Dr. Babasaheb Ambedkar Technological University

(Established as a University of Technology in the State of Maharashtra)

(under Maharashtra Act No. XXIX of 2014)

P.O. Lonere, Dist. Raigad,
Pin 402 103, Maharashtra
Telephone and Fax. : 02140 - 275142
www.dbatu.ac.in

Proposed Course Contents for

B. Tech. in Mechanical Engineering

w.e.f. June 2019

From 3rd Semester - 6th Semester

Vision

The vision of the department is to achieve excellence in teaching, learning, research and transfer of technology and overall development of students.

Mission

Imparting quality education, looking after holistic development of students and conducting need based research and extension.

Graduate Attributes

The Graduate Attributes are the knowledge skills and attitudes which the students have at the time of graduation. These Graduate Attributes identified by National Board of Accreditation are as follows:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering 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.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate

the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Educational Objectives

PEO 1	Graduates should excel in engineering positions in industry and other organizations that emphasize design and implementation of engineering systems and devices.
PEO 2	Graduates should excel in best post-graduate engineering institutes, acquiring advanced degrees in engineering and related disciplines.
PEO 3	Alumni should establish a successful career in an engineering-related field and adapt to changing technologies.
PEO 4	Graduates are expected to continue personal development through professional study and self-learning.
PEO 5	Graduates should be good citizens and cultured human beings, with full appreciation of the importance of professional, ethical and societal responsibilities.

Program Outcomes

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

PO 1	Apply the knowledge of mathematics, basic sciences, and mechanical engineering to the solution of complex engineering problems.
PO 2	Identify, formulate, research literature, and analyze complex mechanical engineering problems reaching substantiated conclusions.
PO 3	Design solutions for complex engineering problems and design mechanical system components that meet the specified needs.
PO 4	Use mechanical engineering research-based knowledge related to interpretation of data and provide valid conclusions.
PO 5	Create, select, and apply modern mechanical engineering and IT tools to complex engineering activities with an understanding of the limitations.
PO 6	Apply reasoning acquired by the mechanical engineering knowledge to assess societal and safety issues.
PO 7	Understand the impact of engineering solutions on the environment, and demonstrate the knowledge 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.
PO 11	Understand the engineering and management principles and apply these to the multidisciplinary environments.
PO 12	Recognize the need for life-long learning in the broadest context of technological change.

Program-Specific Outcomes (PSOs)

PSO 1	Make the students employable in engineering industries.
PSO 2	Motivate the students for higher studies and research.

Abbreviations

PEO:	Program Educational Objectives
PO:	Program Outcomes
CO:	Course Outcomes
L:	No. of Lecture hours (per week)
T:	No. of Tutorial hours (per week)
P:	No. of Practical hours (per week)
C:	Total number of credits
BSH:	Basic Science and Humanity
BSC:	Basic Sciences Course
PCC:	Professional Core Course
OEC:	Open Elective Course
PEC:	Professional Elective Course
BHC:	Basic Humanity Course
ESC:	Engineering Science Course
HSMC:	Humanity Science and Management Course
NCC:	National Cadet Corps
NSS:	National Service Scheme
CA:	Continuous Assessment
MSE:	Mid Semester Exam
ESE:	End Semester Exam

B. Tech. Mechanical Engineering

Course Structure for Semester III [Second Year] w.e.f. 2018-2019

Course Code	Type of Course	Course Title	Weekly Teaching Scheme			Evaluation Scheme				Credits
			L	T	P	CA	MSE	ESE	Total	
BTBSC301	BSC 7	Engineering Mathematics-III	3	1	--	20	20	60	100	4
BTMEC302	ESC 11	Materials Science and Metallurgy	3	1	--	20	20	60	100	4
BTMEC303	PCC 1	Fluid Mechanics	3	1	--	20	20	60	100	4
BTMEC304	PCC 2	Machine Drawing and CAD	2	--	--	20	20	60	100	2
BTMEC305	ESC 12	Thermodynamics	3	1	--	20	20	60	100	4
BTHM3401	HSMC 3	Basic Human Rights	2	--	--	50	--	--	50	Audit (AU/ NP)
BTMEL307	ESC 13	Materials Science and Metallurgy Lab	--	--	2	60	--	40	100	1
BTMEL308	PCC 3	Fluid Mechanics Lab	--	--	2	60	--	40	100	1
BTMEL309	PCC 4	Machine Drawing and CAD Lab	--	--	4	60	--	40	100	2
BTMEF310	Project 1	Field Training /Internship/Industrial Training I	--	--	--	--	--	50	50	1
		Total	16	4	8	330	100	470	900	23

B. Tech. Mechanical Engineering

Course Structure for Semester IV [Second Year] w.e.f. 2018-2019

Course Code	Type of Course	Course Title	Weekly Teaching Scheme			Evaluation Scheme				Credits
			L	T	P	CA	MSE	ESE	Total	
BTMEC401	PCC 5	Manufacturing Processes - I	2	1	--	20	20	60	100	3
BTMEC402	PCC 6	Theory of Machines-I	3	1	--	20	20	60	100	4
BTMEC403	PCC 7	Strength of Materials	3	1	--	20	20	60	100	4
BTMEC404	BSC 8	Numerical Methods in Mechanical Engineering	2	1	--	20	20	60	100	3
BTID405	PCC 8	Product Design Engineering – I	1	--	2	60	--	40	100	2
BTBSE406A	OEC 1	Physics of Engineering Materials	3	--	--	20	20	60	100	3
BTBSE3405A		Advanced Engineering Chemistry								
BTHM3402		Interpersonal Communication Skill& Self Development								
BTMEL407	PCC 9	Manufacturing Processes Lab – I	--	--	2	60	--	40	100	1
BTMEL408	PCC 10	Theory of Machines Lab- I	--	--	2	60	--	40	100	1
BTMEL409	PCC 11	Strength of Materials Lab	--	--	2	60	--	40	100	1
BTMEL410	BSC 9	Numerical Methods Lab	--	--	2	60	--	40	100	1
		Total	14	4	10	400	100	500	1000	23
Minimum 4 weeks training which can be completed partially in third and fourth semester or in at one time.										

B. Tech. Mechanical Engineering

Course Structure for Semester V [Third Year] w.e.f. 2019-2020

Course Code	Type of Course	Course Title	Weekly Teaching Scheme			Evaluation Scheme				Credits
			L	T	P	CA	MSE	ESE	Total	
BTMEC501	PCC 12	Heat Transfer	3	1	--	20	20	60	100	4
BTMEC502	PCC 13	Applied Thermodynamics – I	2	1	--	20	20	60	100	3
BTMEC503	PCC 14	Machine Design – I	2	1	--	20	20	60	100	3
BTMEC504	PCC 15	Theory of Machines-II	3	1	--	20	20	60	100	4
BTMEC505	PCC 16	Metrology and Quality Control	2	1	--	20	20	60	100	3
BTID506	PCC 17	Product Design Engineering - II	1	--	2	60	--	40	100	2
BTMEC506A	OEC 2	Automobile Engineering	3	--	--	--	--	--	--	Audit (AU/ NP)
BTMEC506B		Nanotechnology								
BTMEC506C		Energy Conservation and Management								
BTMEL507	PCC 18	Heat Transfer Lab	--	--	2	30	--	20	50	1
BTMEL508	PCC 19	Applied Thermodynamics Lab	--	--	2	30	--	20	50	1
BTMEL509	PCC 20	Machine Design Practice- I	--	--	2	30	--	20	50	1
BTMEL510	PCC 21	Theory of Machines Lab- II	--	--	2	30	--	20	50	1
BTMEF511	Project 2	Field Training /Internship/Industrial Training II	--	--	--	--	--	50	50	1
		Total	16	5	10	280	100	470	850	24

