-fuel ratio*** on power and efficiency of engine; Variation of engine power with altitude; Supercharging and turbo charging of SI and CI Engines; Advantages and applications of supercharging; Emissions from SI and CI Engines and methods to reduce/control them. Logarithmic plotting of PV-diagrams. High speed Engine Indicators.	
2	**Unit –III** **Properties of Steam** Pure substance; Steam and its formation at constant pressure: wet, dry, saturated and super-heated steam; Sensible heat(enthalpy), latent heat and total heat (enthalpy) of steam; dryness fraction and its determination; degree of superheat and degree of sub-cool; Entropy and internal energy of steam; Use of Steam Tables and Mollier Chart; Basic thermodynamic processes with steam (isochoric, isobaric, isothermal, isentropic and adiabatic process) and their representation on **T-S** Chart and Mollier Charts(h-s diagrams). Significance of Mollier Charts. **Unit –IV** **Steam Generators** - **Definition:** Classification and Applications of Steam Generators; Working and constructional details of fire-tube and water-tube boilers: (Cochran, Lancashire, Babcock and Wilcox boilers); Merits and demerits of fire-tube and water-tube boilers; Modern high pressure boilers (Benson boiler, La Mont boiler) and Super critical boilers (**Once through boilers-*Tower type***); Advantages of forced circulation; Description of boiler mountings and accessories: Different types of Safety Valves, Water level indicator, pressure gauge, Fusible plug, Feed pump, Feed Check Valve, Blow-off Cock, Steam Stop-Valve, Economiser, Super-heater; Air pre-heater and Steam accumulators; Boiler performance: equivalent evaporation, boiler efficiency.	**10 Hrs**
3	**Unit –V** **Vapour Power Cycle** Carnot Cycle and its limitations; Rankine steam power cycle, Ideal and actual; Mean temperature of heat addition; Effect of pressure, temperature and vacuum on Rankine Efficiency; Rankine Cycle Efficiency and methods of improving Rankine efficiency: Reheat cycle, Bleeding (feed-water-heating), Regenerative Cycle, Combined reheat-regenerative cycle; Ideal working fluid; Binary vapour cycle, Combined power and heating cycles. **Unit –VI** **Steam Nozzles** - Definition, types and utility of nozzles; Flow of steam through nozzles; Condition for maximum discharge through nozzle; Critical pressure ratio, its significance and its effect on discharge; Area of **throat** and at **exit** for maximum discharge; Effect of friction; Nozzle efficiency; Convergent and convergent-divergent nozzles; Calculation of Nozzle dimensions (length and diameters of throat and exit); Supersaturated (or metastable) flow through nozzle. **Unit –VII**	**22 Hrs**

	Steam Turbines Introduction; Classification; Impulse versus Reaction turbines. **Simple impulse turbine**: pressure and velocity variation, Velocity diagrams/triangles; Combined velocity diagram/triangle and calculations for force, axial thrust, work, power, blade efficiency, stage efficiency, maximum work and maximum efficiency, effect of blade friction on velocity diagram, effect of speed ratio on blade efficiency, condition for axial discharge.	
4	**Unit –VIII** **De Laval Turbine**: Compounding of impulse turbines: purpose, types and pressure and velocity variation, velocity diagrams/triangles, combined velocity diagram/triangle and calculations for force, axial thrust, work, power, blade efficiency, stage efficiency, overall efficiency and relative efficiency. **Unit –IX** **Impulse-Reaction Turbine**: pressure and velocity variation, velocity diagrams/triangles, Degree of reaction, combined velocity diagram/triangle and calculations for force, axial thrust, work, power, blade efficiency, stage efficiency, overall efficiency and relative efficiency, maximum work and maximum efficiency; Calculations of blade height; **Multistaging**: Overall efficiency and relative efficiency; Reheating, Reheat factor and condition curve; Losses in steam turbines; Back pressure and extraction turbines; Co-generation; Economic assessment; Governing of steam turbines. **Unit –X** **Steam Condensers** Function; Elements of condensing unit; Types of condensers; Dalton's law of partial pressures applied to the condenser problems; Condenser and vacuum efficiencies; Cooling water calculations; Effect of air leakage; Method to check and prevent air infiltration; Description of air pump and calculation of its capacity; **Cooling towers:** function, types and their operation.	**12 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2304.1	To understand combustion phenomenon and thermal analysis of steam power plant components.
CO2	BTME-2304.2	Able to understand the fundamental of the first and second laws of thermodynamics and their application to a wide range of systems.
CO3	BTME-2304.3	Familiar with the fundamental of the air standard cycles and their applications
C04	BTME-2304.4	Have Knowledge of the operation, construction and design of various components of power plants

Suggested Readings / Books:

1. R. Yadav, Sanjay and Rajay, Applied Thermodynamics, Central Publishing House, 1992.
2. J.S. Rajadurai, Thermodynamics and Thermal Engineering, New Age International (P) Ltd. Publishers. 1996

3. D.S. Kumar and V.P. Vasandani, Heat Engineering, Metropolitan Book Co. Pvt. Ltd.2002
4. K. Soman, Thermal Engineering, PHI Learning Pvt. Ltd. 2006
5. G. Rogers and Y. Mayhew, Engineering Thermodynamics, Pearson. 2008
6. W.A.J. Keartan, Steam Turbine: Theory and Practice, ELBS Series. 2007
7. Heywood, Fundamentals of IC Engines, McGraw Hill. 2010
8. V. Ganeshan, Internal Combustion Engines, Tata McGRaw Hill. 2006

SUBJECT TITLE: MANUFACTURING PROCESSES –I
SUBJECT CODE: BTME-2305
SEMESTER: 3
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	**Unit –I Introduction: C**lassification of manufacturing processes, selection criteria for manufacturing processes, general trends in manufacturing	**5 Hrs**
2	**Unit –II Casting Processes:** Introduction to metal casting. patterns: types, materials and allowances. Moulding materials: moulding sand compositions and properties, sand testing, types of moulds, moulding machines. Cores: function, types, core making process, core-prints, chaplets. Elements of gating system and risers and their design. Design considerations of castings. Melting furnaces, cupola furnace, charge calculations, induction furnaces. Casting processes: sand casting, shell mould casting, investment casting, permanent mould casting, full mould casting, vacuum casting, die casting, centrifugal casting, and continuous casting. Metallurgical considerations in casting, Solidification of metals and alloys, directional solidification, segregation, nucleation and grain growth, critical size of nucleus. Cleaning and finishing of castings	**15 Hrs**
3	**Unit –III Welding Processes:** Introduction and classification of welding processes, to welding processes, weldability, welding terminology, general principles, welding positions, and filler metals. Gas welding: principle and practice, oxy-acetylene welding equipment, oxy-hydrogen welding. Flame cutting. Electric arc welding: principle, equipment, relative merits of AC & DC arc welding. Welding processes: manual metal arc welding, MIG welding, TIG welding, plasma arc welding, submerged arc welding. Welding arc and its characteristics, arc stability, and arc blow. Thermal effects on weldment: heat affected zone, grain size	**15 Hrs**

	and its control. Electrodes: types, selection, electrode coating ingredients and their function. Resistance welding: principle and their types i.e. spot, seam, projection, up-set and flash. Spot welding machine. Advanced welding processes: friction welding, friction stir welding, ultrasonic welding, laser beam welding, plasma arc welding, electron beam welding, atomic hydrogen welding, explosive welding, thermit welding, and electro slag welding. Considerations in weld joint design. Other joining processes: soldering, brazing, braze welding.	
4	Unit –IV Inspection and Testing: Casting defects, their causes and remedies. Welding defects, their causes and remedies. Destructive and non-destructive testing: visual inspection, x-ray radiography, magnetic particle inspection, dye penetrate test, ultrasonic inspection, eddy current testing, hardness testing, and micro hardness testing.	**10 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2305.1	To provide students with an overview of a wide variety of manufacturing processes for processing of engineering materials
CO2	BTME-2305.2	To learn principles, operations and capabilities of various metal casting and metal joining processes
CO3	BTME-2305.3	To learn about the casting defects, their causes and remedies in these processes
C04	BTME-2305.4	To analyze the inspection and testing of various mechanical materials

Suggested Readings / Books:

1. Manna, A Textbook of Manufacturing Science and Technology, PHI Publishers. 2001
2. H.S. Shan, Manufacturing Processes, Vol.I. , Pearson Publishers., 2002
3. P. N. Rao, Manufacturing Technology, Foundry, Forming & Welding, Tata McGraw Hill. 2006
4. R.S. Parmar ,Welding Engineering & Technology, Khanna Publishers 1999.
5. SeropeKalpakjian and Steven R. Schmid, Manufacturing Engineering and Technology, Pearson Publishers. 2008

SUBJECT TITLE: STRENGTH OF MATERIALS LAB
SUBJECT CODE: BTME-2307
SEMESTER: 3
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 60
End Term Exam: 40

S. No.	Contents	Contact Hrs
1	To perform tensile test in ductile and brittle materials and to draw stress-strain curve and to determine various mechanical properties.	**2 Hrs**
2	To perform compression test on Cast Iron.	**2 Hrs**
3	To perform any one hardness tests (Rockwell, Brinell&Vicker's test).	**2 Hrs**
4	To perform impact test to determine impact strength.	**2 Hrs**
5	To perform torsion test and to determine various mechanical properties	**2 Hrs**
6	To perform Fatigue test on circular test piece.	**2 Hrs**
7	To perform bending test on beam and to determine the Young's modulus and modulus of rupture.	**2 Hrs**
8	Determination of Bucking loads of long columns with different end conditions	**2 Hrs**
9	To evaluate the stiffness and modulus of rigidity of helical coil spring.	**2 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2307.1	Perform the tensile test on mild steel specimen along with its stress-strain plot
CO2	BTME-2307.2	Perform the compression and hardness test on specimen i.e. cast iron, mild steel, etc.
CO3	BTME-2307.3	Evaluate the torsion and fatigue test on specimens for determining its durability
C04	BTME-2307.4	Perform other test such as fatigue test, bending test, etc. on the specimen

SUBJECT TITLE: APPLIED THERMODYNAMICS LAB
SUBJECT CODE: BTME-2308
SEMESTER: 3
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 60
End Term Exam: 40

S. No.	Contents	Contact Hrs
1	Study of construction and operation of 2 stroke and 4 stroke Petrol and Diesel engines using actual engines or models	**2 Hrs**
2	To plot actual valve timing diagram of a 4 stroke petrol and diesel engines and study its impact on the performance of engine	**2 Hrs**
3	Study of working, construction, mountings and accessories of various types of boilers.	**2 Hrs**
4	To perform a boiler trial to estimate equivalent evaporation and efficiency of a fire tube/ water tube boiler.	**2 Hrs**
5	Determination of dryness fraction of steam and estimation of brake power, Rankine efficiency, relative efficiency, generator efficiency, and overall efficiency of an impulse steam turbine and to plot a Willian's line	**2 Hrs**
6	Determine the brake power, indicated power, friction power and mechanical efficiency of a multi cylinder petrol engine running at constant speed (Morse Test). Performance testing of a diesel engine from no load to full load (at constant speed) for a single cylinder/ multi- cylinder engine in terms of brake power, indicated power, mechanical efficiency and specific fuel consumption.	**2 Hrs**
7	Performance testing of a petrol engine from no load to full load (at constant speed) for a single cylinder/ multi- cylinder engine in terms of brake power, indicated power, mechanical efficiency and specific fuel consumption.	**2 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2308.1	Study the constructional features of different IC engine along with their valve timing diagrams
CO2	BTME-2308.2	Study the constructional feature of different types of boilers and their practical applications
CO3	BTME-2308.3	To determine the indicated power, friction power and mechanical efficiency of IC engine
C04	BTME-2308.4	To determine the performance testing of a petrol engine from no load to full load (at constant speed) for a single cylinder/ multi- cylinder

SUBJECT TITLE: ENGINEERING MATERIALS & METALLURGY LAB
SUBJECT CODE: BTME-2309
SEMESTER: 3
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 60
End Term Exam: 40

S. No.	Contents	Contact Hrs
1	Preparation of models/charts related to atomic/crystal structure of metals.	**2 Hrs**
2	Annealing the steel specimen and study the effect of annealing time and temperature on hardness of steel	**2 Hrs**
3	Hardening the steel specimen and study the effect of quenching medium on hardness of steel.	**2 Hrs**
4	Practice of specimen preparation (cutting, mounting, polishing, etching) of mild steel, aluminium and hardened steel specimens	**2 Hrs**
5	Study of the microstructure of prepared specimens of mild steel, Aluminium and hardened steel.	**2 Hrs**
6	Identification of ferrite and pearlite constituents in given specimen of mild steel	**2 Hrs**
7	Determination of hardenabilty of steel by Jominy End Quench Test.	**2 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2309.1	Determine and make a model for the different types of crystal structure of metals
CO2	BTME-2309.2	To study the working principlesof metallurgical microscope
CO3	BTME-2309.3	Prepare a mild steel samples related to cutting, polishing, etching
C04	BTME-2309.4	To study the different methods such as annealing, normalizing, hardening, etc.

SUBJECT TITLE: INSTITUTIONAL TRAINING
SUBJECT CODE: BTME-2310
SEMESTER: 3
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	2

Internal Assessment: 100

In this student has to submit a file of what they have did in their intuitional training

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2310.1	Understand the basics of workshop technology
CO2	BTME-2310.2	Prepare a job related to carpentry shop, fitting shop, foundry shop
CO3	BTME-2310.3	Prepare a job related to smithy shop, machine shop
C04	BTME-2310.4	To study the basic circuits related to electrical and electronics shop

(Department Elective: I)

SUBJECT TITLE: ENGINEERING MATERIALS & METALLURGY
SUBJECT CODE: BTME-2306
SEMESTER: 3
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam; 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	**Unit –I** **Crystallography:** Atomic structure of metals, atomic bonding in solids, crystal structures, crystal lattice of body centered cubic, face centered cubic, closed packed hexagonal; crystalline and non crystalline materials; crystallographic notation of atomic planes; polymorphism and allotropy; imperfection in solids: theoretical yield strength, point defects, line defects and dislocations, interfacial defects, bulk or volume defects. Diffusion: diffusion mechanisms, steady-state and non-steady-state diffusion, factors affecting diffusion. Theories of plastic deformation, recovery, re-crystallization.	**12 Hrs**
2	**Unit –II** **Phase Transformation:** General principles of phase transformation in alloys, phase rule and equilibrium diagrams, Equilibrium diagrams of Binary systems. Iron carbon equilibrium diagram and various phase transformations. Time temperature transformation curves (TTT curves): fundamentals, construction and applications.	**15 Hrs**
3	**Unit –III** **Heat Treatment**: Principles and applications. Processes viz. annealing, normalizing, hardening, tempering. Surface hardening of steels: Principles of induction and oxyacetylene flame hardening. Procedure for carburising, nitriding and cyaniding. Harden-ability: determination of	**10 Hrs**

	harden-ability. Jominy end-quench test. Defects due to heat treatment and their remedies; effects produced by alloying elements. Composition of alloy steels.	
4	**Unit –IV** **Ferrous Metals and Their Alloys:** Introduction, classification, composition of alloys, effect ofalloying elements (Si, Mn, Ni, Cr, Mo, W, Al) on the structures and properties of steel.	**8 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2306.1	The students will learn the atomic structure of metals, imperfections, diffusion mechanisms and theories of plastic deformation
CO2	BTME-2306.2	To understand equilibrium diagrams, time-temperature transformation curves and heat treatment processes
CO3	BTME-2306.3	Analyze the various properties of Engineering materials
C04	BTME-2306.4	Determine the various stages of materials along with the method of cooling

Suggested Readings / Books:

1. B. Zakharov, Heat Treatment of Metals, University Press. 2006
2. T. Goel and R.S. Walia, Engineering Materials & Metallurgy. 2002
3. Sidney H Avner, Introduction to Physical Metallurgy, Tata Mcgraw-Hill. 2015
4. V. Raghavan, Physical Metallurgy: Principles and Practice, PHI Learning. 2004
5. Y. Lakhin , Engineering Physical Metallurgy, Mir Publishers. 2005

(Department Elective: I)

SUBJECT TITLE: NON CONVENTIONAL ENERGY
SUBJECT CODE: BMEC-2311
SEMESTER: 3rd
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	ContactHrs
1	**Introduction:** Renewable and non-renewable energy sources, their availability and growth in India; energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements	**10 Hrs**
2	**Solar Energy:** Solar radiation - beam and diffuse radiation; earth sun angles, attenuation and measurement of solar radiation; Optical properties of materials and selective surfaces; Principles, general description and design procedures of flat Platte and concentrating collectors; Performance analysis of cylindrical and parabolic collectors; Solar energy storage systems - their types, characteristics and capacity; solar ponds. Applications of solar energy in water, space and process heating, solar refrigeration and air conditioning; water desalination and water pumping; solar thermal power generation; solar cells and batteries; economic analysis of solar systems.	**7 Hrs**
3	**Wind Energy:** Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of accodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection	**10 Hrs**

	considerations.	
4	**Direct energy conversion systems:** i) Magnetic Hydrodynamic (MHD) Generator: gas conductivity and MHD equations; operating principle, types and working of different MHD systems – their relative merits; MHD materials and production of magnetic fields. ii)Thermo-electric generators: Thermo-electric effects and materials; thermo-electric devices and types of thermo-electric generators; thermo-electric refrigeration. iv) iii) Thermionic generators: thermoionic emission and materials; working principle of thermionic Fuel Cells: thermodynamic aspects; types, components and working of fuel cells. v) Performance, applications and economic aspects of above mentioned direct energy conversions systems.	**8 Hrs**
5	**Miscellaneous Non-Conventional energy Systems:** i) Bio-mass: Concept of bio-mass conversion, photo-synthesis and bio-gasification; Bio gas generators and plants - their types constructional features and functioning; digesters and their design; Fuel properties of bio gas and community bio gas plants ii) Geothermal: Sources of geothermal energy - types, constructional features and associated prime movers. iii) Tidal and wave energy: Basic principles and components of tidal and wave energy plants; single basin and double basin tidal power plants; conversion devices Advantages/disadvantages and applications of above mentioned energy systems.	**10 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2311.1	To understand need and Significance of renewable and non-renewable energy sources
CO2	BTME-2311.2	To understand the working of various energy sources
CO3	BTME-2311.3	Analyze of various direct energy conversion systems
C04	BTME-2311.4	The student shall be competent enough to make use of modern tools and software's for analyzing and solving real life problems

Suggested Readings / Books:

1. H.P. Garg and Jai Prakash, Solar Energy : Fundamentals and Applications, Tata McGraw Hill.
2. S.P. Sukhatme, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw Hill.
3. John A. Duffic and W. A. Beckman, Solar Engineering of Thermal Processes, John Wiley.
4. S. L. Sheldon, Chang, Energy Conversion, Prentice Hall.
5. O. M. Bockris and S. Srinivasan, Fuel Cells, McGraw Hill.

(Department Elective: I)

SUBJECT TITLE: INDUSTRIAL ENGINEERING
SUBJECT CODE: BMEC-2312
SEMESTER: 3rd
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	**Introduction:** Definition and scope of industrial engineering, role of an industrial engineer in industry, functions of industrial engineer. Department and its organization, qualities of an industrial engineer **Plant Layout and Material Handling:** Different types of layouts viz. Product, Process and combination layouts, Introduction to layouts based on GT, JIT and Cellular, manufacturing systems, development of plant layout, types of material handling equipment, relationship of material handling with plant layouts.	**10 Hrs**
2	**Work Study:** Areas of applications of work study in industry, method study and work measurements and their interrelationship, reaction of management and labour to work study, role of work study in improving plant productivity and safety.	**7 Hrs**
3	**Method Study:** Objectives and procedure for methods analysis; select, record, examine, develop, define, install and maintain, recording techniques, micro motion and macro motion Study; Principles of motion economy, normal work areas and workplace design. **Work Measurement:** Objectives, work measurement techniques - time study, work sampling, Predetermined motion time standards (PMTS), Determination of time standards, Observed time, Basic time, Normal Time, Rating Factors, allowances, Standard Time.	**10 Hrs**

4	**Value Engineering:** Types of values, concept of value engineering, phases of value engineering Studies, application of value engineering.	**8 Hrs**
5	**Work Design:** Concepts of job enlargements, job enrichment and job rotation, effective job design considering technological and behavioral factors. **Ergonomics:** Introduction to ergonomics consideration in designing Man Machine systems with special reference to design of displays and controls.	**10 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2312.1	Understand the basic concepts of production, productivity and function of management
CO2	BTME-2312.2	To gain knowledge of hierarchy, principles and dimensions of planning function of organizations
CO3	BTME-2312.3	Determine the various theories and approaches related to Industrial Engineering
C04	BTME-2312.4	Discuss the importance of Value Engineering in today's Industry

Suggested Readings / Books:

1. Hicks, "Industrial Engg. And management ",Tata McGraw Hill.
2. Ulrich, "Product Design and Development",Tata McGraw Hill
3. Suresh Dalela and Saurabh, "Work Study and ergonomics",Standard Publishers.
4. R. Bernes, "Motion and time study", John Wiley and sons.
5. D. J. Oborne, "Ergonomics at work", John Wiley and sons.

(Department Elective: I)

SUBJECT TITLE: DIGITAL ELECTRNICS
SUBJECT CODE: BMEC-2313
SEMESTER: 3rd
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S.No.	Contents	Contact Hrs
1	Number system and codes: Binary, octal, hexadecimal and decimal Number systems and their inter conversion, BCD numbers (8421-2421), gray code, excess–3 code, cyclic code, code conversion, ASCII, EBCDIC codes. Binary addition and subtraction, signed and unsigned binary numbers, 1's and 2's complement representation.	**10 Hrs**
2	Boolean Algebra: Basic logic circuits: Logic gates (AND, OR, NOT, NAND, NOR, Ex-OR, Ex- NOR and their truth tables,), Universal Gates, Laws of Boolean algebra, De-Morgan's theorem, Min term, Max term, POS, SOP, KMap, Simplification by boolean theorems, don't care condition Logic Families: Introduction to digital logic family such as RTL, DTL, TTL, ECL, CMOS, IIR, HTL etc., their comparative study, Basic circuit, performance characteristics, Wired logic, open collector output etc.	**7 Hrs**
3	Combinational Logic: The Half adder, the full adder, subtractor circuit. Multiplxer de- multiplexer, decorder, BCD to seven segment Decorder,encoders.	**10 Hrs**
4	Flip flop and Timing circuit: set-reset laches, D-flipflop, R-S flip-flop, J-K Flip-flop, Master slave Flip flop, edge triggered flip-flop, T flip-flop.	**8 Hrs**
5	Registers & Counters: Synchronous/Asynchronous counter	**10 Hrs**

	operation,Up/down synchronous counter, application of counter, Serial in/Serial out shift register, Serial in/Serial out shift register, Serial in/parallel out shift register, parallel in/ parallel out shift register, parallel in/Serial out shift register, Bi-directional register.	

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2313.1	To present a problem oriented introductory knowledge of Digital circuits and its applications.
CO2	BTME-2313.2	Analyze the number system and codes
CO3	BTME-2313.3	To focus on the study of electronic circuits.
C04	BTME-2313.4	Analyze the registers &counters

Suggested Readings / Books:

1. Digital Fundamentals by Morris and Mano, PHI Publication
2. Fundamental of digital circuits by A.ANANDKUMAR,PHI Publication
3. Digital Fundamaentals by FLOYD & JAIN, Pearsons Pub
4. Fundamentals of Logic Design by Charles H. Roth Thomson

Program Name: B. Tech. Mechanical Engineering
Program Code: ME-301

(Department Elective: I)

SUBJECT TITLE: OBJECT ORIENTED PROGRAMMING UISNG C++
SUBJECT CODE: BMEC-2314
SEMESTER: 3rd
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Introduction to C++ and Object oriented Concepts C++ Standard Library, Basics of a Typical C++ Environment, Pre-processors Directives, illustrative Simple C++ Programs. Header Files and Namespaces, library files. Introduction to Objects and Object Oriented Programming, Encapsulation (Information Hiding), Access Modifiers: Controlling access to a class, method, or variable (public, protected, private, package), Other Modifiers, Polymorphism: Overloading, Inheritance, Overriding Methods, Abstract Classes, Reusability, Class's Behaviors.	**15 Hrs**
2	Classes and Data Abstraction: Introduction, Structure Definitions, Accessing Members of Structures, Class Scope and accessing Class Members, Separating Interface from Implementation, Controlling Access Function And Utility Functions, Initializing Class Objects: Constructors, Using Default Arguments With Constructors, Using Destructors, Classes : Const(Constant) Object And Const Member Functions, Object as Member of Classes, Friend Function and Friend Classes, Using This Pointer, Dynamic Memory Allocation with New and Delete, Static Class Members, Container Classes And Integrators, Proxy Classes, Function overloading.	**12 Hrs**
3	Operator Overloading, Inheritance, and Virtual Functions and Polymorphism: Fundamentals of Operator Overloading, Restrictions On	**10 Hrs**

	Operators Overloading, Operator Functions as Class Members vs. as Friend Functions, Overloading, <<, >> Overloading Unary Operators, Overloading Binary Operators. Introduction to Inheritance, Base Classes And Derived Classes, Protected Members, Casting Base- Class Pointers to Derived- Class Pointers, Using Member Functions, Overriding Base – Class Members in a Derived Class, Public, Protected and Private Inheritance, Using Constructors and Destructors in derived Classes, Implicit Derived –Class Object To Base- Class Object Conversion, Composition Vs. Inheritance. Introduction to Virtual Functions, Abstract Base Classes And Concrete Classes, Polymorphism, New Classes And Dynamic Binding, Virtual Destructors, Polymorphism, Dynamic Binding.	
4	Files and I/O Streams and Templates and Exception Handling: Files and Streams, Creating a Sequential Access File, Reading Data From A Sequential Access File, Updating Sequential Access Files, Random Access Files, Creating A Random Access File, Writing Data Randomly To a Random Access File, Reading Data Sequentially from a Random Access File. Stream Input/Output Classes and Objects, Stream Output, Stream Input, Unformatted I/O (with read and write), Stream Manipulators, Stream Format States, Stream Error States. Function Templates, Overloading Template Functions, Class Template, Class Templates and Non-Type Parameters, Templates and Inheritance, Templates and Friends, Templates and Static Members. Introduction, Basics of C++ Exception Handling: Try Throw, Catch, Throwing an Exception, Catching an Exception, Rethrowing an Exception, Exception specifications, Processing Unexpected Exceptions, Stack Unwinding, Constructors, Destructors and Exception Handling, Exceptions and Inheritance.	**8 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2314.1	Introduce the student to the concepts of C++ in computer science.
CO2	BTME-2314.2	Acquire knowledge to make functions , files etc.
CO3	BTME-2314.3	Knowledge of programming language.
C04	BTME-2314.4	Basic understanding on programming.

Suggested Readings / Books:

1. C++ How to Program by H M Deitel and P J Deitel, 1998, Prentice Hall
2. Object Oriented Programming in Turbo C++ by Robert Lafore, 1994, The WAITE Group Press.
3. Programming with C++ By D Ravichandran, 2003, T.M.H

(Department Elective: I)

SUBJECT TITLE: EFFECTIVE WRITING SKILLS
SUBJECT CODE: BMEC-2315
SEMESTER: 3rd
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Introduction to Effective Writing, Effective Writing as an Art Principles of Effective Writing, Types and Stages of Effective Writing	**15 Hrs**
2	Notions of Correctness and Appropriateness, Part I, Notions of Correctness and Appropriateness, Part II, Essay Writing, Types of Essays, Essentials of Academic Writing, Part I, Essentials of Academic Writing, Part II	**12 Hrs**
3	Business Writing and its Functions, Mechanics of Business Writing, Business Letters and Memos, Format of Business Letters and Memos	**10 Hrs**
4	Types of Business Letter , Sales, Complaint and Adjustment Letters, Report Writing, Strategies and Structure of Reports, Style of Report Writing, Creative Writing	**8 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2315.1	Introduce the student to the concepts of effective writing
CO2	BTME-2315.2	Acquire knowledge to Notions of Correctness and Appropriateness
CO3	BTME-2315.3	Knowledge of Business Writing and its Functions
C04	BTME-2315.4	Basic understanding on report writing

Suggested Readings / Books:

1. Turk, Christopher and John Kirkman. Effective Writing. London and New York: Chapman& Hall. Indian Reprint 2003
2. Pinker, Steven. The Sense of Style: The Thinking Person's Guide to Writing in the 21st Century . Penguin Books, Reprint edition ,2015
3. Seely, John. Oxford Guide to Effective Writing and Speaking. OUP 2nd edition, 2005
4. Goins, Jeff. You Are a Writer (So Start Acting Like One). Tribe Press
5. Brohaugh, William. Write Tight: Say Exactly What You Mean with Precision and Power.
6. Janzer. Anne. The Writer's Process: Getting Your Brain in Gear. Cuesta Park Consulting, 201
7. King, Stephen. On Writing: A Memoir of the Craft. Scribner, 2010

Program Name: B. Tech. Mechanical Engineering
Program Code: ME-301

(Department Elective: I)

SUBJECT TITLE: I. C. ENGINES
SUBJECT CODE: BTME-2316
SEMESTER: 3RD
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	ContactHrs
1	**Introduction to IC Engines:** Definition of engine; Heat Engine, Historical Development of IC Engines, Classification & Nomenclature, Application of IC Engines, Air Standard Cycle, Carnot Cycle, Sterling Cycle, Ericson Cycle, Otto Cycle, Diesel cycle, Dual Cycle, Thermodynamics Analysis of these cycles **Actual Working of I.C. Engine:** Working of 4 stroke petrol & diesel engines and their valve timing diagram, working of 2-stroke petrol & diesel engines & their valve timing diagrams, comparison of two stroke & four stroke engines, Actual working of 2 & 4 stroke gas engine and their valve diagram. **Fuel Air Cycles and their analysis:** Introduction to fuel air cycles and their significance, composition of cylinder gases, variable specific heats, Dissociation, effect of no. of moles, comparison of air standards & fuel air cycles, effect of operating variable like compression ratio, fuel air ratio, actual cycles and their analysis; Difference between Actual and Fuel-Air Cycle, Actual and Fuel-Air Cycles for S.I. and C.I. Engines.	**12 Hrs**
2	**IC Engine Fuels:** Introduction, types of fuels, solid, liquid and gaseous fuels, chemical structure of petroleum, petroleum refining process, important qualities of S.I. & C.I. Engine fuels and their rating. Combustion of fuels; Calorific valves of fuels, theoretical determination	**10 Hrs**

	of CV of fuel, combustion equation for hydrocarbon fuels, determination of minimum air required for combustion, conversions of volumetric analysis of mass analysis, Determination of air supplied from volumetric analysis of Dry flue gases, Determination of excess air supplied , Determination of % of carbon in fuel burning to CO & CO2 , Determination of minimum quantity of air supplied. **Fuel Supply System:** Fuel Supply System and fuel pumps, properties of air fuel mixture, a sample carburetor an its working, approximate analysis of simple carburetor, Actual air fuel ratio of single jet carburetor, Exact analysis of single jet carburetor, ideal requirements from a carburetor, limitations of single jet carburetor, different devices used to meet the requirements of an ideal carburetor. Different modern carburetors, introduction to petrol injection, fuel injection systems for C.I.	
3	**Fuel Supply System:** Fuel Supply System and fuel pumps, properties of air fuel mixture, a sample carburetor an its working, approximate analysis of simple carburetor, Actual air fuel ratio of single jet carburetor, Exact analysis of single jet carburetor, ideal requirements from a carburetor, limitations of single jet carburetor, different devices used to meet the requirements of an ideal carburetor. Different modern carburetors, introduction to petrol injection, fuel injection systems for C.I. **Engines:** Classification of injection systems, injection pump, injection pump governor, mechanical governor, fuel injection systems, injection pump Governor, Mechanical Governor, Fuel Injector, Nozzle, Injection of S.I. Engines, Fuel Filters.	**8 Hrs**
4	**Combustion in S.I. Engines:** Introduction, Stages of Combination in S.I. Engine, Flame font propagation, factor influencing the flame speed, ignition lag and factors affecting the lag, Abnormal combustion and knocking, control and measurement of knock, rating of S.I. Engine fuels and anti knock agents, combustion chambers of S.I. Engines. **Supercharging:** Introduction, purpose of supercharging, type of superchargers, analysis of superchargers, performance of superchargers, Arrangement of Supercharger and its installation, Turbo charged engines, supercharging of S.I. & C.I. Engines. Limitations of supercharging. **Measurement and Testing:** Measurement of friction horse power, brake horse power, indicated horse power, measurement of speed, air consumption, fuel consumption, heat carried by cooling water, heat carried by the exhaust gases, heat balance sheet, governing of I.C. Engines, performance characteristics of I.C. Engines: Performance parameters, performance of S.I. Engines, performance of C.I. Engine, Engine performance maps.	**10 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2316.1	To teach students the operating characteristics and thermodynamic analysis of common internal combustion engine cycles.
CO2	BTME-2316.2	To teach students to analyze the combustion process of common fuels
CO3	BTME-2316.3	To make students aware of the roles of fluid flow and heat transfer in engine operation.
C04	BTME-2316.4	To teach students methods to mitigate engine vibration, friction, and wear

Suggested Readings / Books:

1. V. Ganesan, Internal Combustion Engines, Prentice Hall.2008
2. V. M. Damundwar, A Course in Internal Combustion Engines, Dhanpat Rai.2006
3. John B. Heywood, Internal combustion engine fundamentals McGraw-Hill,2019
4. Colin R. Ferguson, Allan Thomson, Kirkpatrick Internal combustion engines: applied thermo sciences, John Wiley & Sons.2008
5. Richard Stone, Introduction to Internal Combustion Engines Society of Automotive Engineers,2010

SYLLABUS

SEMESTER-IV

SUBJECT TITLE: STRENGTH OF MATERIALS-II
SUBJECT CODE: BTME-2401
SEMESTER: 4
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	2	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	**Unit –I Strain energy:** Introduction to strain energy, energy of dilation and distortion. Resilience, stress due to suddenly applied loads. Castigliano's and Maxwell's theorem of reciprocal deflection. **Unit –II Theories of failure**: Maximum principal stress theory, maximum shear stress theory, maximum principal strain theory, total strain energy theory, shear strain energy theory. Graphical representation and derivation of equation for these theories and their application to problems related to two dimensional stress systems	**16 Hrs**
2	**Unit –III Springs:** Open and closed coiled helical springs under the action of axial load and/or couple. Flat spiral springs- derivation of formula for strain energy, maximum stress and rotation. Leaf spring- deflection and bending stresses **Unit –IV Thin cylinders and spheres**: Calculation of Hoop stress, longitudinal stress in a cylinder, effects of joints, change in diameter, length and internal volume. Principal stresses in sphere, change in diameter and internal volume	**16 Hrs**
3	**Unit –V Thick cylinders**: Derivation of Lame's equations, calculation of radial, longitudinal and hoop stresses and strains due to internal pressure in thick cylinders, compound cylinders, hub shrunk on solid shafts, shrinkage allowance and shrinkage stress. **Unit –VI Bending of curved beams**: Calculation of stresses in cranes or chain hooks, rings of circular and trapezoidal section, and chain links with straight sides	**14 Hrs**

4	**Unit –VII Shear stresses in beams**: Shear stress distribution in rectangular, circular, I, T and channel section; built up beams. Shear centre and its importance. **Unit –VIII Rotational discs:** Stresses in rotating discs and rims of uniform thickness; disc of uniform strength.	**14 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2401.1	To enhance deep and vigorous understanding of stress analysis in various machine elements
CO2	BTME-2401.2	To analyze and design a mechanical member from the strength point of view under various conditions
CO3	BTME-2401.3	Apply the concept of failure theories for design
C04	BTME-2401.4	Analyze and design thin, thick cylinders and springs

Suggested Readings / Books:

1. D.S. Bedi, Strength of materials, Khanna book publishing company. 1998
2. G.H. Ryder, Strength of materials, Macmillan India Ltd. 2004
3. R.S Lehri and A.S. Lehri, Strength of materials, vol. 2, S. K. Kataria and Sons. 1998
4. S.S.Rattan, Strength of materials, Tata McGraw Hills. 2002
5. Timoshenko and Gere, Mechanics of materials, CBS publishers. 2013

SUBJECT TITLE: THEORY OF MACHINES – II
SUBJECT CODE: BTME-2402
SEMESTER: 4
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	2	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	**Unit –I Static force analysis**:, Concept of force and couple, free body diagram, condition of equilibrium, static equilibrium of mechanism, methods of static force analysis of simple mechanisms. Power transmission elements, considerations of frictional forces. **Unit –II Dynamic force analysis** Determination of forces and couples for a crank, inertia of reciprocating parts, dynamically equivalent system, analytical and graphical method, inertia force analysis of basic engine mechanism, torque required to overcome inertia and gravitational force of a four bar linkage.	**20 Hrs**
2	**Unit –III Balancing:** Necessity of balancing, static and dynamic balancing, balancing of single and multiple rotating masses, partial unbalanced primary force in an engine, balancing of reciprocating masses, and condition of balance in multi cylinder in line V-engines , concept of direct and reverse crank, balancing of machines, rotors, reversible rotors. **Unit –IV Gears:** Toothed gears, types of toothed gears and its terminology. Path of contact, arc of contact, conditions for correct gearing, forms of teeth, involutes and its variants, interference and methods of its removal. Calculation of minimum number of teeth on pinion/wheel for involute rack, helical, spiral, bevel and worm gears. Center distance for spiral gears and efficiency of spiral gears	**20 Hrs**
3	**Unit –V Gear Trains**: Types of gear trains, simple, compound and epicyclic gear trains, problems involving their applications, estimation of	**14 Hrs**

	velocity ratio of worm and worm wheel. **Unit –VI Gyroscopic motion and couples**: Effect on supporting and holding structures of machines. stabilization of ships and planes, Gyroscopic effect on two and four wheeled vehicles and stone crusher.	
4	**Unit –VII Kinematic synthesis of Mechanism**: Freudenstien equation, Function generation errors insynthesis, two and three point synthesis, Transmission angles, least square techniques.	**6 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2402.1	To understand the basic concepts of inertia forces & couples applied to reciprocating parts of a machine
CO2	BTME-2402.2	To understand balancing of masses and design of gears & gear trains.
CO3	BTME-2402.3	To gain knowledge of kinematic synthesis and different applications of gyroscopic effect
C04	BTME-2402.4	Analyze the stability of automobile, naval ship and other related devices considering gyroscopic effect

Suggested Readings / Books:

1. S.S. Rattan, Theory of Machines, Tata Mc. Graw Hill. 2010
2. John, Gordon, and Joseph, Theory of Machines and Mechanisms, Oxford University Press. 2010
3. Hams Crone and Roggers, Theory of Machines. 2008
4. Shigley, Theory of Machines, McGraw Hill. 2006
5. V.P. Singh, Theory of Machines, DhanpatRai and Sons. 2008.