B. Tech. Mechanical Engineering

Course Structure for Semester VI [Third Year] w.e.f. 2019-2020

Course Code	Type of Course	Course Title	Weekly Teaching Scheme			Evaluation Scheme				Credits
			L	T	P	CA	MSE	ESE	Total	
BTMEC601	PCC 22	Manufacturing Processes- II	2	1	--	20	20	60	100	3
BTMEC602	PCC 23	Machine Design-II	3	1	--	20	20	60	100	4
BTMEC603	PCC 24	Applied Thermodynamics- II	2	1	--	20	20	60	100	3
BTMEC604A	PEC 1	Engineering Tribology	2	1	--	20	20	60	100	3
BTMEC604B		IC Engines								
BTMEC604C		Additive Manufacturing								
BTMEC604D		Mechanical Measurements								
BTMEC605A	OEC 3	Quantitative Techniques in Project Management	3	--	--	20	20	60	100	3
BTMEC605B		Sustainable Development								
BTMEC605C		Renewable Energy Sources								
BTMEC606A	OEC 4	Biology for Engineers	3	--	--	--	--	--	--	Audit (AU/ NP)
BTMEC606B		Solar Energy								
BTMEC606C		Human Resource Management								
BTMEL607	PCC 25	Metrology and Quality Control Lab	--	--	2	30	--	20	50	1
BTMEL608	PCC 26	Machine Design Practice-II	--	--	2	30	--	20	50	1
BTMEL609	PCC 27	IC Engine Lab	--	--	2	30	--	20	50	1
BTMEL610	PCC 28	Refrigeration and Air Conditioning Lab	--	--	2	30	--	20	50	1
BTMEM611	Project 3	Technical Project for Community Services	--	--	4	30	--	20	50	2
		Total	15	4	12	250	100	400	750	22

Semester III
Engineering Mathematics-III

BTBSC301	BSC 7	Engineering Mathematics-III	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

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

CO1	
CO2	
CO3	
CO4	
CO5	
CO6	
CO7	
CO8	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												
CO7												
CO8												

Course Contents:

Unit 1: Laplace Transform[07 Hours]

Definition – conditions for existence ; Transforms of elementary functions ; Properties of Laplace transforms - Linearity property, first shifting property, second shifting property, transforms of functions multiplied by t^n, scale change property, transforms of functions divided by t, transforms of integral of functions, transforms of derivatives ; Evaluation of integrals by using Laplace transform ; Transforms of some special functions- periodic function, Heaviside-unit step function, Dirac delta function.

Unit 2: Inverse Laplace Transform[07 Hours]

Introductory remarks ; Inverse transforms of some elementary functions ; General methods of finding inverse transforms ; Partial fraction method and Convolution Theorem for finding inverse Laplace transforms ; Applications to find the solutions of linear differential equations and simultaneous linear differential equations with constant coefficients.

Unit 3: Fourier Transform [07 Hours]

Definitions – integral transforms ; Fourier integral theorem (without proof) ; Fourier sine and cosine integrals ; Complex form of Fourier integrals ; Fourier sine and cosine transforms ; Properties of Fourier transforms ; Parseval's identity for Fourier Transforms.

Unit 4: Partial Differential Equations and Their Applications [07 Hours]

Formation of Partial differential equations by eliminating arbitrary constants and functions; Equations solvable by direct integration; Linear equations of first order (Lagrange's linear equations); Method of separation of variables – applications to find solutions of one dimensional heat flow equation $\left(\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}\right)$, and two dimensional heat flow equation (i.e. Laplace equation : $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$).

Unit 5: Functions of Complex Variables (Differential calculus)[07 Hours]

Limit and continuity of f(z); Derivative of f(z) ; Analytic functions; Cauchy- Riemann equations in Cartesian and polar forms; Harmonic functions in Cartesian form;Mapping: Translation, magnification and rotation, inversion and reflection , bilinear transformation; Conformal mapping.

Unit 6: Functions of Complex Variables (Integral calculus)[07 Hours]

Cauchy's integral theorem; Cauchy's integral formula; Residues; Cauchy's residue theorem (All theorems without proofs).

Text Books:

1. Higher Engineering Mathematics by B. S. Grewal, Khanna Publishers, New Delhi.
2. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons, New York.
3. A Course in Engineering Mathematics (Vol III) by Dr. B. B. Singh, Synergy Knowledge ware, Mumbai.
4. A Text Book of Applied Mathematics (Vol I & II) by P. N. Wartikar and J. N. Wartikar, Pune VidyarthiGrihaPrakashan, Pune.
5. Higher Engineering Mathematics by H. K. Das and Er. RajnishVerma, S. Chand & CO. Pvt. Ltd., New Delhi.

Reference Books:

1. Higher Engineering Mathematics by B. V. Ramana, Tata McGraw-Hill Publications, New Delhi.
2. A Text Book of Engineering Mathematics by Peter O' Neil, Thomson Asia Pte Ltd., Singapore.
3. Advanced Engineering Mathematics by C. R. Wylie & L. C. Barrett, Tata Mcgraw-Hill Publishing Company Ltd., New Delhi.
4. Integral Transforms and Their Engineering Applications by Dr. B. B. Singh, Synergy. Knowledge ware, Mumbai.
5. Integral Transforms by I. N. Sneddon, Tata McGraw-Hill, New York.

General Instructions:

1. The tutorial classes in Engineering Mathematics-III are to be conducted batch-wise. Each class should be divided into three batches for the purpose.
2. The Continuous Assessment of the students for 20 marks will be done based on assignments, surprise tests, quizzes, innovative approach to problem solving and percentage attendance.
3. The minimum number of assignments should be eight covering all topics.

Material Science and Metallurgy

BTMEC302	ESC 11	Materials Science and Metallurgy	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

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

CO1	Study various crystal structures of materials
CO2	Understand mechanical properties of materials and calculations of same using appropriate equations
CO3	Evaluate phase diagrams of various materials
CO4	Suggest appropriate heat treatment process for a given application
CO5	Prepare samples of different materials for metallography
CO6	Recommend appropriate NDT technique for a given application

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1									
CO2	3	2	2	3	2							
CO3	2	1	2	1	1							
CO4	1	2	2	1	2	1	2	1	1	1		
CO5	1	1	1	3	2		1		1			
CO6	1	1	2	2	2	1	2		1	1		

All units carry 10 Marks each for End Semester Examination.

Course Contents:

Unit 1: Structure of Materials[08 Hours]

Crystal structures, indexing of lattice planes, Indexing of lattice directions, Imperfections in crystals-point defects, line defects, surface and bulk defects, Mechanism of plastic deformation, deformation of single crystal by slip, plastic deformation of polycrystalline materials.

Unit 2: Mechanical Properties and their Testing[08 Hours]

Tensile test, engineering stress-strain curve, true stress-strain curve, types of stress-strain curves, compression test, bend test, torsion test, formability, hardness testing, different hardness tests-Vickers, Rockwell, Brinnel, Impact test, fatigue test, creep test.

Unit 3: Equilibrium Diagrams[09 Hours]
Definitions of terms, rules of solid-solubility, Gibb's phase rule, solidification of a pure metal, plotting of equilibrium diagrams, lever rule, Iron-iron carbide equilibrium diagram, critical temperatures, solidification and microstructure of slowly cooled steels, non-equilibrium cooling of steels, property variation with microstructures, classification and application of steels, specification of steels, transformation products of austenite, TTTdiagram, critical cooling rate, CCT diagram.

Unit 4: Heat Treatment[07 Hours]
Heat treatment of steels, cooling media, annealing processes, normalizing, hardening, tempering, quenching and hardenability, surface hardening processes-nitriding, carbo-nitriding, flame hardening, induction hardening.

Unit 5: Metallography[08 Hours]
Microscopy, specimen preparation, polishing abrasives and cloths, specimen mounting, electrolytic polishing, etching procedure and reagents, electrolytic etching, optical metallurgical microscope, macroscopy, sulphur printing, flow line observations, examination of fractures, spark test, electron microscope.