SUBJECT TITLE: FLUID MECHANICS
SUBJECT CODE: BTME-2403
SEMESTER: 4
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	2	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	**Unit –I Fundamentals of Fluid Mechanics**: Introduction; Applications; Concept of fluid; Difference between solids, liquids and gases; Concept of continuum; Ideal and real fluids; Fluid properties: density, specific volume, specific weight, specific gravity, viscosity (dynamic and kinematic), vapour pressure, compressibility, bulk modulus, Mach number, surface tension and capillarity; Newtonian and non-Newtonian fluids. **Unit –II Fluid Statics:** Concept of static fluid pressure; Pascal's law and its engineering applications; Hydrostatic paradox; Action of fluid pressure on a plane submerged surface (horizontal, vertical and inclined): resultant force and centre of pressure; Force on a curved surface due to hydrostatic pressure; Buoyancy and flotation; Stability of floating and submerged bodies; Metacentric height and its determination; Periodic time of oscillation; Pressure distribution in a liquid subjected to : (i) constant acceleration along horizontal, vertical and inclined direction (linear motion), (ii) constant rotation.	**16 Hrs**
2	**Unit –III Fluid Kinematics:** Classification of fluid flows; Lagrangian and Euler flow descriptions; Velocity and acceleration of fluid particle; Local and convective acceleration; Normal and tangential acceleration; Path line, streak line, streamline and timelines; Flow rate and discharge mean velocity; One dimensional continuity equation; Continuity equation in Cartesian (x,y,z), polar (r,θ) and cylindrical (r,θ,z) coordinates; Derivation of continuity equation using the Lagrangian method in Cartesian coordinates; Rotational flows: rotation, vorticity and circulation; Stream function and velocity potential function, and	**20 Hrs**

	relationship between them; Flow net. **Unit –IV Fluid Dynamics:** Derivation of Euler's equation of motion in Cartesian coordinates, and along a streamline; Derivation of Bernoulli's equation (using principle of conservation of energy and equation of motion) and its applications to steady state ideal and real fluid flows; Representation of energy changes in fluid system (hydraulic and energy gradient lines); Impulse momentum equation; Kinetic energy and momentum correction factors; Flow along a curved streamline; Free and forced vortex motions.	
3	**Unit –V Dimensional Analysis and Similitude:** Need of dimensional analysis; Fundamental and derived units; Dimensions and dimensional homogeneity; Rayleigh's and Buckingham's π - method for dimensional analysis; Dimensionless numbers (Reynolds, Froudes, Euler, Mach, and Weber) and their significance; Need of similitude; Geometric, kinematic and dynamic similarity; Model and prototype studies; Similarity model laws. **Unit –VI Internal Flows:** Laminar and Turbulent Flows: Reynolds number, critical velocity, critical Reynolds number, hydraulic diameter, flow regimes; Hagen – Poiseuille equation; Darcy equation; Head losses in pipes and pipe fittings; Flow through pipes in series and parallel; Concept of equivalent pipe; Roughness in pipes, Moody's chart.	**18 Hrs**
4	**Unit –VII Pressure and Flow Measurement:** Manometers; Pitot tubes; Various hydraulic coefficients; Orifice meters; Venturi meters; Borda mouthpieces; Notches (rectangular, V and Trapezoidal) and weirs; Rotameters.	**6 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2403.1	To develop an understanding of the behavior of fluids at rest or in motion and the subsequent effects of the fluids on the boundaries as the mechanical engineers has to deal with fluids in various applications
CO2	BTME-2403.2	To develop an ability to apply the Bernoulli equation to solve problems in fluid mechanics
CO3	BTME-2403.3	An ability to use potential flow theory to solve problems in fluid mechanics
C04	BTME-2403.4	An ability to perform dimensional analysis for problems in fluid mechanics

Suggested Readings / Books:

1. D.S. Kumar, Fluid Mechanics and Fluid Power Engineering, S.K. Kataria and Sons Publishers. 1996
2. S.K. Som, G. Biswas and S. Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill. 2004
3. C.S.P. Ojha, R. Berndtsson and P.N. Chandramouli, Fluid Mechanics and Machinery, Oxford University Press.2012
4. Y.A. Cengel and J.M. Cimbala, Fluid Mechanics - Fundamentals and Applications, Tata McGraw Hill. 2012

5. B.R. Munson, D.F. Young, T.H. Okiishi and W.W. Huebsch, Fundamentals of Fluid Mechanics, John Wiley and Sons. 2014
6. J.F. Douglas and J.M. Gasiorek, J.A. Swaffield and L.B. Jack, Fluid Mechanics, Pearson 2014
7. V.L. Streeter, E.B. Wylie and K.W. Bedford, Fluid Mechanics, Tata McGraw Hill 2012

SUBJECT TITLE: APPLIED THERMODYNAMICS-II
SUBJECT CODE: BTME-2404
SEMESTER: 4
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	2	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S.No.	Contents	ContactHrs
1	**Unit –I Air Compressors- Introduction**: Classification of Air Compressors; Application of compressors and use of compressed air in industry and other places; Complete representation of compression process on P-v and T-s coordinates with detailed description of areas representing total work done and polytropic work done; Areas representing ***energy lost*** in internal friction, *energy carried away by cooling water* and ***additional flow work*** being done for un-cooled and cooled compression on T-Scoordinates; Best value of index of compression; Isentropic, polytropic and isothermal efficiencies and their representation in terms of ratio of areas representing various energy transfers on T-s coordinates. **Unit –II Reciprocating Air Compressors** Single stage single acting reciprocating compressor (with and without clearance volume): construction, operation, work input and best value of index of compression, heat rejected to cooling medium, isothermal, overall thermal, isentropic, polytropic, mechanical efficiency, **Clearance Volumetric efficiency**, Overall volumetric efficiency, effect of various parameters on volumetric efficiency, free air delivery; Multistage compressors: purpose and advantages, construction and operation, work input, heat rejected in intercoolers, minimum work input, optimum pressure ratio; ***isothermal***, ***overall thermal***, ***isentropic***, ***polytropic*** and ***mechanical*** efficiencies; Performance curves	16 Hrs
2	**Unit –III Positive Displacement Rotary Compressors Introduction:** Comparison of rotary positive displacement compressors with reciprocating compressors; Classification of rotary compressors; Construction, operation, work input and efficiency of positive displacement type of rotary compressors like Roots blower, Lysholm compressor and Vane type	14 Hrs

	Blower. **Unit –IV Thermodynamics of Dynamic Rotary Compressors:** Applications of Steady Flow Energy Equation and thermodynamics of dynamic(i.e., *centrifugal* and *axial flow m/cs*) compressors; Stagnation and static values of pressure, Temperature and enthalpy etc. for flow through dynamic rotary machines; Complete representation of compression process on T-S coordinates with detailed description of areas representing total work done, polytropic work done; ideal work required for compression process, areas representing energy lost in internal friction, energy carried away by cooling water on TS coordinates for an uncooled and cooled compression; ***isentropic***, ***polytropic***, and ***isothermal efficiencies*** as ratios of the areas representing various energy transfers on T-S coordinates	
3	**Unit –V Centrifugal Compressors**:- Complete thermodynamic analysis of centrifugal compressor stage; Polytropic, isentropic and isothermal efficiencies; Complete representation of compression process in the centrifugal compressor starting from ambient air flow through the suction pipe, Impeller, Diffuser and finally to delivery pipe on T-S coordinates; Pre-guide vanes and pre-whirl; Slip factor; Power input factor; Various modes of energy transfer in the impeller and diffuser; Degree of Reaction and its derivation; Energy transfer in backward, forward and radial vanes; Pressure coefficient as a function of slip factor; Efficiency and out-coming velocity profile from the impeller; Derivation of non-dimensional parameters for plotting compressor characteristics; compressor characteristic curves; Surging and choking in centrifugal compressors. **Unit –VI Axial Flow Compressors** Different components of axial flow compressor and their arrangement; Discussion on flow passages and simple theory of aerofoil blading; Angle of attack; coefficients of lift and drag; Turbine versus compressor blades; Velocity vector; Vector diagrams; Thermodynamic analysis; Work done on the compressor and power calculations; Modes of energy transfer in rotor and stator blade flow passages; Detailed discussion on work done factor, degree of reaction, blade efficiency and their derivations; ***Isentropic***, ***polytropic*** and ***isothermal efficiencies***; Surging, Choking and Stalling in axial flow compressors; Characteristic curves for axial flow compressor; flow parameters of axial flow compressor like Pressure Coefficient, Flow Coefficient, Work Coefficient, Temperature-rise Coefficient and Specific Speed; Comparison of axial flow compressor with centrifugal compressor and reaction turbine; Field of application of axial flow compressors.	16 Hrs
4	**Unit –VII Gas Turbines Classification** and comparison of the Open and Closed cycles; Classification on the basis of combustion (at ***constant volume*** or ***constant pressure***); Comparison of gas turbine with a steam turbine and IC engine; Fields of application of gas turbines; Position of gas turbine in power industry; Thermodynamics of constant pressure gas turbine cycle (Brayton cycle); Calculation of net output, work ratio and thermal efficiency of ideal and actual cycles; Cycle air rate, temperature ratio; Effect of changes in specific heat and that of mass of fuel on power	14 Hrs

	and efficiency; Operating variables and their effects on thermal efficiency and work ratio; Thermal refinements like regeneration, inter-cooling and re-heating and their different combinations in the gas turbine cycle and their effects on gas turbine cycle i.e. gas turbine cycle. Multistage compression and expansion; Dual Turbine system; Series and parallel arrangements; Closed and Semi-closed gas turbine cycle; Requirements of a gas turbine combustion chamber; Blade materials and selection criteria for these materials and requirements of blade materials; Gas turbine fuels. **Unit –VIII Jet Propulsion** Principle of jet propulsion; Description of different types of jet propulsion systems like rockets and thermal jet engines, like **(i) Athodyds** (ramjet and pulsejet), **(ii)** Turbojet engine, and **(iii)** Turboprop engine. Thermodynamics of turbojet engine components; Development of thrust and methods for its boosting/augmentation; Thrust work and thrust power; Propulsion energy, Propulsion and thermal (internal) efficiencies; Overall thermal efficiency; Specific fuel c consumption**;** Rocket propulsion, its thrust and thrust power; Propulsion and overall thermal efficiency; Types of rocket motors (e.g. solid propellant and liquid propellant systems); Various common propellant combinations (i.e. fuels) used in rocket motors; Cooling of rockets; Advantages and disadvantages of jet propulsion over other propulsion systems; Brief introduction to performance characteristics of different propulsion systems; Fields of application of various propulsion units.	

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2404.1	For providing comprehensive understanding and thermodynamic analysis of positive displacement air compressors and thermal turbo machines used in power generation, aircraft, spacecraft and rocket propulsion.
CO2	BTME-2404.2	Able to understand the thermodynamic working as well as performance of thermal turbo power machinery
CO3	BTME-2404.3	Analyze and understand the various types of compressor along with their practical applications
C04	BTME-2404.4	Discuss about the working of different types of turbines along their jet propulsion

Suggested Readings / Books:

1. R. Yadav, Sanjay and Rajay, Applied Thermodynamics, Central Publishing House. 1998
2. J.S. Rajadurai, Thermodynamics and Thermal Engineering New Age International (P) Ltd. Publishers.
3. D.S. Kumar and V.P. Vasandani, Heat Engineering, Metropolitan Book Co. Pvt. Ltd. 2002
4. K. Soman, Thermal Engineering, PHI Learning Pvt. Ltd. 2004
5. G. Rogers and Y. Mayhew, Engineering Thermodynamics, Pearson. 2010
6. D.G. Shephered, Principles of Turbo machinery Macmillan. 2012
7. H. Cohen, G.F.C. Rogers and M. Sarvan, Gas Turbine Theory, Longmans.2008

SUBJECT TITLE: MANUFACTURING PROCESSES-II
SUBJECT CODE: BTME-2405
SEMESTER: 4
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	**Unit –I Metal Forming:** Introduction and classification. Rolling process: introduction, classification, rolling mills, products of rolling, rolling defects and remedies. Forging: open and closed die forging, forging operations, hammer forging, press forging and drop forging, forging defects, their causes and remedies. Extrusion: classification, equipment, defects and remedies. Drawing: drawing of rods, wires and tubes, draw benches, drawing defects and remedies. Sheet metal forming operations: piercing, blanking, embossing, squeezing, coining, bending, drawing and deep drawing, and spinning. Punch and die set up. Press working: press types, operations, press tools, progressive and combination dies. Process variables and numerical problems related to load calculation in Rolling, Forging, Extrusion, Drawing and Sheet metal forming. High velocity forming of metals: introduction, electro-hydraulic forming, mechanical high velocity forming, magnetic pulse forming and explosive forming. **Powder Metallurgy:** Introduction, advantages, limitations, and applications methods of producing metal powders, briquetting and sintering.	**15 Hrs**
2	**Unit–II Metal Cutting:** Introduction to machining processes, classification, Mechanics of chip formation process, concept of shear angle, chip contraction and cutting forces in metal cutting, Merchant theory, tool wear, tool life, machinability. Numerical problems based on above mentioned topics, Fundamentals of measurement of cutting forces and chip tool interface temperature. Cutting tools: types, geometry of single point	**15 Hrs**

	cutting tool, twist drill and milling cutter, tool signature. Cutting tool materials: high carbon steels, alloy carbon steels, high speed steel, cast alloys, cemented carbides, ceramics and diamonds, and CBN. Selection of machining parameters. Coolants and lubricants: classification, purpose, function and properties.	
3	**Unit III Machine Tools** Lathe: classification, description and operations, kinematic scheme of lathe, and lathe attachments. Shaping and planing machine: classification, description and operations, drive mechanisms. Milling machine: classification, description and operations, indexing devices, up milling and down milling. Drilling machine: classification, description and operations. Boring machine: classification, description and operations. Grinding machines: classification, description and operations, wheel selection, grinding wheel composition and nomenclature of grinding wheels, dressing and truing of grinding wheels. Broaching machine: classification, description and operations. Speed, feed and machining time calculations of all the above machines.	**15 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2405.1	Students will be able to Explain machining processes and cutting action involved
CO2	BTME-2405.2	Calculate / estimate machining parameters
CO3	BTME-2405.3	Differentiate among various machining processes
C04	BTME-2405.4	Select appropriate machining operation for particular application

Suggested Readings / Books:

1. B. L. Juneja and G. S. Sekhon, Fundamentals of Metal Cutting & Machine Tools, New Age International (P) Ltd. 2008
2. H.S. Shan, Manufacturing Processes, Vol. I&II, Pearson Publishers. 2002
3. PC Sharma, A Text Book of Production Technology, S. Chand & Company Ltd. 1998
4. M. P. Groover, Fundamentals of Modern manufacturing, Wiley 2010
5. SeropeKalpakjian and Steven R. Schmid, Manufacturing Engineering and Technology, Pearson Publishers. 2014

SUBJECT TITLE: THEORY OF MACHINES LAB
SUBJECT CODE: BMTE-2406
SEMESTER: 4
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 60
End Term Exam: 40

S. No.	Contents	Contact Hrs
1	To draw displacement, velocity & acceleration diagram of slider - crank and four bar mechanism.	**2 Hrs**
2	To study the various inversions of kinematic chains.	**2 Hrs**
3	Conduct experiments on various types of governors and draw graphs between height and equilibrium speed of a governor.	**2 Hrs**
4	Determination of gyroscopic couple (graphical method).	**2 Hrs**
5	Balancing of rotating masses (graphical method).	**2 Hrs**
6	Cam profile analysis (graphical method)	**2 Hrs**
7	Determination of gear- train value of compound gear trains and epicyclic gear trains.	**2 Hrs**
8	To draw circumferential and axial pressure profile in a full journal bearing.	**2 Hrs**
9	To determine coefficient of friction for a belt-pulley material combination.	**2 Hrs**
10	Determination of moment of inertia of flywheel.	**2 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2406.1	Analyze and draw the velocity, displacement and acceleration diagrams of various inversions of machines
CO2	BTME-2406.2	To discuss about the working of different types of governors along with their graphical representation
CO3	BTME-2406.3	Graphically represent the working profile of gyroscope, rotating masses and cam profile
C04	BTME-2406.4	Analyze the gear ratio of compound and epicyclic gear trains

SUBJECT TITLE: FLUID MECHANICS LAB
SUBJECT CODE: BMTE-2407
SEMESTER: 4
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 60
End Term Exam: 40

S. No.	Contents	Contact Hrs
1	To determine the metacentric height of a floating vessel under loaded and unloaded conditions.	**2 Hrs**
2	To study the flow through a variable area duct and verify Bernoulli's energy equation.	**2 Hrs**
3	To determine the coefficient of discharge for an obstruction flow meter (venture meter/ orifice meter)	**2 Hrs**
4	To determine the discharge coefficient for a V- notch or rectangular notch.	**2 Hrs**
5	To study the transition from laminar to turbulent flow and to ascertain the lower critical Reynolds number.	**2 Hrs**
6	To determine the hydraulic coefficients for flow through an orifice.	**2 Hrs**
7	To determine the friction coefficients for pipes of different diameters.	**2 Hrs**
8	To determine the head loss in a pipe line due to sudden expansion/ sudden contraction/ bend.	**2 Hrs**
9	To determine the velocity distribution for pipeline flow with a pitot static probe.	**2 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2407.1	To determine the fluid flow and metacentric heights of fluid flow through the vessel
CO2	BTME-2407.2	To evaluate the co-efficient of discharge for the fluid flows through notch
CO3	BTME-2407.3	To evaluate the hydraulic co-efficient and friction co-efficien5t flowing through the orifice
C04	BTME-2407.4	To discuss the velocity distribution of fluid flow pipe lines

SUBJECT TITLE: MANUFACTURING PROCESSES LAB
SUBJECT CODE: BMTE-2408
SEMESTER: 4
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 60
End Term Exam: 40

S. No.	Contents	Contact Hrs
1	**Welding:** To make lap joint, butt joint and T- joints with oxy- acetylene gas welding and manual arc welding processes	**2 Hrs**
2	**Welding:** To study MIG, TIG and Spot welding equipment and make weld joints by these processes	**2 Hrs**
3	**Machining and Forming:** To study constructional features of following machines through drawings/ sketches: a. Grinding machines (Surface, Cylindrical) b. Hydraulic Press c. Draw Bench d. Drawing and Extrusion Dies e. Rolling Mills	**4 Hrs**
4	**Machining and Forming:** To grind single point and multipoint cutting tools	**2 Hrs**
5	**Machining and Forming:** To prepare job on Lathe involving specified tolerances; cutting of V- threads and square threads.	**2 Hrs**
6	**Machining and Forming:** To prepare job on shaper involving plane surface,	**2 Hrs**
7	**Machining and Forming:** Use of milling machines for generation of plane surfaces, spur gears and helical gears; use of end mill cutters.	**2 Hrs**
8	**Machining and Forming:** To determine cutting forces with dynamometer for turning, drilling and milling operations	**2 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-2408.1	Discuss the basic of welding processes along with their practical applications
CO2	BTME-2408.2	Analyze the working principles of machining and forming operations
CO3	BTME-2408.3	Prepare a job in lathe machine and milling machine
C04	BTME-2408.4	Evaluate the cutting forces with the help of dynamometer for different machining operations

SYLLABUS

SEMESTER-V

SUBJECT TITLE: MATHEMATICS-III
SUBJECT CODE: BTME-3500
SEMESTER: 5
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	2	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	**UNIT-1** Fourier Series Periodic functions, Euler's formula. Even and odd functions, Change of Interval, half range expansions, Fourier series of different wave forms. **UNIT-2** Laplace Transforms: Definition, Laplace transforms of various standard functions, properties of Laplace transforms, inverse Laplace transforms, transform of derivatives and integrals, Transform of multiplication and division by t, convolution theorem, Laplace transform of unit step function. Applications to solution of ordinary linear differential equations with constant coefficients.	**22 Hrs**
2	**UNIT-3** Special Functions: Frobenius method for power series solution of differential equations, Bessel's equation, Bessel functions of the first and second kind, Legendre's equation, Legendre polynomial.	**8 Hrs**
3	**UNIT-4** Partial Differential Equations: Formation of partial differential equations, Equations solvable by direct integration, Linear partial differential equations, homogeneous partial differential equations with constant coefficients. Solution by method of separation of variables, Applications: Wave equation and Heat conduction equation in one dimension. Solution of two dimensional Laplace equation (Cartesian co-ordinates).	**14 Hrs**
4	**UNIT-5** Functions of Complex Variable: definition of Limit, continuity, derivative of complex functions, and analytic function. Necessary and sufficient conditions for analytic function (without proof), Cauchy-	**16 Hrs**

	Riemann equation (Cartesian and polar co-ordinates), harmonic functions, orthogonal system, determination of conjugate functions. Miller's Thosmson method, Applications to fluid flow problems. Brief introduction to basic transformations, Bilinear transformations, complex integration: Line integrals in the complex plane, Cauchy's integral theorem, Cauchy's integral formula for analytic function and its derivatives. Taylor's and Laurent's expansions, singular points, poles, residue, Cauchy's Residue theorem, evaluation of real integrals by contour integration (F(*cosx, sinx*)	

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3500.1	Students will be able to comprehensive understanding of Fourier series, Laplace transforms and various mathematical functions in engineering analysis
CO2	BTME-3500.2	To make students able to select various Engineering models for optimization and implementation with aforesaid applications
CO3	BTME-3500.3	To implement the various Mathematic equation for evaluating the results
C04	BTME-3500.4	To understand the function of Partial differential equation and complex variables

Suggested Readings / Books:

1. Kreyszing Erwin, Advanced Engineering Mathematics, Wiley Eastern, 2014
2. B.S Grewal, Higher Engineering Mathematics, Khanna Publishers, 2002
3. N.K Jain, Numerical Solutions of Differential Equations, Prentice Hall,2006
4. Sharma and Gupta, Differential Equations, Krishna Prakashan Media,2008
5. N.P Bali , Text book of Eng Mathematics, Laxmi Publishers,2000

SUBJECT TITLE: DESIGN OF MACHINE ELEMENT-I
SUBJECT CODE: BTME-3501
SEMESTER: 5
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	2	0	5

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Meaning of design with special reference to machine design, definition and understanding of various types of design, design process, design and creativity, general design considerations, concept of tearing, bearing, shearing, crushing, bending and fracture. Designation of materials according to Indian standards code, basic criteria of selection of material, mechanical properties of materials	**12 Hrs**
2	Concept of concurrent engineering in design, introduction to 'Design for X' manufacturing considerations in machine design, stress concentration, factor of safety under different loading conditions, design for static loading, design for variable loading for both limited and unlimited life, concept of fatigue and endurance strength. **Design of fasteners:** Design of rivets for boiler joints, lozenge joints, eccentrically loaded joints. Design of spigot and socket cotter joint, gib and cotter joint and knuckle joint. Design of welded joints for various loading conditions in torsion, shear or direct loads, eccentrically loaded joints	**22 Hrs**
3	**Design of shaft and axles:** Design of solid and hollow shafts for transmission of torque, bending moments and axial forces, Design of shaft for rigidity, Design of axle. **Design of keys and couplings:** Design of keys, design of splines, design of sleeve and solid muff coupling, clamp or compression coupling, rigid and flexible flange coupling, design of	**16 Hrs**

	universal joint.	
4	**Design of levers and links:** Design of levers(foot lever, hand lever, cranked lever, bell crank lever, safety valve lever and shoe brake lever), design of link **Design of pipe joints:** Stresses in pipe joints, design of pipe joints with oval flange, square flange, design of seals and gaskets.	**18 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3501.1	To design the required size of shaft, key and coupling for the given application
CO2	BTME-3501.2	To identify various failures and calculate resisting areas of machine elements
CO3	BTME-3501.3	To design machine element subjected to direct, bending, twisting and combined stress
C04	BTME-3501.4	To implement the Mathematics formulas and thereafter design the various Mechanical elements