Unit 6: Strengthening Mechanisms and Non-destructive Testing[08 Hours]
Refinement of grain size, cold working/strain hardening, solid solution strengthening, dispersion strengthening, Precipitation hardening. Magnetic particle inspection, dye Penetrant inspection, ultrasonic inspection, radiography, eddy current testing, acoustic emission inspection.

Texts:

1. V. D.Kodgire, S.V.Kodgire, "Material Science and Metallurgy for Engineers", Everest Publishing House, Pune, 24thedition, 2008.
2. W. D.Callister, "Materials Science and Engineering: An Introduction", John Wiley and Sons, 5thedition,2001.
3. V.Raghvan, "Material Science Engineering", Prentice Hall of India Ltd., 1992.
4. S. H.Avner, "Introduction to Physical Metallurgy", Tata McGraw Hill, 2ndedition, 1997.
5. R. A.Higgins, "Engineering Metallurgy: Part I", ELBS, 6thedition, 1996.

References:

1. V. B.John, "Introduction to Engineering Materials", ELBS, 6thedition, 2001.
2. G. F.Carter, D. E.Paul, "Materials Science and Engineering", ASM International, 3rd edition, 2000.
3. T. E.Reed-Hill, R.Abbaschian, "Physical Metallurgy Principles", Thomson, 3rdedition, 2003.

Fluid Mechanics

BTMEC303	PCC 1	Fluid Mechanics	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks

Tutorial: 1 hr/week	Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

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

CO1	Define fluid, define and calculate various properties of fluid
CO2	Calculate hydrostatic forces on the plane and curved surfaces and explain stability of floating bodies
CO3	Explain various types of flow. Calculate acceleration of fluid particles
CO4	Apply Bernoulli’s equation and Navier-Stokes equation to simple problems in fluid mechanics
CO5	Explain laminar and turbulent flows on flat plates and through pipes
CO6	Explain and use dimensional analysis to simple problems in fluid mechanics
CO7	Understand boundary layer, drag and lift

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1							1
CO2	3	3	1	1	1							1
CO3	3	3	1	1	1							1
CO4	3	3										1
CO5	3	3										1
CO6	2	3										1
CO7	2	3										1

All units carry 10 Marks each for End Semester Examination.

Course Contents:

Unit 1: Basics[08 Hours]

Definition of fluid, fluid properties such as viscosity, vapour pressure, compressibility, surface tension, capillarity, Mach number etc., pressure at a point in the static mass of fluid, variation of pressure, Pascal’s law, pressure measurement by simple and differential manometers using manometric expression.

Unit 2: Fluid Statics[08 Hours]

Hydrostatic forces on the plane and curved surfaces, centre of pressure, Buoyancy, centre of buoyancy, stability of floating bodies, metacentre and metacentric height its application in shipping.

Unit 3: Fluid Kinematics[08 Hours]

Velocity of fluid particle, types of fluid flow, description of flow, continuity equation, Coordinate freeform, acceleration of fluid particle, rotational and irrotational flow, Laplace’s equation in velocity potential and Poisson’s equation in stream function, flownet.

Unit 4: Fluid Dynamics[08 Hours]

Momentum equation, development of Euler’s equation, Introduction to Navier-Stokes equation, Integration of Euler's equation to obtain Bernoulli's equation, Bernoulli's theorem, Application of Bernoulli's theorem such as venturimeter, orificemeter, rectangular and triangular notch, pitot tube, orifices, etc.

Unit 5: Types of Flow[08 Hours]

a) **Laminar Flow:** Flow through circular pipe, between parallel plates, Power absorbed in viscous flow in bearings, loss of head due to friction in viscous flow.
b) **Turbulent Flow:** Reynolds's experiment, frictional loss in pipe flow, shear stress in turbulent flow, major and minor losses, HGL and TEL, flow through series and parallel pipes.

Unit6: Dimensional Analysis[08 Hours]

a) **Dimensional Analysis:** Dimensional homogeneity, Raleigh's method, Buckingham's theorem, Model analysis, similarity laws and dimensionless numbers.
b) Introductionto boundary layer theory and its analysis.
c) **Forces on Submerged bodies:** Drag, lift, Drag on cylinder, Development of lift in cylinder.

Texts:

1. P. N. Modi, S. M. Seth, "Fluid Mechanics and Hydraulic Machinery", Standard Book House, 10th edition,1991.
2. Robert W. Fox, Alan T. McDonald, "Introduction to Fluid Mechanics", John Wile and Sons, 5th edition.

References:

1. V. L. Streeter, K. W. Bedfordand E. B. Wylie, "Fluid Dynamics", Tata McGraw-Hill, 9th edition, 1998.
2. S. K. Som, G.Biswas, "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw Hill, 2nd edition, 2003.

Machine Drawing and Computer Aided Drafting

BTMEC304	PCC 2	Machine Drawing and Computer Aided Drafting	2-0-0	2 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

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

CO1	Interpret the object with the help of given sectional and orthographic views.
CO2	Construct the curve of intersection of two solids
CO3	Draw machine element using keys, cotter, knuckle, bolted and welded joint
CO4	Assemble details of any given part. i. e. valve, pump , machine tool part etc.
CO5	Represent tolerances and level of surface finish on production drawings
CO6	Understand various creating and editing commands in Auto Cad

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2								3	2		1
CO2	2	1							2	1		1
CO3	2								2	1		
CO4	2	2			1				2	1		1
CO5	1	1			1				2	1		1
CO6	1	1			1				2	2		1

Course Contents:

Unit 1: Sectional Views[04 Hours]
Full section, half section, partial section, off-set section, revolved sections, removed sections, auxiliary section, guidelines for hatching, examples on all above types of sections of machine elements.

Unit 2: Study of Machine Elements[04 Hours]
Study of simple machine elements and components such as screwed fasteners, shaft couplings, pipe joints, riveted and welded joints, bearings, gears, etc.

Unit 3: Interpenetration of Surfaces (Emphasis on Applied Cases)[04 Hours]
Line or curve of intersection of two penetrating cylinders, Cone and cylinder, prism and a cylinder, cone and prism, Forged ends, etc.

Unit 4: Drawing of Assembly and Details[04 Hours]
Part drawing of standard machine components such as valves, components of various machine tools, pumps, shaft couplings, joints, pipe fittings, engine parts, etc.

Unit 5: Production Drawing and Reading Blue Prints[04 Hours]
Types of production drawings, size, shape and description; limits, fits and tolerances, surface roughness and surface roughness symbols, reading the blue prints.

Unit 6: Computer Aided Drafting[04 Hours]
Introduction to Computer Aided Design and Drafting, Advantages of CADD, study of preliminary AutoCAD commands like drawing, dimensioning, viewing commands. Drawing 3D views in AutoCAD, Introduction to AutoLISP programming.

Texts:

1. N. D. Bhatt,“Engineering Drawing”, Charotar Publishing House, Anand, India.
2. N. D. Bhatt, “Machine Drawing”, Charotar Publishing House, Anand, India.
3. Ajeet Sing, “Working with AutoCAD 2000”, Tata McGraw Hill, New Delhi.
4. George Omura, “ABC of AutoLISP”, BPB Publications, New Delhi.

References:

1. Narayana, Kannaiah, Reddy, “Machine Drawing”, New Age International Publishers.
2. AutoCAD and AutoLISPmanuals from Autodesk Corp. U.S.A.
3. ISCode: SP46-1988, Standard Drawing Practices for Engineering Institutes.

Thermodynamics

BTMEC305	ESC 12	Thermodynamics	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

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

CO1	Define the terms like system, boundary, properties, equilibrium, work, heat, ideal gas, entropy etc. used in thermodynamics.
CO2	Study different laws of thermodynamics and apply these to simple thermal systems like balloon, piston-cylinder arrangement, compressor, pump, refrigerator, heat exchanger, etc. to study energy balance.
CO3	Study various types of processes like isothermal, adiabatic, etc. considering system with ideal gas and represent them on p-v and T-s planes.
CO4	Apply availability concept to non-flow and steady flow type systems.
CO5	Represent phase diagram of pure substance (steam) on different thermodynamic planes like p-v, T-s, h-s, etc. Show various constant property lines on them.

Mapping of course outcomes with program outcomes

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

All units carry 10 Marks each for End Semester Examination.

Course Contents:

Unit 1: Fundamental Concepts and Definitions [08 Hours]

Thermodynamic systems; properties, processes and cycles. Thermodynamic equilibrium, Quasi-static process, Macroscopic vs. Microscopic viewpoint, Work and heat Transfer: Work transferred and other types of work, Heat transfer, temperature and its measurement (principle of measurement, various instruments etc.). Zeroth law of thermodynamics, specific heat and latent heat, point function, path function.

Unit 2: First Law of Thermodynamics[08 Hours]

First law of thermodynamics for a closed system undergoing a cycle and change of state, Energy, different forms of energy, Enthalpy, PMM-I control volume.

Application of first law of steady flow processes (nozzle, turbine, compressor pump, boiler, throttle valve etc.)

Unit 3: Second Law of Thermodynamics[08 Hours]
Limitation of first law of thermodynamics, cycle heat engine, refrigerator and heat pump, Kelvin- Plank and Clausius statements and their equivalence, Reversibility and Irreversibility, Carnot cycle, Carnot theorem, Absolute thermodynamic temperature scale.

Unit 4: Entropy[08 Hours]
Introduction, Clausius theorem, T-s plot, Clausius inequality, Entropy and Irreversibility, Entropy principle and its application, combined I and II law, Entropy and direction, Entropy and disorder.

Unit 5: Availability[07 Hours]
Available energy pertaining a cycle, Quality of energy, law of degradation of energy, maximum work in a reversible process, Dead state, Availability in steady flow and non-flow processes, Second law efficiency.

Unit 6: Ideal Gas[09 Hours]
Avogadro's law, Equation of state, ideal gas and process, relation between C_p and C_v, other equation of states.

Properties of Pure Substance: Phase change of pure substance, phase diagram of pure substance, p-v, T-s, and h-s diagrams properties of steam, property table, representation of processes of steam on p-v, T-s, and diagrams, Dryness fraction and its measurement.

Texts:

1. P.K.Nag, " Engineering Thermodynamics", Tata McGraw Hill, New Delhi, 3rd edition,2005.
2. Y. A.Cengel, M. A. Boles, "Thermodynamics - An Engineering Approach", Tata McGraw Hill, 5thedition, 2006.

References:

1. G. J. VanWylen, R. E. Sonntag, " Fundamental of Thermodynamics", John Wiley and Sons, 5thedition, 1998.
2. M. J. Moran, H. N. Shaprio, "Fundamentals of Engineering Thermodynamics", John Wiley and Sons, 4th edition, 2004.

Basic Human Rights

BTHM3401	HSMC 3	Basic Human Rights	2-0-0	Audit

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week	Audit Course

Pre-Requisites: None

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

CO1	Understand the history of human rights.
CO2	Learn to respect others caste, religion, region and culture.
CO3	Be aware of their rights as Indian citizen.

CO4	Understand the importance of groups and communities in the society.
CO5	Realize the philosophical and cultural basis and historical perspectives of human rights.
CO6	Make them aware of their responsibilities towards the nation.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						2						
CO2												
CO3												
CO4									3			
CO5								2		2		
CO6												1

Course Contents:

Unit 1: The Basic Concepts[04 Hours]
Individual, group, civil society, state, equality, justice. Human Values, Human rights and Human Duties: Origin, Contribution of American bill of rights, French revolution. Declaration of independence, Rights of citizen, Rights of working and exploited people

Unit 2: Fundamental Rights and Economic Program [04 Hours]
Society, religion, culture, and their inter-relationship. Impact of social structure on human behavior, Social Structure and Social Problems: Social and communal conflicts and social harmony, rural poverty, unemployment, bonded labour.

Unit 3: Workers and Human Rights[04 Hours]
Migrant workers and human rights violations, human rights of mentally and physically challenged. State, Individual liberty, Freedom and democracy.

Unit 4: NGOs and Human Rights in India[04 Hours]
Land, Water, Forest issues.

Unit 5: Human Rights in Indian Constitution and Law[04 Hours]
i) The constitution of India: Preamble
ii) Fundamental rights.
iii) Directive principles of state policy.
iv) Fundamental duties.
v) Some other provisions.

Unit 6: UDHR and Indian Constitution[04 Hours]
Universal declaration of human rights and provisions of India; Constitution and law; National human rights commission and state human rights commission.

References:

1. Shastry, T. S. N., "India and Human Rights: Reflections", Concept Publishing Company India (P Ltd.), 2005.
2. C. J. Nirmal, "Human Rights in India: Historical, Social and Political Perspectives (Law

in India)", Oxford India.

Material Science and Metallurgy Lab

BTMEL307	ESC 13	Material Science and Metallurgy Lab	0-0-2	1 Credit

Practical Scheme:	Examination Scheme:
Practical: 2 hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

Pre-Requisites: None

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

CO1	
CO2	
CO3	
CO4	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												

List of Practicals/Experiments/Assignments (any ten experiments from the list)

1. Brinell Hardness Test
2. Rockwell Hardness test
3. Erichson Cupping Test
4. Magnaflux Test
5. Dye Penetrant Test
6. Specimen Preparation for Microscopy
7. Sulphur Print Test
8. Spark Test
9. Study and drawing of microstructures of plain carbon steels of varying carbon percentage
10. Study and drawing of microstructures of heat treated steels
11. Jominy End Quench Test
12. Study and drawing of microstructures of cast irons
13. Study and drawing of microstructures of non-ferrous alloys
14. Hardening of steels of varying carbon percentage

Fluid Mechanics Lab

BTMEL308	PCC 3	Fluid Mechanics Lab	0-0-2	1 Credit

Practical Scheme:	Examination Scheme:
Practical: 2 hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

Pre-Requisites: None

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

CO1	Understand laminar and Turbulent flow and determine Critical Reynolds number using Reynolds Apparatus
CO2	Verify Bernoulli's theorem
CO3	Determine pressure drop in flow though pipes and pipe fittings
CO4	Verify momentum equation using impact of jet apparatus
CO5	Determine viscosity using viscometer
CO6	Do calibration of pressure gauges, rotameter
CO7	Use manometers for pressure measurement

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	3	1				1	2		1
CO2	1	1	1	3	1				1	2		1
CO3	1	1	1	3	1				1	2		1
CO4	1	1	1	3	1				1	2		1
CO5	1	1	1	3	1				1	2		1
CO6	1	1	1	3	1				1	2		1
CO7	1	1	1	3	1				1	2		1

List of Practicals/Experiments/Assignments (any ten experiments from the list)

1. Flow visualization technique: characteristics of laminar and turbulent flow patterns using Helleshaw Apparatus.
2. Verification of Bernoulli's theorem
3. Determination of Critical Reynolds number using Reynolds Apparatus
4. Determination of pressure drop in pipes of various cross-sections
5. Determination of pressure drops in pipes of various pipe fittings etc.
6. Viscosity measurement using viscometer(at least one type)
7. Verification of momentum equation using impact of jet apparatus
8. Determination of metacentric height of a floating body
9. Calibration of a selected flow measuring device and Bourdon pressure gauge
10. Gauge and differential pressure measurements using various types of manometers, Bourdon type pressure gauge.
11. Demonstration of measurement using these instruments Lab.
12. Experiment to study hydraulic jump.