Suggested Readings / Books:

1. Joseph E. Shigley, Charles Russell Mischke, Richard Gordon Budynas, Mechanical Engineering Design, McGraw-Hill, 2006
2. Robert C. Juvinall Fundamentals of machine component design, Wiley 2008
3. V.K Jadon, Analysis and design of machine elements, I.K. International,2010
4. V.B Bhandari, Design of Machine elements, Tata Mc. Hill, 2006
5. S.S Jolly, Design of machine elements-I, DhanpatRai and Co., 2012

SUBJECT TITLE: COMPUTER AIDED DESIGN AND MANUFACTURING
SUBJECT CODE: BTME-3502
SEMESTER: 5
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	**Fundamentals of CAD:** Design process with and without computer; CAD/CAM system and its evaluation criteria, brief treatment of input and output devices, Display devices; Functions of a graphics package and Graphics standard GKS, IGES and STEP; Modeling and viewing; Application areas of CAD. **Geometric Transformations:** Mathematics preliminaries, matrix representation of 2 and 3 dimensional Concatenation of transformation matrices. Application of geometric transformations. **Geometric Modeling:** Wireframe model: solid modeling: Boundary Representation (B-rep), Constructive Solid Geometry (CSG), Parametric Modeling Technique ; Mass , volumetric properties calculations; surface modeling, concepts of hidden-line removal and shading: Mechanical Assembly Kinematics analysis and simulation.	**18 Hrs**
2	**Representation of curves and surfaces:** Non-parametric and parametric representation of curves. Parametric representation of Hermite Cubic, Beizer and B-spline curves; Surface and its analysis. Representation of Analytical and synthetic surfaces. Overview of FEM, Advantages and applications, recent advance in FEM, FEA software Basic principles and general procedure of FEM.	**12 Hrs**
3	**NC/CNC Machine Tools:** NC machine tools- basic components, coordinate systems; features of NC machine tools. Computerized Numerical Control (CNC): Tooling for NC	**6 Hrs**

	machines - tool presetting equipment, flexible tooling, tool length compensation, tool path graphics; NC motion control system; Manual part programming, fixed/floating zero. Block format and codes: Computer assisted part programming. DNC and Adaptive Control: Direct numerical control: Adaptive control in machining system; Combined DNC/CNC system.	
4	**Group Technology (GT):** Part families; part classification and coding system, Group technology, machine cells, Advantages of GT. **Computer Aided Process Planning:** Introduction and benefits of CAPP. Types of CAPP systems, machinability, data selection systems in CAPP. **Computer Integrated Manufacturing Systems:** Basic Concepts of CIM: CIM Definition, The meaning of Manufacturing, Types of Manufacturing systems; Need, Elements, Evolution of CIM; Benefits of CIM; Flexible Manufacturing Systems: Physical Components of an FMS. Types of Flexibility, Layout Considerations; FMS benefits.	**9 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3502.1	To understand the concept of Graphic systems and standards and its interfacing for various geometric transformations in design engineering
CO2	BTME-3502.2	To understand various types of design processes for its transformation into wireframe models
CO3	BTME-3502.3	To gain knowledge of Parametric Modeling Techniques and different applications in Mechanical engineering
C04	BTME-3502.4	To understand and analyze the various processes such as group technology, computer aided process planning and computer integrated manufacturing systems

Suggested Readings / Books:

1. Mikell P. Groover, Emory W. Zimmers, CAD/CAM, PHI, 2002
2. D.D. Bedworth, M.R Henderson & P.M. Wolfe, Computer Integrated Design and Manufacturing, Tata McGraw Hill,2008
3. ZeidIbraham, CAD/CAM - theory and Practice, Tata McGraw Hill,1998
4. P. N Rao, CAD/CAM, Tata McGraw Hill,2004
5. C. Elanchezhian, G. ShanmugaSundar, Computer aided manufacturing (CAM), Firewall Media,2010

SUBJECT TITLE: MECHANCIAL MEASUREMENTS AND METROLOGY
SUBJECT CODE: BTME-3503
SEMESTER: 5
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	**General Concepts** Need and classification of measurements and instruments; basic and auxiliary functional elements of a measurement system; Mechanical versus electrical / electronic instruments; primary, secondary and working standards. **Static and Dynamic Characteristics of Instruments** Range and span, accuracy and precision, calibration, hysteresis and dead zone, sensitivity and linearity, threshold and resolution; speed of response, lag, fidelity and dynamic error, dead time and dead zone. Zero, first and second order systems and their response to step, ramp and sinusoidal input signals.	**10 Hrs**
3	**Errors in Measurement** Sources of errors, systematic and random errors; statistical analysis of test-data, probable error and probability tables, rejection of test data, error propagation; Design and planning of experiments and report writing. **Metrology** Line, end and wavelength standards; linear measurements - vernier scale and micrometer, vernier height gauge and depth gauge; comparators - their types, relative merits and limitations; Angular measurements - sine bar, clinometer, angle gauge; concept and measurement of straightness and flatness by interferometry; surface roughness - specifications and measurement, Measurement of major diameter, minor diameter, effective diameter, pitch, angle and form of threads for internal and external threads;	**16 Hrs**

	measurement of tooth thickness, pitch and checking of profile for spur gears.	
5	**Functional Elements** Introduction to sensors and transducers, types of sensors, review of electro-mechanical sensors and transducers - variable resistance, inductance and capacitive pick ups, photo cells and piezo-electric transducers and application of these elements for measurement of position / displacement, speed / velocity / acceleration, force and liquid level. Resistance strain gauges, gauge factor, bonded and unbounded gauges, surface preparation and bonding technique signal conditioning and bridge circuits, temperature compensation, application of strain gauges for direct, bending and torsional loads. Introduction to amplifying, transmitting and recording devices. **Pressure and Flow Measurement** Bourdon tube, diaphragm and bellows, vacuum measurement - Mcleod gauge, thermal conductivity gauge and ionization gauge; Dead weight gauge tester. Electromagnetic flux meters, ultra-sonic flow meters and hot wire anemometer: flow visualization techniques	**13 Hrs**
7	**Temperature Measurement** Thermal expansion methods - bimetallic thermometers, liquid-in-glass thermeter and filled-in-system thermometers; thermo-electric sensors - common thermo couples, reference junction considerations, special materials and configurations; metal resistance thermometers and thermistors; optical and total radiation pyrometers; calibration standards. **Speed, Force, Torque and Shaft Power Measurement** Mechanical tachometers, vibration reed tachometer and stroboscope; proving ring, hydraulic and pneumatic load cells, torque on rotating shafts; Absorption, transmission and driving dynamo meters.	**10 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3503.1	To describe basic concepts of mechanical measurement, errors in measurements and uncertainty
CO2	BTME-3503.2	To identify the type of measurement instruments and their relevant specification etc. which can be used in a particular process parameter measurement selection?
CO3	BTME-3503.3	To explain the theory of stress & strain, force and torque measurements
C04	BTME-3503.4	To measure the speed, force, torque and shaft pressure of various measuring components

Suggested Readings / Books:

1. E.O Doebelin, Measurement System: Application and Design, McGraw Hill, 2012
2. J.P Holman, Experimental Methods for Engineers, McGraw Hill,2013
3. D.S Kumar, Mechanical Measurement and Control, Metropolitan Book Co.,2000
4. R.K Jain, Engineering Metrology, Khanna Publishers,1998
5. B.C Kuo, Automatic Control systems, Prentice Hall,2006

SUBJECT TITLE: AUTOMOBILE ENGINEERING
SUBJECT CODE: BTME-3504
SEMESTER: 5
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	**Introduction** Basic structure, general layout and type of automotive vehicles, Frameless and unitary construction; position of power unit **Power Unit** Power requirements - motion resistance and power loss, tractive effort and vehicle performance curves; selection of power unit and engine performance characteristics; pollution due to vehicle emission and exhaust emission control system, silencers, types of pistons and rings **Fuel Supply System** Air cleaner and fuel pumps; Air fuel requirements and carburation; constructional details of Carter carburetors and fuel injection systems; MPFi (Petrol), Diesel fuel system - cleaning, injection pump, injector and nozzles, Common Rail fuel supply system	**13 Hrs**
2	**Lubrication and Cooling Systems** Necessity of lubrication; Desirable properties of lubricants; various types of lubricants and oil additives; different systems of lubrication - oil filters, oil pumps and oil pressure indicator; crank case ventilation and dilution. Purpose of cooling, air and water cooling systems; radiator, thermostat, pump and fan **Chassis and Suspension** Loads on the frame, considerations of strength and stiffness, engine mounting, independent suspension systems (Mac Pherson, Trailing Links, Wishbone), shock absorbers and stabilizers; wheels and tyres, tyre wear types, constructional details of plies	**12 Hrs**

3	**Transmission system** Basic requirements and standard transmission systems; constructional features of automobile clutch, gear box, differential, front and rear axles; overdrives, propeller shaft, universal joint and torque tube drive; Rear wheel vs front wheel drive, principle of automatic transmission **Steering System** Requirement and steering geometry; castor action, camber and king pin angle, toe-in of front wheels, steering linkages and steering gears; wheel alignment; power steering, Ball re-circulating mechanism **Braking System** General braking requirements; Mechanical, hydraulic, vacuum power and servo brakes; Weight transfer during braking and stopping distances	**14 Hrs**
4	**Electric System** Classification, Introduction to Conventional and transistorized ignition systems; Charging, capacity ratings and battery testing; starter motor and drive arrangements: voltage and current regulation **Maintenance** Preventive maintenance, trouble shooting and rectification in different systems; engine tuning and servicing, major tools used for maintenance of automobiles	**6 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3504.1	To understand the basic layout of an automobile
CO2	BTME-3504.2	Understand the operation of engine cooling, lubrication, ignition, electrical and air conditioning systems
CO3	BTME-3504.3	Analyze the vehicle transmission, suspension, steering and braking systems
C04	BTME-3504.4	Understand automotive electronics and explore latest developments in automobiles

Suggested Readings / Books:

1. W.H Crouse, Automotive mechanics, McGraw Hill,2008
2. J. Heitner, Automotive Mechanics, East West Press,2010
3. Kirpal Singh, Automobile Engineering Vol. I and II, Standard Publishers,2001
4. J. Webster, Auto Mechanics, Glencoe Publishing Co.,2004
5. P.S Gill, Automobile Engineering, S.K Kataria,2004

SUBJECT TITLE: INDUSTRIAL AUTOMATION AND ROBOTICS
SUBJECT CODE: BTME-3505
SEMESTER: 5
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	**Introduction:** Concept and scope of automation, Socio economic impacts of automation, Types of Automation, Low Cost Automation **Fluid Power**: Fluid power control elements, Standard graphical symbols, Fluid power generators, Hydraulic and pneumatic Cylinders - construction, design and mounting; Hydraulic and pneumatic Valves for pressure, flow and direction control	**16 Hrs**
2	**Basic hydraulic and pneumatic circuits:** Direct and Indirect Control of Single/Double Acting Cylinders, Designing of logic circuits for a given time displacement diagram & sequence of operations, Hydraulic & Pneumatic Circuits using Time Delay Valve & Quick Exhaust Valve Memory Circuit & Speed Control of a Cylinder. Troubleshooting and "Causes & Effects of Malfunctions". Basics of Control Chain Circuit Layouts. Designation of specific Elements in a Circuit	**8 Hrs**
3	**Fluidics:** Boolean algebra, Truth Tables, Logic Gates, Coanda effect **Electrical and Electronic Controls** Basics of Programmable logic controllers (PLC), Architecture & Components of PLC ,Ladder Logic Diagrams	**10 Hrs**
4	**Transfer Devices and feeders:**	**11 Hrs**

	Classification, Constructional details and Applications of Transfer devices, Vibratory bowl feeders, Reciprocating tube, Centrifugal hopper feeders **Robotics Introduction:** Classification based on geometry, control and path movement, Robot Specifications, Robot Performance Parameters Robot Programming, Machine Vision, Teach pendants, Industrial Applications of Robots	

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3505.1	To understand the need and concept of Automation in Conventional Mechanical System
CO2	BTME-3505.2	To understand various types of Basic hydraulic and pneumatic circuits systems
CO3	BTME-3505.3	To gain knowledge of Electrical and Electronic Controls and Industrial Applications of Robots
C04	BTME-3505.4	Analyze and understand the various transfer devices and feeders

Suggested Readings / Books:

1. Anthony Esposito, Fluid Power with applications, Pearson, 2008
2. S. R Majumdar, Pneumatic Control, McGraw Hill,2006
3. S. R Deb, Robotic Technology and Flexible Automation, Tata Mc Hill,2012
4. Saeed B. Niku Introduction to Robotics, Wiley India, 2014
5. AshitavaGhosal, Robotics, Oxford,2006

SUBJECT TITLE: COMPUTER AIDED DESIGN AND MANUFACTURING LAB
SUBJECT CODE: BMTE-3506
SEMESTER: 5
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 60
End Term Exam: 40

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	**Introduction to modeling (using any CAD software)**: 2D drawing using sketcher – 2 Drawings 3D modeling using 3D features (Modeling of Crane Hook, Bench Vice, Screw Jack components) Assembling and drafting (any 2 above mentioned assemblies) with proper mating conditions and interference checking. Surface modeling – (Computer mouse, Plastic bottles with spraying Nozzle)	**16Hrs**
2	**Computer Aided Manufacturing:** Manual part programming on CNC Lathe and CNC Milling – (4 programs, 2 for each) Computer Aided Part programming for CNC Lathe and CNC Milling to generate tool path, NC code, and Optimization of tool path (to reduce machining time) using any CAM software.	**8 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3506.1	To understand the basics of working with Auto CAD, also to be familiar with various 2D commands
CO2	BTME-3506.2	Analyze and draw a 2D and 3D models of various Mechanical Components
CO3	BTME-3506.3	To understand the basics of part programming and CNC lathe and CNC milling machine

C04	BTME-3506.4	Analyze and draw a 2D and 3D models of various Mechanical Components

Suggested Readings / Books:

1. CAD/CAM by Groover and Zimmer, Prentice Hall, 2005.
2. CAD/CAM: Theory and Practice by I. Zeid, McGraw Hill, 2004.
3. Geometric Modeling by M.E. Mortenson, 2001.

SUBJECT TITLE: MECHANICAL MEASUREMENTS AND METROLOGY LAB
SUBJECT CODE: BMTE-3507
SEMESTER: 5
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 60
End Term Exam: 40

S. No.	Contents	Contact Hrs
1	Measurement of an angle with the help of sine bar	**2 Hrs**
2	Measurement of surface roughness of a machined Plate, Rod and Pipe	**2 Hrs**
3	Measurement of gear elements using profile projector	**2 Hrs**
4	Measurement of effective diameter of external threads using Three wire method	**2 Hrs**
5	Measurement of thread element by Tool makers microscope	**2 Hrs**
6	Calibration of a pressure gauge with the help of a dead weight gauge tester	**2 Hrs**
7	Use of stroboscope for measurement of speed of shaft	**2 Hrs**
8	Use of pitot tube to plot velocity profile of a fluid through a circular duct	**2 Hrs**
9	Preparation of a thermocouple, its calibration and application for temperature measurement	**2 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3507.1	Use of various measuring instruments as per their practical applications
CO2	BTME-3507.2	To measure the angle, surface roughness, gear profile and effective of various machined elements
CO3	BTME-3507.3	To measure the pressure and speed as per the practical approach
C04	BTME-3507.4	To analyze and measure the temperature using thermocouples

SUBJECT TITLE: AUTOMOBILE ENGINEERING LAB
SUBJECT CODE: BMTE-3508
SEMESTER: 5
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 60
End Term Exam: 40

S. No.	Contents	Contact Hrs
1	Valve refacing and valve seat grinding and checking for leakage of valves	**2 Hrs**
2	Trouble shooting in cooling system of an automotive vehicle	**2 Hrs**
3	Trouble shooting in the ignition system, setting of contact breaker points and spark plug gap	**2 Hrs**
4	Demonstration of steering system and measurement of steering geometry angles and their impact on vehicle performance.	**2 Hrs**
5	Demonstration of Various Transmission System of an automotive vehicle.	**2 Hrs**
6	Trouble shooting in braking system with specific reference to master cylinder, brake shoes, overhauling of system and the adjusting of the system and its testing.	**2 Hrs**
7	Fault diagnosis in transmission system including clutches, gear box assembly and differential.	**2 Hrs**
8	Replacing of ring and studying the method of replacing piston and piston rings	**2 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3508.1	To understand the basic layout of valve mechanism used in engine block assembly
CO2	BTME-3508.2	To analyze the trouble shooting of ignition system and cooling system in automobile engine
CO3	BTME-3508.3	To understand the various transmission systems of an automobile vehicle
C04	BTME-3508.4	To diagnose the faults in transmission system including clutches, gear box assembly, etc.

SUBJECT TITLE: INDUSTRIAL AUTOMATION AND ROBOTICS LAB
SUBJECT CODE: BMTE-3509
SEMESTER: 5
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 60
End Term Exam: 40

S. No.	Contents	Contact Hrs
1	Design and assembly of hydraulic / pneumatic circuit.	**2 Hrs**
2	Demonstration and working of power steering mechanism	**2 Hrs**
3	Study of reciprocating movement of double acting cylinder using pneumatic direction control valves	**2 Hrs**
4	Use of direction control valve and pressure control valves clamping devices for jig and fixture	**2 Hrs**
5	Study of robotic arm and its configuration	**2 Hrs**
6	Study the robotic end effectors	**2 Hrs**
7	Study of different types of hydraulic and pneumatic valves	**2 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3509.1	Analyze and design of basic circuits used in automation industry
CO2	BTME-3509.2	Demonstrate the working of power steering along with control valves
CO3	BTME-3509.3	Use of control valves and clamping devices for jig and fixtures
C04	BTME-3509.4	Study and analyze the working of robotic arm and robot end effectors.

SUBJECT TITLE: PERSONALITY DEVELOPMENT-I
SUBJECT CODE: BTPD-3521
SEMESTER: 5
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	2

Internal Assessment: 60
External Assessment: 40

In this student has to attend the classes for improving their personality skills

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTPD-3521.1	Demonstrate soft skills required for business situations and understand the importance of soft skills as well as interpersonal skills
CO2	BTPD-3521.2	Develop various kind of soft and professional skills
CO3	BTPD-3521.3	Communicate fluently
C04	BTPD-3521.4	Understand the importance of team building and time management
C05	BTPD-3521.5	Learn active listening and responding skills
C06	BTPD-3521.6	Learn the accurate styles of digital communication

SUBJECT TITLE: INDUSTRIAL TRAINING
SUBJECT CODE: BTME-3510
SEMESTER: 5
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	2

Internal Assessment: 60
End Term Exam: 40

In this student has to submit a file of what they have did in their Industrial training

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3510.1	To participate in ongoing projects of the industry
CO2	BTME-3510.2	Determine the use of advanced machining tools and techniques
CO3	BTME-3510.3	Interact with industry personnel and follow the Engineering practices
C04	BTME-3510.4	Develop awareness about general workshop behavior and built a team skills

SYLLABUS

SEMESTER-VI

SUBJECT TITLE: DESIGN OF MACHINE ELEMENTS -II
SUBJECT CODE: BTME-3601
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	2	0	5

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	**Transmission Drives** Belt and rope drives: Basics, Characteristics of belt drives, selection of flat belt, Design of Flat belt, V-belt and rope (steel wire), Design of the pulley for the same, Chain Drives: Basics, Roller chains, polygonal effect, power rating, selection of chain, Gear drives: Standard system of gear tooth and gear module, gear tooth failure, strength of gear tooth, terminology of spur, helical, bevel, worm and worm wheel, Design of spur, helical, straight bevel gears, worm and worm wheel	**15 Hrs**
2	**Bearings** **Slider:** Principle of hydrodynamic lubrication, modes of lubrication, Reynolds equation, bearing performance parameters, slider bearing design **Roller**: Types, selection guidelines, static and dynamic load carrying capacity, Stribeck's equation, equivalent bearing load, load life relationship, selection of bearing, comparison of roller and slider bearing	**8 Hrs**
3	**Design of Flywheel** Introduction, Energy stored in a flywheel, stresses in a rim, design considerations **Springs** Types; end styles of helical compression spring; stress and deflection equation; surge in spring; nipping of leaf spring; Design of close-coil helical spring and multi leaf spring.	**19 Hrs**
4	**Clutches** Design of contact clutches i.e. plate, multi-disc, cone and centrifugal	**18 Hrs**

	clutches. **Brakes** Design of band, disc, block with shoe and internal expanding brakes.	

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3601.1	Able to design components of mechanical systems
CO2	BTME-3601.2	Capable of designing mechanical components and assemblies for industrial & domestic applications
CO3	BTME-3601.3	Capable of modifying the existing systems and developing better components
C04	BTME-3601.4	Analyze and design of various types of clutches and brake of an automobile, vehicle

Suggested Readings / Books:

1. Joseph E. Shigley, Charles Russell Mischke, Richard Gordon Budynas, Mechanical Engineering Design, McGraw-Hill.2006.
2. Robert C. Juvinall Fundamentals of machine component design, JohnWiley Eastern.2008
3. V.K Jadon, Analysis and design of machine elements, I.K. International.2010
4. V.B Bhandari, Design of Machine elements, Tata Mc-Graw. Hill.2006
5. S.S Jolly, Design of machine elements-II, DhanpatRai and Co.2012

SUBJECT TITLE: HEAT TRANSFER
SUBJECT CODE: BTME-3602
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	**Introduction:** Concept of heat transfer, Difference between the subject of "Heat Transfer" and its parent subject "Thermodynamics". Different modes of heat transfer - conditions, convection, and radiation. **Conduction:** Fouier's law of heat conduction, coefficient of thermal conductivity, effect of temperature and pressure on thermal conductivity of solids, liquids and gases and its measurement. Three-dimensional general conduction equation in rectangular, cylindrical and spherical coordinates involving internal heat generation and unsteady state conditions. Derivation of equations for simple one dimensional steady state heat conduction from three dimensional equations for heat conduction though walls, cylinders and spherical shells (simple and composite), electrical analogy of the heat transfer phenomenon in the cases discussed above. Influence of variable thermal conductivity on conduction through simple cases of walls / cylinders and spheres. Equivalent areas, shape factor, conduction through edges and corners of walls and critical thickness of insulation layers on electric wires and pipes carrying hot fluids. Internal generation cases along with some practical cases of heat conduction like heat transfer through piston crown, through under-ground electrical cables/Hot fluid pipes etc and case of nuclear fuel rod with and without cladding. Introduction to unsteady heat transfer, Newtonian heating and cooling of solids; definition and explanation of the term thermal diffusivity.	**20 Hrs**

	Numerical	
2	**Theory of Fins:** Concept of fin, classification of fins and their applications. Straight fins of uniform cross-section; e.g. of circular, rectangular or any other cross-section). Straight fins with varying cross-sectional area and having triangular or trapezoidal profile area. Circumferential fins of rectangular cross-section provided on the circumference of a cylinder. Fin performance: fin effectiveness and fin efficiency, total fin effectiveness, total fin efficiency. Optimum design of straight fin of rectangular and triangular profile area. Application of fins in temperature measurement of flow through pipes and determination of error in its measurement. Numerical.	**8 Hrs**
3	**Convection:** Free and forced convection. Derivation of three-dimensional mass, momentum and energy conservation equations (with introduction to Tensor notations). Boundary layer formation, laminar and turbulent boundary layers (simple explanation only and no derivation). Theory of dimensional analysis and its application to free and forced convective. heat transfer. Analytical formulae for heat transfer in laminar and turbulent flow over vertical and horizontal tubes and plates. Numerical. Newton's law of cooling. Overall coefficient of heat transfer. Different design criterion for heat exchangers. Log mean temperature difference for evaporator and condenser tubes, and parallel and counter flow heat exchangers, Calculation of number and length of tubes in a heat exchanger effectiveness and number of transfer units(NTU); Numerical.	**12 Hrs**
4	**Convection with Phase Change (Boiling and Condensation):** Pool boiling, forced convection boiling, heat transfer during pool boiling of a liquid. Nucleation and different theories of nucleation, different theories accounting for the increased values of h.t.c. during nucleate phase of boiling of liquids; different phases of flow boiling (theory only), Condensation, types of condensation, film wise condensation on a vertical and inclined surface, Numerical. **Radiation:** Process of heat flow due to radiation, definition of emissivity, absorptivity, reflectivity and transmissivity. Concept of black and grey bodies, Plank's law of nonchromatic radiation. Kirchoff's law and Stefan Boltzman's law. Interchange factor. Lambert's Cosine law and the geometric factor. Intensity of Radiation (Definition only), radiation density, irradiation, radiosity and radiation shields. Derivation formula for radiation exchange between two bodies using the definition of radiosity and irradiation and its application to cases of radiation exchange between three or four bodies (e.g. boiler or other furnaces), simplification of the formula for its application to simple bodies like two parallel surfaces, concentric cylinders and a body enveloped by another body etc. Error in Temperature measurement by a thermocouple probe due to radiation	**20 Hrs**

	losses.	

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3602.1	To understand the basic modes of heat transfer
CO2	BTME-3602.2	Account for the consequence of heat transfer in thermal analyses of engineering systems
CO3	BTME-3602.3	Obtain numerical solutions for conduction, convection and radiation heat transfer problems
C04	BTME-3602.4	Design heat exchangers using LMTD and NTU methods

Suggested Readings / Books:

1. Frank P. Incropera and David P. De Witt, Fundamentals of Heat and Mass transfer, John Wiley.2014
2. P.S. Ghoshdastidar, Heat Transfer, Oxford Press.2008
3. D.S. Kumar, Fundamentals of Heat and Mass Transfer, SK Kataria & Sons (6^{th}/7^{th} Edition).2002
4. A.J. Chapman, Heat Transfer, McGraw Hill Book Company, New York.2004
5. J.P. Holman, Heat Transfer, Tata McGraw-Hill Publishing Company Ltd.(Special Indian Edition).2006
6. YunusA.Cengel, Heat and Mass Transfer, Tata McGraw Hills Education Private Ltd (Special Indian Edition).2008
7. Eckert & Drake, Heat and Mass Transfer, McGraw Hill Book Company, New York.2012

SUBJECT TITLE: FLUID MACHINERY
SUBJECT CODE: BTME-3603
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	**General Concepts**: Impulse momentum principle; jet impingement on stationary and moving flat plates, and on stationary or moving vanes with jet striking at the centre and tangentially at one end of the vane; calculations for force exerted, work done and efficiency of jet. Basic components of a turbo machine and its classification on the basis of purpose, fluid dynamic action, operating principle, geometrical features, path followed by the fluid and the type of fluid etc. Euler's equation for energy transfer in a turbo machine and specifying the energy transfer in terms of fluid and rotor kinetic energy changes.	**6 Hrs**
2	**Pelton Turbine**: Component parts and operation; velocity triangles for different runners, work output; Effective head, available power and efficiency; design aspects such as mean diameter of wheel, jet ratio, number of jets, number of buckets with working proportions **Francis and Kaplan Turbines**: Component parts and operation velocity triangles and work output; working proportions and design parameters for the runner; Degree of reaction; Draft tubes - its function and types. Function and brief description of commonly used surge tanks, Electro- Mechanical governing of turbines	**16 Hrs**
3	**Centrifugal Pumps:** Layout and installation; Main elements and their functions; Various types and classification; Pressure changes in a pump - suction, delivery and	**16 Hrs**

	manometric heads; vane shape and its effect on head-capacity relationships; Departure from Euler's theory and losses; pump output and efficiency; Minimum starting speed and impeller diameters at the inner and outer periphery; Priming and priming devices, Multistage pumps - series and parallel arrangement; submersible pumps. Construction and operation; Axial and mixed flow pumps; Trouble shooting - field problems, causes and remedies. **Similarity Relations and Performance Characteristics**: Unit quantities, specific speed and model relationships, scale effect; cavitation and Thoma's cavitation number; Concept of Net Positive Suction Head (NPSH) and its application in determining turbine / pump setting	
4	**Reciprocating Pumps**: Components parts and working; pressure variations due to piston acceleration; acceleration effects in suction and delivery pipes; work done against friction; maximum permissible vacuum during suction stroke; Air vessels **Hydraulic Devices and Systems**: Const., operation and utility of simple and differential accumulator, intensifier, fluid coupling and torque converter, Air lift and jet pumps; gear, vane and piston pumps, Hydraulic Rams	**12 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3603.1	To understand the basic concepts of impact of jet with respect to hydro turbo machines
CO2	BTME-3603.2	Discuss the different machinery along with their practical approach
CO3	BTME-3603.3	To understand and design various types of hydraulic turbines and their phenomenon for static and dynamic application
C04	BTME-3603.4	To gain knowledge of different hydraulic pumps and their characteristics for different applications in Mechanical engineering

Suggested Readings / Books:

1. R.L. Daughaty, Hydraulic Turbines, McGraw Hill. 2009
2. JagdishLal, Hydraulic Machines by Metropolitan Book Co 1998
3. D.S. Kumar, Fluid Mechanics and Fluid Power Engineering, SK Kataria and Sons,1996
4. K. Subramaniam, Hydraulic Machines, Tata McGraw Hill.2007
5. R.K. Purohit., Hydraulic Machines, Scientific Publishers. 2011

SUBJECT TITLE: HEAT TRANSFER LAB
SUBJECT CODE: BTME-3604
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 60
End Term Exam: 40

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Determination of thermal conductivity of: A solid insulating material by slab method, Powder materials by concentric spheres method / or by some transient heat transfer technique, A metal by comparison with another metal by employing two bars when kept in series and /or in parallel under different boundary conditions, Liquids by employing thin layer	**4 hrs**
2	Determination of coefficient of heat transfer for free/forced convection from the surface of cylinder/plate when kept: Along the direction of flow, Perpendicular to the direction of flow, Inclined at an angle to the direction of flow	**4 Hrs**
3	To plot the pool boiling curves for water and to determine its critical point	**2 Hrs**
4	Determination of heat transfer coefficient for i) film condensation ii) drop-wise condensation	**2 Hrs**
5	Determination heat transfer coefficient by radiation and hence find the Stefan Boltzman's constant using two plates/two cylinders of same size by making one of the plates/cylinders as a black body.	**2 Hrs**
6	Determination of shape factor of a complex body by an analog technique	**2 Hrs**
7	To plot the temperature profile and to determine fin effectiveness and fin efficiency for: 1. A rod fin when its tip surface is superimposed by different boundary condition like Insulated tip, Cooled tip and Temperature controlled tip 2. Straight triangular fins of various sizes and optimization of fin proportions 3. Circumferential fins of rectangular/triangular section	**4 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3604.1	Understand the effects of various heat transfer modes
CO2	BTME-3604.2	To experimentally determine the thermal conductivity of insulating rod and powders

CO3	BTME-3604.3	Comparative evaluation between natural and forced conventions through experimental approach
C04	BTME-3604.4	Determine the experimentation on radiation for finding out the value of Stefan Boltzmann's constant and emissivity of metallic surface

SUBJECT TITLE: FLUID MACHINERY LAB
SUBJECT CODE: BTME-3605
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 60
End Term Exam: 40

S. No.	Contents	Contact Hrs
1	Determination of various efficiencies of Hydraulic Ram	**2 Hrs**
2	To draw characteristics of Francis turbine/Kaplan Turbine	**2 Hrs**
3	To study the constructional features of reciprocating pump and to perform test on it for determination of pump performance	**2 Hrs**
4	To draw the characteristics of Pelton Turbine	**2 Hrs**
5	To draw the various characteristics of Centrifugal pump	**2 Hrs**
6	Determine the effect of vane shape and vane angle on the performance of centrifugal fan/Blower	**2 Hrs**
7	A visit to any Hydroelectric Power Station	**2 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3605.1	Interpret the dynamic action of liquid jets in developing motive forces on objects
CO2	BTME-3605.2	Explain the concept of hydraulic ram and different types of turbine
CO3	BTME-3605.3	Illustrate the concept of specific speed and unit quantities as applied to turbines and pumps
C04	BTME-3605.4	Explain the construction of centrifugal pumps. Make use of the governing equations for head developed, power and efficiency of centrifugal pumps

SUBJECT TITLE: PERSONALITY DEVELOPMENT-II
SUBJECT CODE: BTPD-3621
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 60
External Assessment: 40

In this student has to attend the classes for improving their personality skills

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTPD-3621.1	Make use of techniques for self-awareness and self-development
CO2	BTPD-3621.2	Apply the conceptual understanding of communication into everyday practice
CO3	BTPD-3621.3	Understand the importance of teamwork and group discussions skills
C04	BTPD-3621.4	Develop time management and stress management
C05	BTPD-3621.5	Apply business etiquette effectively an engineer requires communicate fluently and develop all the soft and profession skills required for corporate sector
C06	BTPD-3621.6	Learn to overcome problems associated with personality

SUBJECT TITLE: MINOR PROJECT
SUBJECT CODE: BTME-3606
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 60
End Term Exam: 40

In this student has to give a proposal to the project they have decided

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3606.1	To find out the relevant research gaps from the existing literature review
CO2	BTME-3606.2	Analyze the problem formulation and identify the methodology of your work
CO3	BTME-3606.3	Design the blue prints of your project
C04	BTME-3606.4	Fabrication of your project

(OPEN ELECTIVE-I)

SUBJECT TITLE: STATISTICAL AND NUMERICAL METHODS IN ENGINEERING
SUBJECT CODE: BTME-3600
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Data, its Arrangements and Measures: Introduction: Data, Data Array; Frequency Distribution Construction and Graphic representation. Mean, median, mode and standard deviation. Probability and Probability Distributions: Introduction: Definition probability and Probability Distribution; Conditional probability; Random variables, Poisson, Normal and Binomial distributions Sampling and Sampling Distributions: Introduction: Fundamentals of Sampling, Large samples, small samples; Normal sampling distributions; Sampling distribution of the means, t-Distribution, F-Distribution, Chi-square Distribution.	**22 Hrs**
2	Errors in Numerical Calculations: Errors and their analysis, general error formula, errors in a series approximation Solution of Algebraic and Transcendental Equations: Bisection method, iteration method, Method of false position, Newton-Raphson method, solution of systems of non linear equations. Interpolation Method: Finite difference, forward, backward and central difference, Difference of polynomial, Newton's formulae for interpolation, central difference interpolation formulae, Interpolation with unevenly spaced points, Newton's	**20 Hrs**

	general interpolation formula, interpolation by iteration.	
3	Numerical Differentiation and Integration: Numerical differentiation, maximum and minimum values of a tabulated function; Numerical Integration-trapezoidal rule, Simpson1/3 rule, Simpsons 3/8 rule, Newton-cots integration formulae; Euler-Meclaurin formula, Gaussian integration(One dimensional only) Solution of Linear Systems of Equations: Gauss Elimination method (fall and banded symmetric and unsymmetric systems), Gauss Jordon method. Eigen value problems (Power method only).	**10 Hrs**
4	Numerical solution of ordinary and partial differential equations: Solution by Taylor's series, Prediction -correction method, Boundary value problems, Prediction corrector method, Euler's and modified Euler's method, Runge-Kutta method, finite difference methods. Finite difference approximation to derivatives, Solution to Laplaces equation- Jacobi's method, Gauss -Siedel method.	**8 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3600.1	To understand the basic concepts of data collection and distribution for approximation of system problems
CO2	BTME-3600.2	To understand various types of optimization techniques for different application
CO3	BTME-3600.3	To implement the use of differentiation and Integration in numerical methods
C04	BTME-3600.4	To gain knowledge of ordinary and partial differential equations and its applications in Mechanical Engineering

Suggested Readings / Books:

1. S. S. Sastry, Introductory methods of numerical analysis by: Prentice Hall of India. 2005
2. V. RajaRaman, Computer Oriented Numerical Methods. 2008
3. S.D. Conte, Cari De Boor, Elementary Numerical Analysis, McGraw Hill.2012
4. B. Cornahn, Applied Numerical Methods, John Wiley.2013
5. Richard I. Levin, S. David., Rubin Statistics for Management, Pearson. 2012

(OPEN ELECTIVE-I)

SUBJECT TITLE: ENTERPRISE RESOURCE PLANNING
SUBJECT CODE: BTME-3600
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	**Unit I** ERP Introduction, Benefits, Origin, Evolution and Structure: Conceptual Model of ERP, the Evolution of ERP, the Structure of ERP.	**15 Hrs**
2	**Unit II** Business Process Reengineering, Data ware Housing, Data Mining, Online Analytic Processing (OLAP), Product Life Cycle Management (PLM), LAP, Supply chain Management.	**10 Hrs**
3	**Unit III** ERP Marketplace and Marketplace Dynamics: Market Overview, Marketplace Dynamics, the Changing ERP Market. ERP- Functional Modules: Introduction, Functional Modules of ERP Software, Integration of ERP, Supply chain and Customer Relationship Applications.	**10 Hrs**
4	**Unit IV** ERP Implementation Basics, ERP Implementation Life Cycle, Role of SDLC/SSAD, Object Oriented Architecture, Consultants, Vendors and Employees.	**8 Hrs**
5	**Unit V** ERP & E-Commerce, Future Directives- in ERP, ERP and Internet, Critical success and failure factors, Integrating ERP into organizational culture. Using ERP tool: either SAP or ORACLE format to case study.	**10 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3600.1	Develop model for ERP for large projects
CO2	BTME-3600.2	Develop model for E-commerce architecture for any application
CO3	BTME-3600.3	Describe the advantages, strategic value, and organizational impact of utilizing an ERP system for the management of information across the functional areas of a business: sales and marketing, accounting and finance, human resource man-agreement, and supply chain.
C04	BTME-3600.4	Demonstrate a working knowledge of how data and transactions are integrated in an ERP system to manage the sales order process, production process, and procurement process.

Suggested Readings / Books:

1. Alexis Leon, “ERP Demystified”, Tata McGraw Hill
2. Rahul V. Altekar “Enterprise Resource Planning”, Tata McGraw Hill,
3. Vinod Kumar Garg and Venkitakrishnan N K, “Enterprise Resource Planning – A Concepts and Practice”, PHI
4. Mary Summer, “Enterprise Resource Planning”- Pearson Education

(OPEN ELECTIVE-I)

SUBJECT TITLE: ELECTRICAL MEASURING INSTRUMENTS
SUBJECT CODE: BTME-3600
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Basics of Measurements: Accuracy, Precision, resolution, reliability, repeatability, validity, Errors and their analysis, Standards of measurement. Bridge Measurement: DC bridges- wheatstone bridge, AC bridges – Kelvin, Hay, Maxwell, Schering and Wien bridges, Wagner ground Connection. Electronic Instruments for Measuring Basic Parameters: Amplified DC meter, AC Voltmeter, True- RMS responding Voltmeter, Electronic multi-meter, Digital voltmeter, Vector Voltmeter.	**15 Hrs**
2	Oscilloscopes: Cathode Ray Tube, Vertical and Horizontal Deflection Systems, Delay lines, Probes and Transducers, Specification of an Oscilloscope. Oscilloscope measurement Techniques, Special Oscilloscopes – Storage Oscilloscope, Sampling Oscilloscope. Signal Generators: Sine wave generator, Frequency – Synthesized Signal Generator, Sweep frequency Generator. Pulse and square wave generators. Function Generators	**10 Hrs**
3	Signal Analysis: Wave Analyzer, Spectrum Analyzer. Frequency Counters: Simple Frequency Counter; Measurement errors; extending frequency range of counters Transducers: Types, Strain Gages, Displacement Transducers.	**10 Hrs**
4	Digital Data Acquisition System: Interfacing transducers to Electronics Control and Measuring System. Instrumentation Amplifier, Isolation Amplifier. An Introduction to Computer-Controlled Test Systems.IEEE-488	**18 Hrs**

	GPIB Bus	

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3600.1	Identify various types of electronic instrument suitable for specific measurement.
CO2	BTME-3600.2	Classify various errors present in measuring instruments.
CO3	BTME-3600.3	Comprehend different types of signal generators and analyzers, their construction and operation.
C04	BTME-3600.4	Describe the working principle, selection criteria and applications of various transducers used in measurement systems.

Suggested Readings / Books:

1. Modern Electronics Instrumentation & Measurement Techniques, by Albert D.Helstrickand William D.Cooper, Pearson Education. Selected portion from Ch.1, 5-13.
2. Elements of Electronics Instrumentation and Measurement-3rd Edition by Joshph
3. J.Carr.Pearson Education. Selected portion from Ch.1,2,4,7,8,9,13,14,18,23 and 25.