Machine Drawing and Computer Aided Drafting Lab

BTMEL309	PCC 4	Machine Drawing and Computer-aided Drafting Lab	0-0-4	2 Credits

Practical Scheme:	**Examination Scheme:**
Practical: 4 hrs/batch	Continuous Assessment: 60 Marks

	External Exam: 40 Marks

Pre-Requisites: None

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

CO1	Draw Conventional representation of standard machine components, welds, materials etc.
CO2	Draw sectional view of a given machine component.
CO3	Develop Assemble view from details of given component i.e. valve, pump, machine tool part, etc.
CO4	Combine details of given machine component and draw assembled view.
CO5	Use various Auto-Cad commands to draw orthographic projection
CO6	Draw sectional view from pictorial view of given machine component using Auto-Cad

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1		1				1			
CO2	2	1	1		1				1			1
CO3	3	1	1		1				2	1		2
CO4	3	1	1		1				2	1		1
CO5	2	1	1		2				2	2		1
CO6	1	1	1		1				1	1		1

List ofPracticals/Experiments/Assignments (minimum six assignments should be completed)

1. One full imperial drawing sheet consisting the drawing/sketches of representation of standard components, symbols of pipe joints, weld joints, rivet joint etc., surface finish symbols and grades, limit, fit and tolerance sketches.
2. Two full imperial drawing sheets, one consisting of assembly and the other consisting of details of any one standard component such as valves, components of various machine tools, pumps, joints, engine parts, etc.
3. Two assignment of AutoCAD: Orthographic Projections of any one simple machine component such as bracket, Bearing Housing or Cast component for Engineers such as connecting rod, Piston, etc.; with dimensioning and detailing of three views of components.
4. 3-D model at least one simple machine component.

Semester IV
Manufacturing Processes-I

BTMEC401	PCC 5	Manufacturing Processes-I	2-1-0	3 Credits

Pre-Requisites: None

Teaching Scheme:	Examination Scheme:
Lecture: 2hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

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

CO1	Identify castings processes, working principles and applications and list various defects in metal casting
CO2	Understand the various metal forming processes, working principles and applications
CO3	Classify the basic joining processes and demonstrate principles of welding, brazing and soldering.
CO4	Study center lathe and its operations including plain, taper turning, work holding devices and cutting tool.
CO5	Understand milling machines and operations, cutters and indexing for gear cutting.
CO6	Study shaping, planing and drilling, their types and related tooling's

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1		1	1				1		1
CO2	2	2	1		1	1				1		1
CO3	2	1	1		1	1				1		1
CO4	1		1		1	1				1		1
CO5	2		1		1	1				1		1
CO6	1				1	1				1		1

All units carry 10 Marks each for End Semester Examination.

Course Contents:

Unit 1: Introduction and Casting Processes[06 Hours]
What is manufacturing? Selection of manufacturing processes
Introduction to casting; solidification of metals: Pure metals, Alloys; fluid flow; fluidity of molten metal; heat transfer: Solidification time, Shrinkage; defects: Porosity; Metal casting processes: Introduction; sand casting, shell molding, investment casting; Permanent-mold casting, vacuum casting, die casting, centrifugal casting; Inspection of casting; melting practice and furnaces, general design considerations for casting.

Unit 2: Rolling and Forging Processes[06 Hours]

Introduction to Rolling; Flat-rolling Process: Roll Force, Torque, and Power Requirements, Geometric Considerations; Flat-rolling Practice: Defects in Rolled Plates and Sheets; Rolling Mills; Various Rolling Processes and Mills.

Introduction to forging, Open-die forging; Impression-die and Closed-die forging; various forging Operations; Forgeability of Metals: Forging Defects; Die Design, Die Materials, and Lubrication; Forging Machines.

Unit 3: Extrusion, Drawing and Sheet Metal Forming[06 Hours]

Introduction; Extrusion Process; Hot Extrusion; Cold Extrusion: Impact extrusion, Hydrostatic Extrusion; Extrusion Defects; Extrusion Equipment; Drawing Process; Drawing Practice; Drawing Defects and Residual Stresses; Drawing Equipment.

Introduction to sheet metal forming; Shearing: Shearing operations, Characteristics and Type of Shearing Dies; Sheet-metal Characteristics and Formability, Formability Tests for Sheet Metals; Bending Sheets, Plates, and Tubes; Deep Drawing: Deep Drawability, Deep-drawing Practice; Spinning; Design Considerations in Sheet-metal Forming; Equipment for Sheet-metal Forming.

Unit 4: Joining Processes[06 Hours]

Oxy-fuel-gas Welding; Arc-Welding Processes: Non consumable Electrode; Arc-welding Processes: Consumable Electrode, Shielded Metal-arc Welding, Submerged-arc Welding, Gas Metal-arc Welding; Electrodes for Arc Welding; The Weld joint, Quality, and Testing: Weld Quality, Weldability, Testing of Welds; Joint Design and Process Selection.

Introduction to solid state welding, Friction Welding, Resistance Welding: Spot, Seam, Projection Welding. Introduction to brazing and soldering; Brazing: Brazing Methods, Design for Brazing; Soldering: Types of Solders and Fluxes, Solderability, Soldering Techniques, Soldering Applications and Design Guidelines; Mechanical Fastening, Design for Mechanical Fastening.

Unit 5: Machining Processes: Turning and Hole Making[06 Hours]

Introduction; The Turning Process; Lathes and Lathe Operations: Lathe Components, Work holding Devices and Accessories, Lathe Operations, Types of Lathes, Turning-process Capabilities, Design Considerations and Guidelines for Turning Operations, Chip Collection Systems, Cutting Screw Threads; Boring and Boring Machines; Drilling, Drills, and Drilling Machines: Drills, Material-removal Rate in Drilling, Thrust Force and Torque, Drill Materials and Sizes, Drilling Practice, Drilling Machines, Design Considerations for Drilling; Reaming and Reamers; Tapping and Taps.

Unit 6: Machining Processes: Milling, Broaching and Gear Manufacturing[06 Hours]

Introduction, Milling and Milling Machines: Peripheral Milling, Face Milling, End Milling, Other Milling Operations and Milling Cutters, Tool holders, Milling Process Capabilities, Design and Operating Guidelines for Milling, Milling Machines; Planing and Shaping; Broaching and Broaching Machines; Gear Manufacturing by Machining: Form Cutting, Gear Generating, Cutting Bevel Gears, Gear-finishing Processes, Design Considerations and Economics of Gear Machining.

Text:

1. SeropeKalpakjian and Steven R. Schmid, “Manufacturing Engineering and Technology”, Addison Wesley Longman (Singapore) Pte. India Ltd., 6thedition, 2009.

References:

1. Milkell P. Groover, " Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", John Wiley and Sons, New Jersey, 4th edition, 2010.
2. Paul DeGarmo, J.T. Black, Ronald A. Kohser, " Materials and Processes in Manufacturing", Wiley, 10th edition, 2007.

Theory of Machines- I

BTMEC402	PCC 6	Theory of Machines-I	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

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

CO1	Define basic terminology of kinematics of mechanisms
CO2	Classify planar mechanisms and calculate its degree of freedom
CO3	Perform kinematic analysis of a given mechanism using ICR and RV methods
CO4	Perform kinematic analysis of a given mechanism analytically using vector or complex algebra method
CO5	Perform kinematic analysis of slider crank mechanism using Klein's construction and analytical approach

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Introduction [08 Hours]

Definition of link, pair, kinematics chain, inversions, inversions of single and double slider crank chain, kinematic diagrams of mechanisms, equivalent linkage of mechanism, degree of freedom.

Study of various mechanisms such as straight line mechanisms, pantograph, Geneva mechanism, steering gear mechanisms and Hooke's joint.

Instantaneous centre of rotation, body and space centrodes and their applications, Kennedy's theorem and its applications.

Unit 2: Velocity Acceleration Analysis [08 Hours]

Velocity and acceleration analysis and its purpose, velocity and acceleration diagrams using

relative velocity method, Corioli's component of acceleration, Velocity and acceleration analysis by vector methods, coordinate system, Loop closure equation, Chase solutions, velocity and acceleration by vector and complex algebra.
Velocity and acceleration of slider crank mechanism by analytical method and Klein's construction.

Unit 3: Friction and Lubrication[08 Hours]
Dry friction, friction between nut and screw with different types of threads, Uniform wear theory and uniform pressure theory, Frication at pivot and collars, Friction in turning pair, Friction circle and friction axis, Friction in mechanisms.
Lubrication, Viscosity, Viscous flow, Boundary lubrication, Thick film lubrication, Hydrostatic and hydrodynamic lubrications.

Unit 4: Clutch, Brakes and Dynamometers[08 Hours]
Friction Clutches: Single plate and multi-plate clutch, Cone clutch, Centrifugal clutch, Torque transmitting capacity, Clutch operating mechanism.
Brakes: Shoe brake, Internal and external shoe brakes, Block brakes, Band brakes, Band and block brakes, Braking torque.
Dynamometers: Different types of absorption and transmission type dynamometers, Construction and working of eddy current dynamometer, Torque measurement.

Unit 5: Cams and Followers[08 Hours]
Types of cams and followers, Analysis of motion, Jump and ramp of cam, Determination of cam profiles for a given follower motion, Circular arc cam, Tangent cam, Cycloidal cam.

Unit 6: Balancing[08 Hours]
Balancing of rotating masses in one and several planes, Balancing of reciprocating, masses in single and multi-cylinder engine viz., inclined, radial and v-type engines, Primary and secondary balancing analysis, Concept of direct and reverse cranks, Balancing of locomotive engines, Effect of partial balancing, Static and dynamic balancing.

Texts:

1. A. Ghosh, A. K. Malik, "Theory of Mechanisms and Machines", Affiliated East-West Press Pvt. Ltd., New Delhi.
2. S. S. Rattan, "Theory of Machines", Tata McGraw Hill, New Delhi.

References:

1. Thomas Beven, "Theory of Machines", CBS Publishers and Distributors, Delhi.
2. J. E. Shigely, J. J. Uicker, "Theory of Machines and Mechanisms", Tata McGraw Hill Publications, New York, International Student Edition, 1995.

Strength of Materials

BTMEC403	PCC 7	Strength of Materials	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: Engineering Mechanics

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

CO1	State the basic definitions of fundamental terms such as axial load, eccentric load, stress, strain, E, μ, etc.
CO2	Recognize the stress state (tension, compression, bending, shear, etc.) and calculate the value of stress developed in the component in axial/eccentric static and impact load cases.
CO3	Distinguish between uniaxial and multiaxial stress situation and calculate principal stresses, max. shear stress, their planes and max. normal and shear stresses on a given plane.
CO4	Analyze given beam for calculations of SF and BM
CO5	Calculate slope and deflection at a point on cantilever /simply supported beam using double integration, Macaulay's , Area-moment and superposition methods
CO6	Differentiate between beam and column and calculate critical load for a column using Euler's and Rankine's formulae

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

All units carry 10 Marks each for End Semester Examination.

Course Contents:

Unit 1: Simple Stresses and Strains[08 Hours]
Mechanical properties of materials, analysis of internal forces, simple stresses and strains, stress-strain curve, Hooke's law, modulus of elasticity, shearing, thermal stress, Hoop stress, Poisson's ratio, volumetric stress, bulk modulus, shear modulus, relationship between elastic constants.

Unit 2: Principal Stresses and Strains[08 Hours]
Uni-axial stress, simple shear, general state of stress for 2-D element, ellipse of stress, principal stresses and principal planes, principal strains, shear strains, strain rosettes, Mohr's circle for stresses and strains.
Strain energy and resilience: Load-deflection diagram, strain energy, proof resilience, stresses due to gradual, sudden and impact loadings, shear resilience, strain energy in terms of principal stresses.

Unit 3: Combined Stresses[08 Hours]
Combined axial and flexural loads, middle third rule, kernel of a section, load applied off the axes of symmetry.

Shear and Moment in Beams: Shear and moment, interpretation of vertical shear and bending moment, relations among load, shear and moment.

Unit 4: Stresses in Beams[08 Hours]

Moment of inertia of different sections, bending and shearing stresses in a beam, theory of simple bending, derivation of flexural formula, economic sections, horizontal and vertical shear stress, distribution shear stress for different geometrical sections-rectangular, solid circular, I-section, other sections design for flexure and shear.

Unit 5: Beam Deflections[08 Hours]

Differential equation of deflected beam, slope and deflection at a point, calculations of deflection for determinate beams by double integration, Macaulay's method, theorem of area-moment method (Mohr's theorems), moment diagram by parts, deflection of cantilever beams, deflection in simple supported beams, mid-span deflection, conjugate beam method, deflection by method of superstition.

Unit 6: Torsion[08 Hours]

Introduction and assumptions, derivation of torsion formula, torsion of circular shafts, stresses and deformation indeterminate solid/homogeneous/composite shafts, torsional strain energy.

Columns and Struts: Concept of short and long Columns, Euler and Rankine's formulae, limitation of Euler's formula, equivalent length, eccentrically loaded short compression members.

Texts:

1. S. Ramamrutham, "Strength of Materials", DhanpatRai and Sons, New Delhi.
2. F. L. Singer, Pytle, "Strength of Materials", Harper Collins Publishers, 2002.
3. S. Timoshenko, "Strength of Materials: Part-I (Elementary Theory and Problems)", CBS Publishers, New Delhi.

References:

1. E. P.Popov, "Introduction to Mechanics of Solid", Prentice Hall, 2nd edition, 2005.
2. S. H. Crandall, N. C. Dahl, T. J. Lardner, "An introduction to the Mechanics of Solids", Tata McGraw Hill Publications, 1978.
3. S. B. Punmia, "Mechanics of Structure", Charotar Publishers, Anand.
4. B. C. Punmia, Ashok Jain, Arun Jain, "Strength of Materials", Laxmi Publications.

Numerical Methods in Mechanical Engineering

BTMEC404	BSC 8	Numerical Methods in Mechanical Engineering	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

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

CO1	Describe the concept of error
CO2	Illustrate the concept of various Numerical Techniques
CO3	Evaluate the given Engineering problem using the suitable Numerical Technique
CO4	Develop the computer programming based on the Numerical Techniques

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit1: Error Analysis [06 Hours]
Significant figures, round-off, precision and accuracy, approximate and true error, truncation error and Taylor series, machine epsilon, data uncertainties, error propagation, importance of errors in computer programming.

Unit2: Roots of Equations [06 Hours]
Motivation, Bracketing methods: Bisection methods, Open methods: Newton Raphson method, Engineering applications.

Unit3: Numerical Solution of Algebraic Equations [06 Hours]
Motivation, Cramer's rule, Gauss- Elimination Method, pivoting, scaling, engineering applications.

Unit4: Numerical Integration and Differentiation [06 Hours]
Motivation, Newton's Cotes Integration Formulas: Trapezoidal Rule, Simpson's rule, engineering applications Numerical differentiation using Finite divide Difference method

Unit5: Curve Fitting and Interpolation [08 Hours]
Motivation, Least Square Regression: Linear Regression, Polynomial regression.
Interpolation: Newton's Divide Difference interpolation, engineering applications.
Solution to Ordinary Differentiation Equations: Motivation**,** Euler's and Modified Euler's Method, Heun's method, Runge–Kutta Method, engineering applications.

Unit6: Computer Programming [04 Hours]
Overview of programming language, Development of at least one computer program based on each unit.

Texts:

1. Steven C Chapra, Reymond P. Canale, "Numerical Methods for Engineers", TataMcGraw Hill Publications, 2010.
2. E.Balagurusamy, "Numerical Methods", TataMcGraw Hill Publications,1999.