(OPEN ELECTIVE-I)

SUBJECT TITLE: WIRELESS AND MOBILE COMMUNICATIONS
SUBJECT CODE: BTME-3600
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Introduction to wireless communications: Evolution of mobile radio communications, paging system, cordless telephone system, cellular telephone system, Modern wireless communication systems: 2G networks, 3G networks, Bluetooth and personal area networks.	**15 Hrs**
2	Mobile radio propagation: large scale path loss – Free space propagation model, basic propagation mechanisms. Digital Cellular Transmission, Spread Spectrum Transmissions Local Area & Ad Hoc Networks: LAN Technologies: Evolution of Wireless LAN, IEEE802.11, Physical, Layer, MAC Sub-layer, routing algorithms. Adhoc networks: Characteristics – Performance issues. Overview to Wireless ATM, HYPERLAN, IEEE802.15 Wireless PAN, and Home RF.	**18 Hrs**
3	Bluetooth Cellular concepts: Frequency reuse, channel assignment strategies, hand off strategies, interference and system capacity, improving coverage and capacity in cellular systems, routing in mobile hosts. Mobile IP – DHCP – Mobile transport layer – Indirect TCP – Snooping TCP – Transmission / time-out freezing – Selective retransmission –Transaction oriented TCP.	**20 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3600.1	Explain the Classification of mobile communication systems
CO2	BTME-3600.2	To introduce the concepts and techniques associated with Wireless Cellular Communication systems.
CO3	BTME-3600.3	To familiarize with state of art standards used in wireless cellular systems.
C04	BTME-3600.4	Ability to analyze improved data services in cellular communication

Suggested Readings / Books:

1. W illiam Stallings, "Wireless Communications and Networks", 2nd edition, Prentice Hall of India / Pearson Education, 2007.
2. Uwe Hansmann, Lothar Merk, Martin S Nicklons and Thomas Stober, "Principles of Mobile Computing", 2nd edition, Springer International, 2007.
3. Raj Kamal, "Mobile Computing", 2nd edition, Oxford University Press, 2007.
4. Dharma P Agarwal and Carlos Cordeiro, "Adhoc and Sensor Networks - Theory and Applications", 1st edition, World Scientific Publications, 2007.
5. C Siva Ram Murthy, " Adhoc Wireless Networks Architecture and Protocols", 2nd edition, Prentice Hall PTR, 2008.

(DEPARTMENTAL ELECTIVE-II)

SUBJECT TITLE: AUTOMOTIVE CHASSIS SYSTEM
SUBJECT CODE: BTME-3611
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Front Axle and Steering System Functions of front axle, Types of front axle, Construction, Stub axle and Wheel bearing, Front wheel steering Geometry – castor, Camber, King pin inclination, toe-in, toe-out, Centre point Steering, Self-returning property, Adjusting and checking of front wheel geometry, Ackerman and Davis steering linkages, Steering system layout, Steering gear boxes.	**15 Hrs**
2	Wheels and Tyres Basic requirements of wheels and tyres, Types of road wheels, Construction of wheel assembly, wheel balancing, Tyre construction, material, types, tubeless, cross ply radial type, tyre sizes and designation, Aspect ratio, tyre trade pattern, tyre valve, Tyre inflation pressure, safety precautions in tyres, Tyre rotation and matching, Types of Tyre wear and their causes, Selection of tyres under different applications, tyre retreating hot and cold, factors affecting tyre performance.	**18 Hrs**
3	Braking Systems Function and requirements of braking system, Types of brakes, Elementary theory of shoe brake, drum brake arrangement, disc brake arrangement, self-energizing, brake friction material. brake linkages, hydraulic brake system and components, hydraulic brake fluids, air brakes, vacuum servo assisted brake, engine exhaust brake, parking brakes, dual power brake system, regenerative brake system, fail-safe brake, anti – lock brakes, anti-	**10 Hrs**

	skid brakes, brake efficiency and testing, weight transfer, braking ratio.	
4	Vehicle Chassis Introduction To chassis, chassis operating condition, chassis frame, vehicle components location. Manufacturing processes for chassis, causes of chassis failure	**10 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3611.1	Elaborate the constructional details and operations of chassis systems like steering system, suspension system etc.
CO2	BTME-3611.2	Interpret the underlying mechanics of the chassis systems.
CO3	BTME-3611.3	Apply steering geometry for a given vehicular application.
C04	BTME-3611.4	Select/Configure components or subsystems for integration into main chassis system.

Suggested Readings / Books:

1. Motor Vehicles, Newton, Steed and Garrot, 13th Edition, Butterworth London
2. Vehicle and Engine Technology, Heisler, Second Edition SAE International Publication.
3. Advanced Vehicle Technology, Heisler,Second Edition SAE International Publication.
4. The Automotive Chassis, J. Reimpell H. Stoll, J.W. Betzler, SAE International Publication.

(DEPARTMENTAL ELECTIVE-II)

SUBJECT TITLE: NON-DESTRUCTIVE TESTING
SUBJECT CODE: BTME-3612
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Introduction: Classification of techniques of material testing, Need and Significance of Non Destructive Testing methods, type of Non Destructive testing methods	**6 Hrs**
2	Radiographic Examination: Radiant energy and radiography, practical applications, X-ray and Gamma –ray equipment, effect of variables on radiographs, requirement of a good radiograph, interpretation of radiograph, safety precautions, Xeroradiography.	**12 Hrs**
3	Magna flux methods: Basic principles, scope and applications, magnetic analysis of steel bars and tubing magnetization methods, equipment, inspection medium, preparation of surfaces Fluorescent Penetration inspection, Demagnetization.	**10 Hrs**
4	Electrical and ultrasonic Methods: Basic principles, flaw detection in rails and tubes (Sperry Detector), Ultrasonic testing surface roughness, moisture in wood, Detection of defects in ferrous and non ferrous metals, plastics, ceramics, measurement of thickness, hardness, stiffness, sonic material analyzer, proof tests, concrete test hammer. Photoelasticity:	**12 Hrs**

	Concept and applications of Plane and circular polarization, Photo stress, models.	

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3612.1	To understand need and Significance of Non Destructive Testing methods in engineering perspective
CO2	BTME-3612.2	To select an appropriate NDT technique as per requirement
CO3	BTME-3612.3	The student shall be able to set various process parameters and control the NDT process for the desired output parameters
C04	BTME-3612.4	The student shall be competent enough to make use of modern tools and software's for analyzing and solving real life problems

Suggested Readings / Books:

1. H.E. Davies, G.E Troxell and GFW Hauck, The testing of Engg materials, McGraw Hill. 2014
2. W.H Armstrong, Mechanical Inspection, McGraw Hill.2010

Program Name: B. Tech. Mechanical Engineering
Program Code: ME-301

(DEPARTMENTAL ELECTIVE-II)

SUBJECT TITLE: PRODUCT DESIGN AND DEVLOPMENT
SUBJECT CODE: BTME-3613
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

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Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	**Visual Design:** Basic elements and concept of visual design-line color, Balance proportion, Size shape mass, unity and variety, Special relationships and composition in two and three dimensions.	**8 Hrs**
2	**Form and Color:** Elementary forms their characteristics and significance in design. Form transition, Form in relation to ergonomics, material and manufacturing process, color as an element of design, color clarification dynamics, interrelation of colors, colors and traditions; Psychological use of color form and material.	**12 Hrs**
3	**Product Graphics:** Meaning and objectives of product graphics. Basic principles of graphic design, Visual communication aspects of product graphics, Graphics of displays and control panels.	**6 Hrs**
4	**Product Detailing:** Standard fastening and joining details in different materials; Temporary and permanent joints, Detailing for plastic products, Detailing for fabricated products in sheet metal **Products Development:** Definition and objective, Role of designer in product development. Manufacturing and economic aspects of product development, Product	**14 Hrs**

	promotions, product developments.	

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3613.1	Describe the characteristics used for product design and development.
CO2	BTME-3613.2	Assess the customer requirements in product design
CO3	BTME-3613.3	Identify various aspects of design such as industrial design, design for manufacture, assembly, service and quality and product architecture.
C04	BTME-3613.4	Explain various principles and technologies used for the preparation of prototype.

Suggested Readings / Books:

1. W.H. Mayal, Industrial Design for Engineers, London Liifee Books Ltd.2006
2. Huchingson R. Dale, New Horizons for Human Factors in Design, McGraw Hill.2008
3. N.L. Svensson, Engineering Design. 2002
4. R. Matousek, Engineering Design. 2004
5. K. J. Mccormick (Ed), Human Factor Engineering, McGraw Hill. 2005

Program Name: B. Tech. Mechanical Engineering
Program Code: ME-301

(DEPARTMENTAL ELECTIVE-II)

SUBJECT TITLE: MECHATRONICS
SUBJECT CODE: BTME-3614
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S No.	Content	Contact Hrs
1.	Introduction: Definitions, trends, control systems, microprocessor / micro controller based controllers, PC based controllers, applications: SPM, robot, CNC machine, FMS, CIM. Sensor Technology: Sensor and transducers, terminology, displacement, position, proximity - encoders, velocity - tachogenerators, force - strain gauges, pressure, temperature-thermocouples, RTDs, thermistors, light sensors - photoelectric sensors, IR sensors, sensor selection.	**9 Hrs**
2	Electronic Devices and Circuits: Semiconductor devices, diodes and LEDS, zener diodes and voltage regulator, inductive kick, bandwidth, frequency %& response of a measurement system, bipolar transistor circuits, amplifiers. Electromechanical Drives: Relays and solenoids, stepper motors, DC brushed and brushless motors, DC servo motors, AC / DC motors for non-servo motion drives, braking methods, pulse width modulated, Bipolar driver, Mosfet drives, SCR drives, variable frequency drives. Digital Electronics: Digital logic, number systems, logic gates, Boolean algebra, Karnaughrnaps, sequential logic	**11Hrs**
3	Signal Conditioning: Introduction, the operational amplifier, protection, filtering, Wheatstone bridge, digital signals, multiplexers, data acquisition, digital signal processing, pulse-modulation. Precision Mechanical Actuation: Pneumatic actuation systems, electro-pneumatic actuation systems, hydraulic actuation systems, electro-	**11 Hrs**

	hydraulic actuation systems, mechanical systems, types of motion, kinematics, inverse kinematics, timing belts, ball screw and nut, linear motion guides, linear bearings, harmonic transmission, bearings, motor / drive selection	
4	Microprocessors: Control, microcomputer structure, microcontrollers, digital interfacing, analog interfacing, DAC, ADC, applications. Input / Output Systems: Interfacing, input / output ports, interface requirements, peripheral interface adapters, serial communication interface, direct memory access. Control System: System transfer function, Laplace transformation and its applications, continuous and discrete processes, proportional control, integral control, differential control, PID control, digital controllers, control system performance, controller tuning, adaptive control, frequency response, PLC, PMC, Introduction to fuzzy logic and neural networks.	**11 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3614.1	Understand key elements of Mechatronics system, representation into block diagram
CO2	BTME-3614.2	Understand concept of transfer function, reduction and analysis
CO3	BTME-3614.3	Interfacing of Sensors, Actuators using appropriate DAQ micro-controller
C04	BTME-3614.4	Time and Frequency domain analysis of system model (for control application)

Suggested Readings / Books:

1. Understanding Electro-Mechanical Engineering - An Introduction to Mechatronics by Kamm, Prentice-Hall of India.
2. Computer Control of Manufacturing system by, Koren, McGraw Hill.
3. Production Systems and CIM by Groover, PHI.
4. Flexible Manufacturing systems by Maleki, Prentice Hall.
5. Feedback Control Systems by BC. Kuo, PHI.

Program Name: B. Tech. Mechanical Engineering
Program Code: ME-301

(DEPARTMENTAL ELECTIVE-II)

SUBJECT TITLE: TOOL DESIGN
SUBJECT CODE: BTME-3615
SEMESTER: 6
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S No.	Content	Contact Hrs
1.	Design of Jigs: Introduction – Location Principles – Six Point Location Principle – Locators – Clamping Principles – Clamping Devices – Drill Jigs – Drill Bushes – Drill Jig Types – Design and Development of Jigs for given components.	**9 Hrs**
2	Design of Fixtures: Milling Fixtures – Milling Methods – Milling Fixture Types – Turning fixtures – Broaching Fixtures – Grinding Fixtures – Assembly, Inspection and Welding Fixtures – Modular Fixtures – Design and Development of Fixtures for given components.	**11 Hrs**
3	Design of Dies: Power presses types and construction details, die cutting operation, cutting action in die and punch, center of pressure, clearance and its significance, cutting forces, methods of reducing cutting forces, methods of punch support, strippers, stock stops, guide pilots, knockout, design of blanking and piercing dies. Design Concepts and description of the components of progressive dies. Design of progressive dies. Design of compound dies. Design of combination dies.	**11 Hrs**
4	Drawing Dies: Metal flow and factors affecting drawing, blank size calculations, drawing force, single and double acting drawing dies, design and development of drawing dies for different components.Bending and Forming Dies: Spring back, bend allowance; calculation of development length, bending force calculations types of bending dies. Curling dies.Forging process and forging dies. (Introductory Treatment)	**11 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-3615.1	To develop a solution oriented approach by in depth knowledge of Machine Tool Design
CO2	BTME-3615.2	To address the underlying concepts, methods and application of Machine Tool Design
CO3	BTME-3615.3	To analyze the different types of die structure
C04	BTME-3615.4	Study about bending and forming dies

Suggested Readings / Books:

1. Design Principles of Metal-Cutting Machine Tools by F. Koenigsberger
2. Machine Tool Design by N. K. Mehta. McGraw Hill Publishing
4. Machine Tool Design by Acherkan, Mir publishing
5. Machine Tool Design by S.K, Basu, Oxford and IBH Publishing
6. Machine tool design by Sen and Bhattacharya, CBS Publications

SYLLABUS

SEMESTER-VII

SUBJECT TITLE: INDUSTRIAL ENGINEERING
SUBJECT CODE: BTME-4701
SEMESTER: 7
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Introduction: Definition and scope of industrial engineering, Functions of industrial engineering department and its organization, Qualities of an industrial engineer, concept of production and productivity Concepts of Management: Functions of Management, Evolution of Management Thought: Taylor's Scientific Management, Fayol's Principles of Management, Douglas Mc-Gregor's Theory X and Theory Y, Mayo's Hawthorne Experiments, Hertzberg's Two Factor Theory of Motivation, Maslow's Hierarchy of Human Needs – Systems Approach to Management.	**11 Hrs**
3	Designing Organizational Structures: Concept, Importance and characteristics of organization, Types of organization - Project, matrix and informal organization. Span of control, Delegation of authority. Management Planning, Decision Making and Control: Steps, hierarchy, principles and dimensions of planning function, Approaches to decision making, Decision support systems, Basic control process, control parameters, principles of control	**9 Hrs**
5	Plant Location & Layout: Plant location: definition, factors affecting the plant location, comparison of rural and urban sites-methods for selection. Plant layout: Needs for a good layout, Different types viz. Product, process and combination layouts, Introduction to layouts based on the GT, JIT and cellular	**10 Hrs**

	manufacturing systems, Development of plant layout. Productivity: Definition, reasons for low productivity, methods to improve productivity, relation between work-study and productivity.	
7	Work Analysis: Definition, need and scope of Work Analysis. Method-study: Definition, objectives, step-by-step procedure, questioning techniques, charts and diagrams for recording data. Principles of motion economy; Development and installation of new method. Work measurement: Definition, various techniques of work-measurement such as work-sampling, stopwatch time study & its procedure, Job selection, Equipment and Forms used for work measurement, need for rating operator, methods of rating, allowances and their types, standard time. Standard data techniques. Value Engineering: Definition, Types of values, concept, phases and application of value engineering.	**10 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-4701.1	Understand the basic concepts of production, productivity and function of management
CO2	BTME-4701.2	To gain knowledge of hierarchy, principles and dimensions of planning function of organizations
CO3	BTME-4701.3	Determine the various theories and approaches related to Industrial Engineering
C04	BTME-4701.4	Discuss the importance of Value Engineering in today's Industry

Suggested Readings / Books:

1. Philip E Hick, Industrial Engineering & Management, Tata McGraw Hill. 2014
2. Lawrence D. Miles, Techniques of Value Analysis and Engineering, McGraw Hill. 2012
3. R.N. Nauhria, RajnishParkash, Management of Systems, Wheeler Publishers 2004
4. S. Buffa, Modern Production Management, Wiley Eastern. 2008
5. H.S. Shan, Work Study and Ergonomics, DhanpatRai and Co. (P) Ltd. 2004

SUBJECT TITLE: REFRIGERATION AND AIRCONDITIONING
SUBJECT CODE: BTME-4702
SEMESTER: 7
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Basic Concepts: Definition of Refrigeration and Air conditioning; Difference between Refrigeration and cooling; Difference between Refrigeration and Air conditioning; Brief history of Refrigeration and Air conditioning; Natural and Mechanical Refrigeration; Applications of Refrigeration and Air conditioning; Definitions of refrigerant, cooling/ Refrigeration effect, cooling capacity, heating effect, heating capacity; Units of refrigeration; Coefficient of performance and Energy Efficient Ratio; COP of a refrigerator; and COP/EPR of a heat pump; Single Phase Reversed Carnot cycle and its limitations; Two Phase Reversed Carnot cycle and its limitations; Methods of Refrigeration; Numerical. Gas Cycle Refrigeration and Aircraft Refrigeration & Air conditioning: Bell Coleman/Reversed Brayton/ Reversed Joule Cycle and its analysis; Numerical; optimum COP and pressure ratio (No mathematical Analysis); Applications of Gas Cycle Refrigeration; Necessity of aircraft refrigeration and air conditioning; Classification of aircraft refrigeration and air conditioning systems; Simple/basic aircraft refrigeration and air conditioning system (with and without evaporative cooler); Need of evaporator cooler; Boot Strap aircraft refrigeration and air conditioning system (with and without evaporative cooler); Regenerative aircraft refrigeration and air conditioning system; Reduced Ambient aircraft refrigeration and air conditioning system; Dry Air Rated Temperature (DART); Comparison of different aircraft refrigeration and air conditioning systems; Numerical.	**13 Hrs**

2	Vapour Compression Refrigeration Cycle: Vapour compression refrigeration system and its basic components; Representation of Simple/ Theoretical vapour compression refrigeration cycle on P-v, T-s and P-h diagrams; Dry versus wet compression; expansion versus throttling of liquid refrigerant; Analysis of Simple/Theoretical vapour compression refrigeration cycle; Introduction of P-h diagram/chart and Refrigeration Tables; Determination of properties of sub cooled, saturated and superheated refrigerant by using saturated properties & specific heat tables/saturated & superheated properties tables and P-h diagram; Compressor work and volumetric efficiency; Effect on performance and cooling capacity due to change in evaporator pressure, condenser pressure, sub cooling of liquid refrigerant, super heating of suction vapours, use of liquid - vapour regenerative heat exchanger; Effect on performance and cooling capacity due to heat exchange of vapours with compressor cylinder walls, pressure drop in suction (wire drawing) and discharge valves, pressure drop in evaporator and condenser; Actual vapour compression refrigeration cycle on T-s and P-h diagrams (No mathematical analysis); Numericals. Flash gas, its advantages and disadvantages, and its removal: flash chamber, liquid sub-cooler; Brief introduction (no mathematical analysis) to compound (multistage) compression, its advantages, schematic representation of these systems with use of flash chamber, water intercooler, flash intercooler, liquid sub-cooler (independent and combination of these); Brief introduction (no mathematical analysis) to multiple evaporator systems, schematic representation of these systems with use of individual and multiple expansion valves arrangements, with single and multiple (individual and compound) compressor.	**10 Hrs**
3	Vapour Absorption Refrigeration Cycle (No Mathematical Analysis): Principle of vapour absorption refrigeration; basic components of the vapour absorption refrigeration system; Desirable properties of absorption system refrigerant and absorbent; Aqua - ammonia vapour absorption refrigeration system; Lithium Bromide - water absorption system (Single and double effect);Electrolux refrigeration system; comparison between vapour absorption and compression systems. Refrigerants: Classification and nomenclature of refrigerants; Desirable thermodynamic, chemical and physical properties of refrigerants; comparative study of commonly used refrigerants and their fields of application; Azeotropes; Zeotropes; Effect of moisture and oil miscibility; Refrigerants dying agents and antifreeze solution; leak detection and charging of refrigerants; environmental aspects of conventional refrigerants; Ecofriendly refrigerants and action plan to reduce ecological hazards. Alternative Refrigeration Systems and Low Temperature Refrigeration: (No Mathematical Analysis) Steam Jet Refrigeration; Mixed Refrigeration Systems; Vortex Tube	**12 Hrs**

	Refrigeration, Thermoelectric cooling; Transcritical Carbon Dioxide Compression Refrigeration; Cascade Refrigeration System; Linde and Claude cycles, cryogenics and its engineering applications.	
4	6. Air Conditioning Concepts and Applications: Psychrometry; Dry Air; Moist Air; Basic laws obeyed by Dry Air and Moist Air; Psychrometric properties of air: Dry bulb, wet bulb and dew point temperatures, Relative and specific humidity, degree of saturation adiabatic saturation temperature, enthalpy of air and water vapours; Psychrometric chart and its use; Adiabatic mixing of moist air streams without condensation and with condensation; Numerical. Human requirement of comforts; effective temperature and comfort charts; Industrial and comfort air conditioning Psychometric Processes: Basic psychrometric processes; Sensible heat process; Latent heat process; Total heat process; Sensible heat factor; Evaporative cooling; cooling with dehumidification; Heating with dehumidification; chemical dehumidification; By-pass factor; Contact factor; Psychrometric processes in air conditioning equipment: Cooling coils, Heating coils, cooling and dehumidification coils, Evaporative coolers, Adiabatic dehumidifiers, Steam injection, Air washer; Numerical. Calculations for Air conditioning Load and for Rate and state of Supply Air: Sources of heat load; sensible and latent heat load; Cooling and heating load estimation; Apparatus dew point temperature; Rate and state of supply air for air conditioning of different types of premises; Numerical Refrigeration and Air Conditioning Equipment: Brief description of compressors, condensers, evaporators and expansion devices; Cooling towers; Ducts; dampers; grills; air filters; fans; room air conditioners; split units; Package and central air conditioning plants.	**23 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-4702.1	Understand the basic concepts and principles of refrigeration and air conditioning systems
CO2	BTME-4702.2	Discuss different types of aircraft refrigeration system and their performances under different conditions
CO3	BTME-4702.3	To gain knowledge of refrigerants and factors influencing air conditioning
C04	BTME-4702.4	Study the importance of psychometric chart and along with processes and also determine the calculations related to air conditioning load

Suggested Readings / Books:

1. C.P. Arora, Refrigeration and Conditioning, Tata McGraw Hill. 2001
2. Manohar Prasad, Refrigeration and Conditioning, Wiley Eastern Limited.1998
3. Jordan and Priester, Refrigeration and Conditioning, Prentice Hall of India. 2008
4. W.F. Stoecker, Refrigeration and Conditioning, McGraw Hill.2010

SUBJECT TITLE: MECHANICAL VIBRATIONS
SUBJECT CODE: BTME-4703
SEMESTER: 7
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
4	1	0	4

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Introduction: Basic concepts, Types of vibration, Periodic & Harmonic vibrations, Methods of vibration analysis	**6 Hrs**
2	Vibration of Single Degree of Freedom System: Undamped free vibrations, damped free vibrations and damped force vibration system, Modelling of stiffness and damping (both viscous and coulomb), estimation of damping by decay plots, vibration isolation transmissibility, vibration measuring instruments.	**10 Hrs**
3	Two degrees of Freedom systems: a) Principal modes of vibrations, natural frequencies, amplitude ratio, undamped free, damped free, forced harmonic vibration, semi-definite systems, combined rectilinear & angular modes; Lagrange's equation. b) Application to un-damped and damped absorbers: Vibration absorber – principle; centrifugal pendulum vibration absorber, torsional vibration damper, untuned dry friction and viscous vibration damper, torsional vibration abosrber.	**14 Hrs**
4	Multi-degree of freedom systems: Undamped free vibrations, influence coefficients, Generalised coordinates, orthogonality principal, matrix iteration method, Rayleigh and Dunkerley, Holzer's , Stodola method, Eigen values and eigen vectors. Continuous systems: Lateral vibrations of a string, longitudinal vibrations of bars, transverse vibrations of beams, Euler's equation of motion for beam vibration,	**26 Hrs**

	natural frequencies for various end conditions, torsional vibration of circular shafts.	