References:

1. V. Rajaraman, “Fundamental of Computers”, Prentice Hall of India,NewDelhi,2003.
2. S. S. Sastri,“IntroductoryMethodsofNumericalMethods”,PrenticeHallofIndia,NewDelhi, 3rd edition,2003.
3. K. E. Atkinson, “An Introduction to Numerical Analysis”,Wiley,1978.
4. M.J. Maron, “Numerical Analysis: A Practical Approach”, Macmillan, New York, 1982

Product Design Engineering - I

BTID405	PCC 8	Product Design Engineering - I	1-0-2	2 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture-cum-demonstration: 1 hr/week Design Studio/Practical: 2 hrs/week	Continuous Assessment: 60 Marks End Semester Exam: 40 Marks

- **Pre-requisites:** Knowledge of Basic Sciences, Mathematics and Engineering Drawing
- **Design Studio/Practical:** 2 hrs to develop design sketching and practical skills
- **Continuous Assessment:** Progress through a product design and documentation of steps in the selected product design
- **End Semester Assessment:** Product design in studio with final product specification

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

1. Create simple mechanical designs
2. Create design documents for knowledge sharing
3. Manage own work to meet design requirements
4. Work effectively with colleagues

Course Contents:

Unit 1: Introduction to Engineering Product Design

Trigger for Product/Process/System, Problem solving approach for Product Design, Disassembling existing product(s) and understanding relationship of components with each other, Sketching of components, identifying materials and their processing for final product, fitting of components, understanding manufacturing as scale of the components, Reverse engineering concept, case studies of products in markets, (or in each discipline), underlying principles, Case studies of product failures, Revival of failed products, Public/Society’s perception of products, and its input into product design.

Unit 2: Ideation

Generation of ideas, Funneling of ideas, Short-listing of ideas for product(s) as an individual or group of individuals, Sketching of products, Market research for need, competitions, Scale and cost, Initial specifications of products.

Unit 3: Conceptualisation

Designing of components, Drawing of parts and synthesis of a product from its component parts, Rendering the designs for 3-D visualization, Parametric modelling of product, 3-D visualization of mechanical products, Detail engineering drawings of components.

Unit 4: Detailing

Managing assembling, product specifications – data sheet, Simple mechanical designs, Workshop safety and health issues, Create documents for the knowledge sharing.

- **Hands-on Activity Charts for Use of Digital Tools:**

		No. of hrs
Activity 1	Learn the basic vector sketching tools	2
Activity 2	General understanding of shading for adding depth to objects. Understanding of editing vectors	2
Activity 3	Begin developing a thought process for using digital sketching	3
Activity 4	Create a basic shape objects sphere, box cylinders	3
Activity 5	Create automotive wheel concepts	3
Activity 6	Understanding navigation and data panel interface	2
Activity 7	Solid and surface modelling, rendering 3-D models	4
Activity 8	Product market and product specification sheet	3
Activity 9	Documentation for the product	2

Reference:

1. Model Curriculum for "Product Design Engineer – Mechanical", NASSCOM (Ref. ID: SSC/Q4201, Version 1.0, NSQF Level: 7)
2. Eppinger, S., & Ulrich, K.(2015). Product design and development. McGraw-Hill Higher Education.
3. Green, W., & Jordan, P. W. (Eds.).(1999).Human factors in product design: current practice and future trends. CRC Press.
4. Sanders, M. S., & McCormick, E. J. (1993). Human factors in engineering and design. McGRAW-HILLbookcompany.
5. Roozenburg, N. F., &Eekels, J. (1995). Product design: fundamentals and methods (Vol. 2). John Wiley & Sons Inc.
6. Lidwell, W., Holden, K., & Butler, J.(2010). Universal principles of designs, revised and updated: 125 ways to enhance usability, influence perception, increase appeal, make better

design decisions, and teach through design. Rockport Pub.

Physics of Engineering Materials

BTBSE406A	OEC 1	Physics of Engineering Materials	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

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

CO1	Understand the different types of structures of solid, defects in solids and analysis of crystal structure by X-ray diffraction technique.
CO2	Understand the origin and types of magnetism, significance of hysteresis loo in different magnetic materials and their uses in modern technology
CO3	Understand the band structure of solids and conductivity, categorization of solids on the basis of band structure, significance of Fermi-Dirac probability functions
CO4	Understand the principles of superconductivity, their uses in modern technology
CO5	Understand the position of Fermi level in intrinsic and extrinsic semiconductors, Semiconductor conductivity
CO6	Understand the electric field in dielectric
CO7	Understand basics of Nano materials, synthesis methods and characterization techniques

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2		3	3		1					3
CO2	3	3			1		2		2		1	2
CO3	2	2			1		1					3
CO4	3	3			1		3		1		1	2
CO5	3	2		2	1		1					1
CO6	3	2			2		2		3		1	2
CO7	2	3	1		3	1	3	1				1

Course Contents:

Unit 1: Crystallography [06 Hours]

Crystal directions and planes, Diatomic Crystal (CsCl, NaCl, Diamond, $BaTiO_3$) Crystal imperfection, Point defects, Line defects, Surface and Volume defects, Structure properties relationship, structure determination by X-ray diffraction.

Unit 2: Magnetic Materials [06 Hours]

Origin of magnetization using atomic theory, classification of magnetic materials and properties, Langevin's theory of Dia, Para and ferromagnetism, Soft and Hard magnetic materials and their uses, Domain theory of ferromagnetism, Hysteresis loss, Antiferromagnetic and Ferrimagnetic materials, Ferrites and Garnets, magnetic bubbles, magnetic recording.

Unit 3: Conducting and Superconducting Materials[06 Hours]

Band theory of solids, Classical free electron theory of metals, Quantum free electron theory, Density of energy states and carrier concentration, Fermi energy, Temperature and Fermi energy distribution, Superconductivity, Factor affecting Superconductivity, Meissner effect, Type-I and Type-II superconductors, BCS theory, Josephson effect, High temperature superconductors, Application of superconductors (Cryotron, magnetic levitation)

Unit 4: Semiconducting Materials [06 Hours]

Band structure of semiconductor, Charge carrier concentration, Fermi level and temperature, Electrical conductivity, Hall effect in semiconductors, P-N junction diode, Preparation of single crystals, LED, Photovoltaic Cell

Unit 5: Dielectric Materials [06 Hours]

Dielectric constant and polarizability, types of polarization, temperature and frequency dependences of Dielectric parameter, internal fields in solids, Clausius-Mosotti equation, dielectric loss, dielectric breakdown, ferroelectric, pyroelectric and piezoelectric materials, applications of dielectric materials

Unit 6: Nano Materials [06 Hours]

Nano materials: Introduction and properties, synthesis of nano materials, Carbon Nano Tubes, Characterization techniques of nano materials- SEM, TEM, EDAX, FMR, XRD. Applications of Nano materials.

Texts:

1. Kittle, "Introduction to Solid state Physics", John Wiley and Sons, 8th edition, 2004.
2. M. Srivastava, C. Srinivasan, "Science of Engineering Materials and Carbon Nanotubes", New Age International Publication, 3rd edition, 2010.
3. A. J. Dekker, "Solid State Physics", Pan Macmillan and Co. Ltd., London, 01stJuly, 1969.

References:

1. V. Raghavan, "Material Science and Engineering", Prentice Hall Publication, 5th edition, 2007.
2. A. J. Dekker, "Electrical Engineering Materials", Prentice Hall Publication, 1st edition, 1959.