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-4703.1	Understand the basic concepts and principles of Vibrations, concept of damping and vibration measuring instruments systems
CO2	BTME-4703.2	To understand different types of absorber and their performances under different conditions
CO3	BTME-4703.3	To gain knowledge of various vibration equations and their factors influencing conditionality of situations
C04	BTME-4703.4	Analyze the multi degree freedom and continuous systems for the vibrating motion

Suggested Readings / Books:

1. G.K. Grover, Mechanical Vibrations Hem Chand and Bros. 2006
2. K.K. Purjara, Mechanical Vibrations, DhanpatRai and Sons, Delhi. 2008
3. V.P.Singh, Mechanical Vibrations DhanpatRai and Sons, Delhi. 2002
4. Debabrata Nag, Mechanical Vibration, John Wiley India.2012
5. Thomson, Mechanical Vibration, Prentice Hall. 2014

SUBJECT TITLE: CONSTITUTION OF INDIA
SUBJECT CODE: BTMC-4701
SEMESTER: 7
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3 Hrs

S. No.	Contents	Contact Hrs
1	Constitutional Development, Preamble, Fundamental Rights: Right to Equality, Right to Freedom, Right to Life	**10 Hrs**
2	Writs, Fundamental Duties, Directive Principles	**5 Hrs**
3	Union and State Executive, Union and State Legislature, Union and State Judiciary	**10 Hrs**
4	4.4 Emergency 4.5 Relation between Centre & State 4.6 Basic Structure *Students are expected to study current and landmark case laws.	**10 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTMC-4701.1	Identify and explore the basic features and modalities about Indian constitution.
CO2	BTMC-4701.2	Differentiate and relate the functioning of Indian parliamentary system at the center and state level.
CO3	BTMC-4701.3	Differentiate and relate the functioning of Indian parliamentary system at the center and state level.

Suggested Readings / Books:

1. Constituent Assembly Debates
2. M.P. Jain: Indian Constitutional Law, 2018
3. Mahendra P. Singh: V.N. Shukla's Constitution of India, 2016
4. J.N. Pandey: Constitutional Law of India, 2015
5. The Constitution of India, 1950

SUBJECT TITLE: REFRIGERATION AND AIRCONDITIONING LAB
SUBJECT CODE: BTME-4704
SEMESTER: 7
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 60
End Term Exam: 40

S. No.	Contents	Contact Hrs
1	Study of various elements of a vapour compression refrigeration system through cut sections models / actual apparatus.	**2 Hrs**
2	Study and performance testing of domestic refrigerator.	**2 Hrs**
3	Study the performance testing of Electrolux refrigerator.	**2 Hrs**
4	Study and performance testing of an Ice plant.	**2 Hrs**
5	Calculation/ Estimation of cooling load for a large building.	**2 Hrs**
6	Visit to a central Air conditioning plant for study of processes for winter and summer air conditioning	**2 Hrs**
7	Visit to a cold storage for study of its working.	**2 Hrs**
8	Study and performance testing of window type room air conditioner.	**2 Hrs**
9	Study and performance testing of water cooler.	**2 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-4704.1	Demonstrate the different parts of domestic refrigerator and brief its importance
CO2	BTME-4704.2	Analyze the performance of various vapour compression cycles
CO3	BTME-4704.3	Discuss the various components of air conditioner setup and analyze its performance index
C04	BTME-4704.4	Visit of central air conditioned plant and cold storage plant for its practicality

SUBJECT TITLE: MECHANCIAL VIBRATION LAB
SUBJECT CODE: BTME-4705
SEMESTER: 7
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 60
End Term Exam: 40

S. No.	Contents	Contact Hrs
1	Determine the viscosity of given fluid by single wire torsional pendulum.	**2 Hrs**
2	Determine the natural frequencies of a coupled pendulum.	**2 Hrs**
3	Find out the fundamental natural frequency of a cantilever beam	**2 Hrs**
4	Determine the modulus of elasticity from free vibration test	**2 Hrs**
5	Study of forced vibration of a two degree of freedom system under harmonic excitation	**2 Hrs**
6	Study of a dynamic absorber	**2 Hrs**
7	Determine coefficient of dry friction from measurement of natural frequency of vibration of a bar resting on two disks rotating in opposite direction	**2 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-4705.1	Understand the importance of vibration in mechanical components
CO2	BTME-4705.2	To determine the natural frequency of coupled pendulum and cantilever beam
CO3	BTME-4705.3	Analyze the forced vibration of two degree of freedom under SHM
C04	BTME-4705.4	Evaluate the co-efficient of friction of the mechanical systems along with its calculations

SUBJECT TITLE: MAJOR PROJECT
SUBJECT CODE: BTME-4706
SEMESTER: 7
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	2	1

Internal Assessment: 60
End Term Exam: 40

In this student has to build a project and has to make a file for the same.

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-4706.1	Design and development of your project work as per the objectives
CO2	BTME-4706.2	To implement the actual working of your project as per the industrial relevancy
CO3	BTME-4706.3	Discuss the relevant conclusion and scope of future work of you project
C04	BTME-4706.4	Prepare for your project work file and seminar ppt. report

(DEPARTMENTAL ELECTIVE-III)

SUBJECT TITLE: AUTOMOTIVE CONTROL
SUBJECT CODE: BTME-4711
SEMESTER: 7
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S.No.	Contents	ContactHrs
1	Introduction of Common Technology: Engine related systems. Ignition system, computer controlled petrol fueling injection systems, Engine management systems, Anti-lock braking systems, Traction control system, Stability Control system, air conditioning, computer controlled diesel engine system.	**8 Hrs**
2	Computer ECM: Fundamental parts of computer, Principles of operation, Computer data, Computer interfaces, Computer memories, Adaptive operating strategy of the ECM.	**7 Hrs**
3	Digital Electronics: Logic gates, truth tables, Application of Logic gates, Flip-Flop, Analogue to Digital Conversion, Digital to Analogue conversion, Digital Displays (LED Display and Liquid crystal displays).	**8 Hrs**
4	Sensors: Introduction of sensors and transducers Electromagnetic Sensors, Optical sensors, variable resistance type sensors, temperature sensors, Pressure sensors, variable capacitance sensors, Flow sensors, Piezoelectric sensors, Oxygen Sensor, Practical Importance of sensors.	**8 Hrs**
5	Actuators: Introduction of Actuators, Actuators operation, Injectors, Exhaust gas recirculation actuators, motors, Solenoids, ABS actuators.	**4 Hrs**
6	Additional Technology: Computer performance, Supplementary restraint systems (SRS),Coded ignition key, Fault tracing, Precautions when working with computer controlled system.	**5 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-4711.1	To understand the principles and working of different systems of automobiles
CO2	BTME-4711.2	To understand the principles and design of different systems of automobiles
CO3	BTME-4711.3	To understand the principles and working of Microprocessor based automobiles.
C04	BTME-4711.4	To understand the principles and working of sensors and actuators.

Suggested Readings / Books:

1. Allan W.M. Bonnick, 'Automotive Computer Controlled Systems', Butterworth-Heinemann: A Division of Reed Educational and Professional Publishing Ltd.
2. Willium B. Ribbens, Willium B. Ribbens, 'Understanding Automotive Electronics', Elsevier Science, **2003.**
3. Ronald K. Jurgen, 'Sensors and Transducers', SAE, **2003.**
4. Jack Erjavec, 'Automotive Technology' Robert Scharff Delmar Publications Inc., **1992.**

(DEPARTMENTAL ELECTIVE-III)

SUBJECT TITLE: NON TRADITIONAL MACHINING
SUBJECT CODE: BTME-4712
SEMESTER: 7
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Introduction: Latest trends in Manufacturing, Introduction to Flexible manufacturing system, Introduction to computer integrated manufacturing, Limitations of conventional machining processes, Development of Non-conventional machining processes, their classification, advantages and major applications.	**5 Hrs**
2	Advanced Mechanical Processes: Ultrasonic machining, Water Jet Machining and Abrasive Flow Machining-elements of process, Applications and limitations	**10 Hrs**
3	Electrochemical & Chemical Removal Processes: Principle of operation, elements and applications of Electrochemical Machining, Electrochemical grinding, Electrochemical deburring, Electrochemical honing, Chemical Machining, Photochemical machining.	**10 Hrs**
4	Thermal Metal Removal Processes: Electric Discharge Machining- Mechanism of metal removal, electrode feed control, die electric fluids flushing, selection of electrode material, applications. Plasma Arc Machining- Mechanism of metal removal, PAM parameters, Equipment's for unit, safety precautions and applications. Laser Beam machining- Material removal, limitations and advantages. Hot machining- method of heat, Applications and limitations. Electon-Beam Machining-, Generation and control of electron beam, process	**15 Hrs**

	capabilities and limitations. Hybrid Machining Processes: Concept, classification, application, Advantages	

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-4712.1	Students will be able to categorize different material removal, joining processes as per the requirements of material being used to manufacture end product.
CO2	BTME-4712.2	Students will be able to select material processing technique with the aim of cost reduction, reducing material wastage & machining time.
CO3	BTME-4712.3	Students will be able to combine & develop novel hybrid techniques from the state of art techniques available.
C04	BTME-4712.4	Students will be able to perform process analysis taking into account the various responses considered in a process.

Suggested Readings / Books:

1. P.C. Panday and H.S. Shan, Modern Machining Processes, Tata McGraw Hill. 1998
2. G. Boothroyd and W.A. Knight, Fundamentals of Machining and Machine Tools, Marcel Dekker Inc.2006
3. G.F. Benedict, Non-traditional Manufacturing Processes, Marcel Dekker Inc.2006
4. V.K Jain, Advanced Machining Processes, Allied Publishers.2000
5. Hassan Abdel, Gawad El-hofy Fundamentals of Machining Processes: Conventional and Nonconventional Processes, Taylor & Francis. 2008

(DEPARTMENTAL ELECTIVE-III)

SUBJECT TITLE: INDUSTRIAL TRIBOLOGY
SUBJECT CODE: BTME-4713
SEMESTER: 7
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Introduction: Tribological considerations, Nature of surfaces and their contact, Physical, mechanical properties of surface layer, Geometrical properties of surfaces, methods of studying surfaces, Study of contract of smoothly and rough surfaces	**5 Hrs**
2	Friction and Wear: Role of friction and laws of static friction, causes of friction, adhesion theory, Laws of rolling friction, Friction of metals and non-metals; Friction measurements. Definition of wear, mechanism of wear, friction affecting wear, wear measurement, Wear of metals and non-metals.	**10 Hrs**
3	Lubrication and Lubricants: Introduction, dry friction, Boundary lubrication, classic hydrodynamics, hydrostatic and elasto hydrodynamic lubrication, Functions of lubricants, Types of lubricants and their industrial uses, properties of liquid and grease lubricants; lubricant additives , general properties and selection.	**10 Hrs**
4	Special Topics: Selection of bearing and lubricant, bearing maintenance, diagnostic maintenance of tribological components, lubrication systems, Filters and filtration.	**15 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-4713.1	The basic objective of the subject is to deal fundamentals of friction, wear and lubrication
CO2	BTME-4713.2	The subject is useful in understanding the nature of surfaces of engineering materials.
CO3	BTME-4713.3	The basic objective of the subject is to learn about types of lubricants.
C04	BTME-4713.4	The subject is useful in understanding the various tribological applications.

Suggested Readings / Books:

1. O'Conner and Royle, Standard Hand Book of Lubrication Engg., McGraw Hill.2004
2. Halling and Wykeham, Introduction to Tribology, Publications Ltd.2008
3. RaymonoO.Gunther, Lubrication, Bailey Bros and Swinfan Ltd.2010
4. PT Barwll, Rearing Systems, Principles and Practice,Oxford press.2006
5. A Cameron, Basic Lubrication Theory, Wiley (Indian Edition).2008

(DEPARTMENTAL ELECTIVE-III)

SUBJECT TITLE: FINITE ELEMENT METHODS
SUBJECT CODE: BTME-4714
SEMESTER: 7
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Introduction: Finite Element Method for solving field problems. Stress and Equilibrium. Strain -Displacement relations. Stress - strain relations.	**5 Hrs**
2	One Dimensional Problems: Finite element modeling coordinates and shape functions. Potential Energy approach: Assembly of Global stiffness matrix and load vector. Finite element equations, Treatment of boundary conditions, Quadratic shape functions.	**10 Hrs**
3	Analysis of Beams: Element stiffness matrix for two node, two degrees of freedom per node beam element. Finite element modelling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions. Finite element modelling of Axisymmetric solids subjected to Axis ymmetric loading with triangular elements.	**10 Hrs**
4	Two dimensional four noded isoparametric elements and numerical integration. Steady state heat transfer analysis: one dimensional analysis of a fin and two dimensional analysis of thin plate. Analysis of a uniform shaft subjected to torsion. Dynamic Analysis: Formulation of finite element model, element matrices, evaluation of Eigen values and Eigen vectors for a stepped bar and a beam.	**15 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-4714.1	The basic concepts of Finite Element methods and its applications to complex engineering problems
CO2	BTME-4714.2	The characteristics and selection of different finite elements used in finite element methods
CO3	BTME-4714.3	The equilibrium equations and stress-strain relations for different boundary conditions encountered in structural and heat transfer continuum problems
C04	BTME-4714.4	The application of the FEM technique to dynamic problems and validate the solutions through simulation software for real time applications

Suggested Readings / Books:

1. Chandraputla Ashok and Belegundu, 'Introduction to Finite Elements in Engineering', Prentice -Hall.
2. S.S. Rao, 'The Finite Element Methods in Engineering', Pergamon.
3. J.N. Reddy, 'An Introduction to Finite Element Method', McGraw Hill.
4. Alavala, 'Finite Element Methods', TMH.
5. Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith and Ted G. Byrom, 'The Finite Element Method for Engineers', John Wiley & Sons. (ASIA) Pte Ltd
6. C.S. Krishna Murthy, 'Finite Element Analysis'.

(DEPARTMENTAL ELECTIVE-III)

SUBJECT TITLE: STATISTICAL QUALITY CONTROL
SUBJECT CODE: BTME-4715
SEMESTER: 7
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Introduction: Definition and Need of quality, Aspects of quality, Quality characteristic, Quality specification, Quality function, Economics of quality. Inspection, Its objectives and types, Inspection versus Quality Control, Statistical Quality Control, its Tools, Advantages, limitations and Applications. Probability & Statistics: Definition, Laws, Probability Distributions (Normal Binomial, Poisson, Exponential) & related problems. Measures of Central tendency & Dispersion, Concept of Variation, Variable and attribute data, Frequency distribution.	**10 Hrs**
2	Control Charts: Concept of variability, Assignable and chance causes, Concept of specifications and tolerances, Definition and objectives of control charts, Control charts for variables and attributes and related problems, Variable charts vs attribute charts, Patterns on control charts, Type–I & Type-II Errors, Process capability and its methods of determination.	**10 Hrs**
3	Acceptance Sampling: Definition, Advantages over 100% inspection, Methods of taking samples, Operating characteristics curve & its characteristics. Single, Double and Multiple, Sequential Sampling Plan & Related problems. Quality Assurance: Need, Principles, Essentials and Advantages of Quality Assurance System, Quality Manual, Field complaints, Quality Audit & its	**10 Hrs**

	types, Quality Assurance Methods, Quality Control vs. Quality Assurance.	
4	Quality Systems: Description of ISO: 9000 series of standards, ISO: 9001–2000 Systems. Description of TQM, Concept of Quality Circles, JIT System, Taguchi's Concept of Quality, Zero Defect Concept, 6s Concept and 5S.	**10 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-4715.1	Understand the philosophy and basic concepts of quality improvement
CO2	BTME-4715.2	Demonstrate the ability to use the methods of statistical process control
CO3	BTME-4715.3	Demonstrate the ability to design, use, and interpret control charts for attribute
C04	BTME-4715.4	Design, use, and interpret exponentially weighted moving average and moving average control charts.

Suggested Readings / Books:

1. M. Mahajan, 'Statistical Quality Control', DhanpatRai& Co.
2. AmitavMitra, 'Fundamentals of Quality Control', Pearson Education.
3. E.L. Grant & R.S. Leavenworth, 'Statistical Quality Control', McGraw Hill & Co.
4. Feigenbaum, 'Total Quality Control', McGraw Hill & Co.
5. D.C. Montgomery DC, 'Introduction to Statistical Quality Control', John Wiley & Sons Inc.
6. Stephan B. Vardeman, J. Marcus Jobe, 'Statistical QA Methods for Engineers', John Wiley & Sons Inc.
7. J.R. Taylor, 'Quality Control systems', McGraw Hill Int. Education.

(DEPARTMENTAL ELECTIVE-III)

SUBJECT TITLE: HUMAN RESOURCE MANAGEMENT
SUBJECT CODE: BTME-4720
SEMESTER: 7th
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Introduction: Introduction to Human Resource Management and its definition, functions of Human Resource Management & its relation to other managerial functions. Nature, Scope and Importance of Human Resource Management in Industry, Role & position of Personnel function in the organization. Procurement and Placement: Need for Human Resource Planning; Process of Human Resource Planning; Methods of Recruitment; Psychological tests and interviewing; Meaning and Importance of Placement and Induction, Employment Exchanges (Compulsory Notification of vacancies) Act 1959, The Contract Labour (Regulation & Abolition) Act 1970.	**10 Hrs**
2	Training & Development: Difference between training and Development; Principles of Training; Employee Development; Promotion-Merit v/s seniority Performance Appraisal, Career Development & Planning. Job analysis & Design: Job Analysis: Job Description & Job Description, Job Specification.	**8 Hrs**
3	Job Satisfaction: Job satisfaction and its importance; Motivation, Factors affecting motivation, introduction to Motivation Theory; Workers ' Participation,	**8 Hrs**

	Quality of work life. The Compensation Function: Basic concepts in wage administration, company's wage policy, Job Evaluation, Issues in wage administration, Bonus & Incentives, Payment of Wages Act-1936, Minimum Wages Act-1961	
4	Integration: Human Relations and Industrial Relations; Difference between Human Relations and Industrial Relations, Factors required for good Human Relation Policy in Industry; Employee Employer relationship Causes and Effects of Industrial disputes; Employees Grievances & their Redressal, Administration of Discipline, Communication in organization, Absenteeism, Labour Turnover, Changing face of the Indian work force and their environment, Importance of collective Bargaining; Role of trade unions in maintaining cordial Industrial Relations. Maintenance: Fringe & retirement terminal benefits, administration of welfare amenities, Meaning and Importance of Employee Safety, Accidents-Causes & their Prevention, Safety Previsions under the Factories Act 1948; Welfare of Employees and its Importance, Social security, Family Pension Scheme, ESI act 1948, Workmen's Gratuity Act 1972, Future challenges for Human Resource Management.	**14 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-4720.1	Develop the understanding of the concept of human resource management and to understand its relevance in organizations
CO2	BTME-4720.2	Develop necessary skill set for application of various HR issues
CO3	BTME-4720.3	Analyze the strategic issues and strategies required to select and develop manpower resources
C04	BTME-4720.4	Integrate the knowledge of HR concepts to take correct business decisions

Suggested Readings / Books:

1. T.N. Chhabra- Human Resource Management (DhanpatRai& Co.) 2010
2. A.P Verma- Human Resource Management (S.K Kataria & Sons) 2008

(DEPARTMENTAL ELECTIVE-III)

SUBJECT TITLE: AUTOMOTIVE AERODYNAMICS
SUBJECT CODE: BTME-4717
SEMESTER: 7
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	ContactHrs
1	Introduction: Scope, historical developments, fundamentals of fluid mechanics, flow phenomenon related to vehicles, external and Internal flow problem, resistance to vehicle motion, performance, fuel consumption and performance potential of vehicle aerodynamics, engine cooling requirement, air flow to passenger compartment, duct for air conditioning, cooling of transverse engine and rear engine.	**10 Hrs**
2	Aerodynamic drag of Cars: Cars as a bluff body, flow field around car, drag force, types of drag force, analysis of aerodynamic drag, drag coefficient of cars, strategies for aerodynamic development, low drag profiles	**5 Hrs**
3	Shape Optimization of Cars: Front end modification, front and rear wind shield angle, boat tailing, hatch back, fast back and square back, dust flow patterns at the rear, effects of gap configuration, effect of fasteners.	**10 Hrs**
4	Vehicle Handling: Origin of forces and moments on a vehicle, lateral stability problems, methods to calculate forces and moments – vehicle dynamics under side winds, the effects of forces and moments, characteristics of forces and moments, dirt accumulation on the vehicle, wind noise, drag reduction in commercial vehicles	**15 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-4717.1	Apply CFD to a range of problem
CO2	BTME-4717.2	Understand lift, drag and down force definitions and calculations.
CO3	BTME-4717.3	Demonstrate a knowledge and understanding of aerodynamics in automotive field.
C04	BTME-4717.4	Understand the principles and functions of wind tunnel.

Suggested Readings / Books:

1. Frank W. Liou, 'Rapid Prototyping and engineering Applications', CRC Press, 2007.
2. D.T. Pham and S.S. Dimov, 'Rapid Manufacturing', Springer.
3. Kevin Otto, Kristin Wood, 'Product Design', Pearson.

(DEPARTMENTAL ELECTIVE-III)

SUBJECT TITLE: ELECTRIC AND HYBRID VEHICLES
SUBJECT CODE: BTME-4718
SEMESTER: 7
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Introduction to Electric Vehicle (EV) & Hybrid Vehicle(HV): A brief history of Electric and Hybrid vehicles, basic architecture of hybrid drive train and analysis of series drive train., vehicle motion and the dynamic equations for the vehicle, types of HV and EV, advantages over conventional vehicles, limitations of EV and HV, impact on environment of EV and HV technology, disposal of battery, cell and hazardous material and their impact on environment	**10 Hrs**
2	Power Management and Energy Sources of EV and HV: Power and Energy management strategies and its general architecture of EV and HV, various battery sources, energy storage, battery based energy storage and simplified models of battery, Battery Management Systems (BMS), fuel cells, their characteristics and simplified models, Super capacitor based energy storage, its analysis and simplified models, flywheels and their modeling for energy storage in HV/BEV, hybridization of various energy storage devices, Selection of the energy storage technology. Power Electronics in EV & HV: Introduction, various power electronics converter topologies and its comparisons, Control of convertor operations in EV and HV, battery chargers used in EV & HV, emerging power electronic	**5 Hrs**

	devices.	
3	DC and AC Machines & Drives in EV & HV: Various types of motors, selection and size of motors, Induction motor drives and control characteristics, Permanent magnet motor drives and characteristics, Brushed& Brushless DC motor drive and characteristics, switched reluctance motors and characteristics, IPM motor drives and characteristics, mechanical and electrical connections of motors.	**10 Hrs**
4	Components & Design Considerations of EV & HV: Design parameters of batteries, ultra-capacitors and fuel cells, aerodynamic considerations, calculation of the rolling resistance and the grade resistance, calculation of the acceleration force, total tractive effort, torque required on the drive wheel, transmission efficiency, consideration of vehicle mass, electric vehicle chassis& body design, general issues in design, specifications and sizing of components Electric and Hybrid Vehicles and Grid interconnection Issues: Introduction to smart charging: Grid to vehicle and vehicle to grid, smart metering and ancillary services, preliminary discussion on vehicle to vehicle and vehicle to personal communication systems, introduction to battery charging stations and its installation and commissioning, preliminary discussion on estimation on station capacity and associated technical issues, different connectors, policy regulations and standards for EV and HV, BEE standards, Indian and Global scenario, case studies	**15 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-4718.1	To deliver and discuss the about architecture, power electronics based drive control systems, battery management systems and grid integration issues of Electric and Hybrid vehicle
CO2	BTME-4718.2	Discuss the about battery management systems
CO3	BTME-4718.3	Discuss the about grid integration issues of Electric and Hybrid vehicle
C04	BTME-4718.4	Demonstrate different configurations of electric vehicles and its components, hybrid vehicle configuration by different techniques, sizing of components and design \ optimization and energy management

Suggested Readings / Books:

1. Iqbal Hussein, “Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press, 2nd Edition, 2003.
2. James Larminie, John Lowry, “Electric Vehicle Technology”, Wiley publications, 1Edition, 2003
3. B D McNicol, D A J Rand, “Power Sources for Electric Vehicles”, Elsevier publications, 1st Edition, 1998.
4. Seth Leitman, “Build Your Own Electric Vehicle” MC Graw Hill, 1st Edition, 2013

(DEPARTMENTAL ELECTIVE-III)

SUBJECT TITLE: ADDITIVE MANUFACTURING
SUBJECT CODE: BTME-4719
SEMESTER: 7
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Introduction to Rapid Prototyping: Classification of Manufacturing Processes, Introduction to Rapid Prototyping and Additive Manufacturing, History of development of RP, Engineering design process, Rapid Prototyping and its Impact, Product development, Product Prototyping and Product Development Product Prototyping: Need of Product Prototyping, Prototype Planning and Management, Product and Prototype Cost Estimation, Prototype Design Methods and tools	**10 Hrs**
2	CAD Modeling: Geometrical Modelling Techniques, Wireframe Modelling, Surface Modelling and solid modeling, Slicing methods and software	**5 Hrs**
3	Rapid Prototyping Processes: Rapid Prototyping Overview, Rapid Prototyping Procedure, Liquid-Based RP Processes, Solid-Based RP Processes, Powder-Based RP Processes, Prototyping Materials, Modeling of Material Properties, Modeling and Design of Materials and Structures. Direct Digital Prototyping and Manufacturing: Solid Models and Prototype Representation, Reverse Engineering for Digital Representation, Prototyping and Manufacturing Using CNC Machining, Fully Automated Digital Prototyping and Manufacturing.	**10 Hrs**
4	Direct Methods for Rapid Tool Production: Classification of Direct Rapid Tool Methods, Direct ACESTM Injection Moulds, Laminated Object Manufactured (LaM) Tools, DTM Rapid Tool, Sand Form, EOS Direct	**15 Hrs**

	Tool Process, Direct Metal Tooling using 3Dp. Applications of Rapid Prototyping: Functional Models, Rapid Tooling, Rapid Manufacturing, Engineering Applications, Medical Model, and Art Models, Engineering Analysis Models. Indirect Methods for Rapid Tool Production: Metal Deposition Tools, RTV Tools, Epoxy Tools, Ceramic Tools, Cast Metal Tools, Investment Casting, Fusible Metallic Core, Sand Casting, Keltool Process.	

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-4716.1	To introduce students the basics of additive manufacturing/rapid prototyping and its applications in various fields, reverse engineering techniques
CO2	BTME-4716.2	Demonstrate the knowledge of Additive Manufacturing and Rapid Prototyping technologies
CO3	BTME-4716.3	Describe different RP techniques
C04	BTME-4716.4	Discuss fundamentals of Reverse Engineering

Suggested Readings / Books:

1. Frank W. Liou, 'Rapid Prototyping and engineering Applications', CRC Press, 2007.
2. D.T. Pham and S.S. Dimov, 'Rapid Manufacturing', Springer.
3. Kevin Otto, Kristin Wood, 'Product Design', Pearson

(DEPARTMENTAL ELECTIVE-III)

SUBJECT TITLE: TOTAL QUALITY MANAGEMENT
SUBJECT CODE: BTME-4720
SEMESTER: 7
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.	**10 Hrs**
2	Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.	**5 Hrs**
3	The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.	**10 Hrs**
4	Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.	**5 Hrs**
	Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards—AS 9100, TS16949 and TL 9000--ISO 9001 Requirements—Implementation— Documentation—Internal Audits—Registration--ENVIRONMENTAL MANAGEMENT SYSTEM:	**10 Hrs**

	Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001— Benefits of EMS.	

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-4720.1	Discuss various dimensions of product and service quality
CO2	BTME-4720.2	Apply the TQM principles for quality improvement in organization
CO3	BTME-4720.3	Explain various ISO Standards and Quality systems practiced in various sector
C04	BTME-4720.4	Summarize the basic concepts in total quality management relevant to manufacturing and service Sectors

Suggested Readings / Books:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.

(DEPARTMENTAL ELECTIVE-III)

SUBJECT TITLE: OPERATION RESEARCH
SUBJECT CODE: BTME-4720
SEMESTER: 7
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Introduction: Introduction to Operations Research: Basics definition, scope, objectives, phases, models and limitations of Operations Research. Linear Programming Problem – Formulation of LPP, Graphical solution of LPP. Simplex Method, Artificial variables, Big-M method, two-phase method, degeneracy and unbound solutions.	**8 Hrs**
2	Transportation Problem: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. Assignment Model: Formulation. Hungarian method for optimal solution. Solving unbalanced problem. Traveling salesman problem and assignment problem. Sequencing Models: Solution of Sequencing Problem–Processing n Jobs through 2 Machines–Processing n Jobs through 3 Machines – Processing 2 Jobs through m machines– Processing n Jobs through m Machines.	**12 Hrs**
3	Dynamic Programming: Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems, Game Theory: Competitive games, rectangular games, saddle point, minimax (maxim in) method of optimal strategies, value of the game.	**12 Hrs**

	Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	
4	Replacement Models: Replacement of Items that Deteriorate whose maintenance costs increase with time without change in the money value. Replacement of items that fail suddenly: individual replacement policy, group replacement policy. Inventory Models: Inventory costs. Models with deterministic demand– model (a) demand rate uniform and production rate infinite, model (b) demand rate non-uniform and production rate infinite, model (c) demand rate uniform and production rate finite.	**10 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-4720.1	Solve linear programming problems using appropriate techniques and optimization solvers, interpret the results obtained
CO2	BTME-4720.2	Determine optimal strategy for Minimization of Cost of shipping of products from source to Destination/ Maximization of profits of shipping products using various methods, Finding initial basic feasible and optimal solution of the Transportation problems
CO3	BTME-4720.3	Model competitive real-world phenomena using concepts from game theory. Analyse pure and mixed strategy games
C04	BTME-4720.4	Formulate Network models for service and manufacturing systems, and apply operations research techniques and algorithms to solve these Network problems

Suggested Readings / Books:

1. P. SankaraIyer, 'Operations Research', Tata McGraw-Hill. 2006
2. A.M. Natarajan, P. Balasubramani, A. Tamilarasi, 'Operations Research', Pearson Education.2008
3. J.K. Sharma, 'Operations Research Theory & Applications,' Macmillan India Ltd. 2012
4. P.K. Gupta and D.S. Hira, 'Operations Research', S. Chand & Co. 1998
5. J.K. Sharma., 'Operations Research, Problems and Solutions', 3rdEdn.,Macmillan India Ltd. 2012

(DEPARTMENTAL ELECTIVE-III)

SUBJECT TITLE: MATERIAL MANAGEMENT
SUBJECT CODE: BTME-4720
SEMESTER: 7th
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Introduction: Meaning, definition, functions of materials management, Concept of integrated material management, Relationship of material management with other Organizational functions.	**4 Hrs**
2	Material Planning & Budgeting: Need for material planning, Factors affecting material planning, Techniques of material planning, Material classification, codification and standardization, Material budgeting - meaning and need, techniques of material budgeting.	**6 Hrs**
3	Inventory Control: Need and meaning of inventory, types of inventory, functions of inventory control, Inventory costs, Inventory control tool - ABC, VED, XYZ and FSN: Economic order Quantity and replenishment of stocks. Physical control of inventory: Fixed order, Two bin and Kardex systems Material requirement planning (MRP-I) Spare parts control for maintenance purposes. Evaluation of inventory control performance. Concept of Just-in-Time(JIT). Use of computers for inventory control Purchasing: Purchasing principles, procedures and systems, Functions of purchasing,	**22 Hrs**

	Make-or-buy decision, Vendor development and vendor rating. Factors affecting purchase decisions, Legal aspects of purchasing, Documentation and procedure for import.	
4	Storage: Functions and importance of store keeping, types of stores, store accounting and store verification, Legal aspects of store keeping, Management of surplus, scrap and obsolete items. Importance of material handling in store keeping, handling equipment.	**8 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-4720.1	Identifying the scope for integrating materials management function over the logistics and supply chain operations
CO2	BTME-4720.2	Identify, study, compare, and evaluate alternatives, select and relate with a good supplier
CO3	BTME-4720.3	Analyzing the materials in storage, handling, packaging, shipping distributing and standardizing.
C04	BTME-4720.4	Integrate important materials functions to both products and services & use MRP,ERP,& PLM managing materials

Suggested Readings / Books:

1. M.M. Verma, Materials Management, S. Chand and Co. 2010
2. Gopal Krishnan and Sundaresan, Material Management - An Integrated Approach, Prentice Hall.2006
3. Dobbler and Burt, Purchasing and materials management, Tata McGraw Hill.2008
4. M. Starr and D. Miller, Inventory control, Prentice Hall.2012

(DEPARTMENTAL ELECTIVE-III)

SUBJECT TITLE: SOLAR ENERGY
SUBJECT CODE: BTME-4720
SEMESTER: 7th
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Introduction: Renewable and non-renewable energy sources, their availability and growth in India; energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements	**10 Hrs**
2	Solar Energy: Solar radiation - beam and diffuse radiation; earth sun angles, attenuation and measurement of solar radiation; Optical properties of materials and selective surfaces; Principles, general description and design procedures of flat Platte and concentrating collectors; Performance analysis of cylindrical and parabolic collectors; Solar energy storage systems - their types, characteristics and capacity; solar ponds. Applications of solar energy in water, space and process heating, solar refrigeration and air conditioning; water desalination and water pumping; solar thermal power generation; solar cells and batteries; economic analysis of solar systems.	**7 Hrs**
3	Wind Energy: Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of accodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection	**10 Hrs**

	considerations.	
4	Direct energy conversion systems: Magnetic Hydrodynamic (MHD) Generator: gas conductivity and MHD equations; operating principle, types and working of different MHD systems – their relative merits; MHD materials and production of magnetic fields. Thermo-electric generators: Thermo-electric effects and materials; thermo-electric devices and types of thermo-electric generators; thermo-electric refrigeration. Thermionic generators: thermoionic emission and materials; working principle of thermionic Fuel Cells: thermodynamic aspects; types, components and working of fuel cells Performance, applications and economic aspects of above mentioned direct energy conversions systems.	**8 Hrs**
5	Miscellaneous Non-Conventional energy Systems: Bio-mass: Concept of bio-mass conversion, photo-synthesis and bio-gasification; Bio gas generators and plants - their types constructional features and functioning; digesters and their design; Fuel properties of bio gas and community bio gas plants Geothermal: Sources of geothermal energy - types, constructional features and associated prime movers. Tidal and wave energy: Basic principles and components of tidal and wave energy plants; single basin and double basin tidal power plants; conversion devices Advantages/disadvantages and applications of above mentioned energy systems.	**10 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-4720.1	Conceptual knowledge of the technology, economics and regulation related issues associated with solar power development and management
CO2	BTME-4720.2	Ability to analyse the viability of solar power projects
CO3	BTME-4720.3	Capability to integrate various options and assess the business and policy environment regarding solar power projects
C04	BTME-4720.4	Advocacy of strategic and policy recommendations on usage of solar power

Suggested Readings / Books:

1. H.P. Garg and Jai Prakash, Solar Energy : Fundamentals and Applications, Tata McGraw Hill.
2. S.P. Sukhatme, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw Hill.
3. John A. Duffic and W. A. Beckman, Solar Engineering of Thermal Processes, John Wiley.

(DEPARTMENTAL ELECTIVE-III)

SUBJECT TITLE: OPTIMIZATION TECHNIQUES
SUBJECT CODE: BTME-4720
SEMESTER: 7th
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
3	0	0	3

Internal Assessment: 40
End Term Exam: 60
Duration of Exam: 3Hrs

Instructions for Question Paper

The question paper consist of three sections A, B & C. Section-A is compulsory consisting of 10 short answer type questions of 2 marks each from the whole syllabus. Section-B consists of 6 questions covering whole syllabus. Students will attempt any four questions. Each question carries 5 marks. Section-C consists of 3 questions from the whole syllabus. Students will attempt any two questions. Each question carries 10 Marks

Contents of Syllabus

S. No.	Contents	Contact Hrs
1	Introduction: Historical Development; Engineering applications of Optimization; Optimization techniques – classical and advanced techniques. Art of Modeling Origin of OR and its role in solving industrial problems: General approach for solving OR problems. Classification of mathematical models: various decision making environments.	**10 Hrs**
2	Linear Programming: Formulation of linear mathematical models: Graphical and simplex techniques for solution of linear programming problems, Motivation of simplex method, Simplex algorithm and construction of simplex tableau; Simplex criterion; Minimization versus maximization problems, Big-M method and two phase method, Introduction to duality theory and sensitivity analysis.	**7 Hrs**
3	Transportation and Assignment Models: Various initial basic feasible solutions methods, Optimization of transportation and assignment using different methods considering the concept of time and cost function. Dynamic Programming: Characteristics of dynamic programming problems, deterministic dynamic programming, and probabilistic dynamic programming. Queuing Theory: Basic structure of queuing model, Types of queuing situation: Queuing models with Poisson's input and exponential service, their application to simple situations.	**20 Hrs**

4	Network Models: Shortest route and traveling sales man problems, PERT & CPM, analysis of time bound project situations, construction of networks, identification of critical path, slack and float, crashing of network for cost reduction. Non-linear Programming Models: Graphical illustration to non-linear programming problems, introduction to different types of non-linear programming problems. Problems related to the topic.	**8 Hrs**

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-4720.1	Recall the theoretical foundations of various issues related to linear programming modeling to formulate real-world problems as a L P model
CO2	BTME-4720.2	Demonstrate the optimized material distribution schedule using transportation model to minimize total distribution cost.
CO3	BTME-4720.3	Identify appropriate equipment replacement technique to be adopted to minimize maintenance cost by eliminating equipment break-down
C04	BTME-4720.4	Demonstrate the various selective inventory control models to analyse and optimize inventory systems.

Suggested Readings / Books:

1. H.A. Taha, 'Operations Research', Prentice Hall of India, New Delhi.
2. H.M. Wagner, 'Principles of Operations Research', Prentice Hall.
3. P.K. Gupta and D.S. Hira, 'Operations Research', S. Chand & Co.

SYLLABUS

SEMESTER-VIII

SUBJECT TITLE: INDUSTRIAL TRAINING
SUBJECT CODE: BTME-4801
SEMESTER: 8th
CONTACT HOURS/WEEK:

Lecture (L)	Tutorial (T)	Practical (P)	Credit (C)
0	0	0	12

Internal Assessment: 200
End Term Exam: 300

In this the student has to do the industrial training and has to make a file for the same.

COURSE OUTCOMES: On completion of this course, the students will be able to

CO1	BTME-4801.1	To participate in ongoing and upcoming projects of the industry
CO2	BTME-4801.2	Determine the use of advanced techniques and machining tools
CO3	BTME-4801.3	Interact with industry personnel and follow the Engineering practices
C04	BTME-4801.4	Develop awareness about general workshop behavior and built a team skills