Advanced Engineering Chemistry

BTBSE3405A	OEC 1	Advanced Engineering Chemistry	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks

	Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

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

CO1	Classify and explain various types of Corrosion and should apply methods to minimize the rate of corrosion.
CO2	Understand and apply the concepts of Photochemical and Thermal reactions.
CO3	Understand the basic concepts of Polymers, Polymerization and Moulding techniques; Determine molecular weight of High-Polymers.
CO4	Understand and apply the basic techniques in Chemistry and capable to explain the concepts of Solvent Extraction.
CO5	Understand and apply various types of Spectroscopic, Chromatographic techniques and also able to explain the concepts of Thermo-Gravimetric Analysis (TGA).

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Corrosion and Its Control [08 Hours]

Introduction, Fundamental reason, Electrochemical Corrosion, Direct Chemical Corrosion, Factors affecting the rate of corrosion, types of corrosion-Galvanic, Pitting Corrosion, Stress corrosion, methods to minimize the corrosion- Proper design, Cathodic and Anodic protection.

Unit 2: Photochemical and Thermal Reactions [06 Hours]

Introduction, Laws of Photochemistry, Measurement of absorbed intensity, Quantum yield or efficiency, Jablonski Diagram, Photosynthesis reaction of Hydrogen Bromide, Brief Discussion on Thermal Reactions – Cope Rearrangement.

Unit 3: Polymers [06 Hours]

Introduction, Nomenclature of Polymers, Type of Polymerization, Molecular Weight Determination by Osmotic Pressure and Viscosity Method, Plastic and its Classification, Constituents of Plastic, Moulding of Plastic by Injection Method.

Unit 4: Reaction Mechanism and Reaction Intermediates [06 Hours]

Introduction of Reaction Mechanism, Brief introduction of Reactivity of Substrate (Inductive Effect, Mesomeric Effect, Electromeric Effect, Hyperconjugative Effect), Bond Fission: Homolytic and Heterolytic Bond Fission, Reaction Intermediates: Carbocation (Structure, Stability and Applications).

Rearrangement Reactions

Intramolecular Rearrangement: Isomerisation, Beckmann Rearrangement, Benzidine

Rearrangement.
Intermolecular Rearrangement: Orton Rearrangement, Diazoamino Rearrangenment.

Unit 5: Spectroscopy [08 Hours]
Brief introduction to spectroscopy, UV–Visible Spectroscopy: Laws of absorption, instrumentation and application. IR spectroscopy: introduction, theory, instrumentation and application. Brief discussion on NMR Spectroscopy, AAS (Atomic Absorption Spectroscopy).

Unit 6: Instrumental Methods of Analysis [06 Hours]
Introduction to Chromatography, Types of Chromatography (Adsorption and partition chromatography), Thin Layer Chromatography, Gas Chromatography – introduction, theory, instrumentation. Brief discussion of Thermo gravimetric analysis (TGA).

Texts:
1. Bhal and Bhal, "Advance Organic Chemistry", S. Chand and Company, New Delhi, 1995.
2. P. C. Jain, Monica Jain, "Engineering Chemistry", Dhanpat Rai and Sons, Delhi, 1992.
3. Bhal, Tuli, "Text book of Physical Chemistry", S. Chand and Company, New Delhi, 1995.
4. Chatwal Anand, "Instrumental Methods of analysis", Himalaya Publication.
5. Text Book of Organic Chemistry by Rakesh K. Parashar, V.K. Ahluwalia.

References:
1. L. Finar, "Organic Chemistry", Vol. I and II, Longman Gr. Ltd and English Language Book Society, London.
2. G. M. Barrow, "Physical Chemistry", Tata McGraw Hill Publication, New Delhi.
3. Shikha Agarwal, "Engineering Chemistry-Fundamentals and applications", Cambridge Publishers, 2015.
4. O. G. Palanna, "Engineering Chemistry", Tata McGraw Hill Publication, New Delhi.
5. WILEY, Engineering Chemistry, Wiley India, New Delhi 2014.
6. Willard, "Instrumental Methods of analysis", Merrit, Tata McGraw Hill Publications.
7. Glasstone, "Physical Chemistry", D. Van Nostrand Company Inc., 2^{nd} edition, 1946.
8. Peter Atkins, "Physical Chemistry", W. H. Freeman and Co., 9^{th} edition, 2009.

Interpersonal Communication Skill & Self Development

BTHM3402	OEC 1	Interpersonal Communication Skill& Self Development	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks(Duration 03 hrs)

Pre-Requisites: None

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

CO1	Acquire interpersonal communication skills
CO2	Develop the ability to work independently.
CO3	Develop the qualities like self-discipline, self-criticism and self-management.
CO4	Have the qualities of time management and discipline.

CO5	Present themselves as an inspiration for others
CO6	Develop themselves as good team leaders

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								1				
CO2										2		
CO3												2
CO4									1			
CO5										2		
CO6											3	

Course Contents:

Unit 1:Development of Proficiency in English[06 Hours]
Speaking skills, Feedback & questioning technique, Objectivity in argument (Both one on one and in groups). 5 Wsand 1 H and 7 Cs for effective communication.
Imbibing etiquettes and manners. Study of different pictorial expressions of non-verbal communication and their analysis

Unit 2: Self-Management[06 Hours]
Self-Management, Self-Evaluation, Self-discipline, Self-criticism; Recognition of one’s own limits and deficiencies, dependency, etc.; Self-Awareness, Self-Management, Identifying one’s strengths and weaknesses, Planning & Goal setting, Managing self-emotions, ego, pride. Leadership and Team Dynamics

Unit 3: Time Management Techniques[06 Hours]
Practice by game playing and other learning strategies to achieve the set targets Time Management Concept; Attendance, Discipline and Punctuality; Acting in time, Quality /Productive time.

Unit 4: Motivation/Inspiration[06 Hours]
Ability to shape and direct working methods according to self-defined criteria, Ability to think for oneself, Apply oneself to a task independently with self-motivation.
Motivation techniques: Motivation techniques based on needs and field situations

Unit 5: Interpersonal Skills Development[06 Hours]
Positive Relationship, Positive Attitudes, Empathise: comprehending others’ opinions, points of views, and face them with understanding, Mutuality, Trust, Emotional Bonding, Handling Situations (Interview), Importance of interpersonal skills.

Unit 6: Effective Computing Skills[06 Hours]
Designing an effective Presentation; Contents, appearance, themes in a presentation, Tone and Language in a presentation, Role and Importance of different tools for effective presentation.

References:

1. Mitra, Barun, “Personality Development and Soft Skills”, Oxford University Press, 2016.
2. Ramesh, Gopalswamy, “The Ace of Soft Skills: Attitude, Communication and Etiquette for Success”, Pearson Education, 2013.
3. Stephen R. Covey, “Seven Habits of Highly Effective People: Powerful Lessons in Personal Change”, Free Press Publisher, 1989.
4. Rosenberg Marshall B., “Nonviolent Communication: A Language of Life” 3rd edition, Puddle dancer Press, 1st September, 2003.

Manufacturing Processes Lab-I

BTMEL407	PCC 9	Manufacturing Processes Lab - I	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

Pre-Requisites: None

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

CO1	Perform plain turning, step turning, knurling, eccentric turning, chamfering and facing operations on lathe.
CO2	Prepare setup and fabricate composite job using milling, shaping and drilling machine.
CO3	Making spur gears on a milling machine.
CO4	Prepare sand casting setup using split pattern for simple component.
CO5	Perform joining of two plate using TIG/MIG welding.
CO6	Demonstrate cutting of a sheet metal using flame cutting.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1		3	1		1		1	2		1
CO2	1	1		3	1		1		1	2		1
CO3	1	1		3	1		1		1	2		1
CO4	2	1		3	1		1		1	2		1
CO5	2	1		3	1		1		1	2		1
CO6	1	1		3	1		1		1	1		1

List of Practicals/ Experiments/ Assignments

Each student shall be required to submit any six jobs from the following:

1. Making a job with a process plan involving plain, step and taper turning as well thread cutting as operations on a Centre lathe.
2. Preparation of process planning sheet for a job including operations such as milling, drilling and shaping.
3. Making a spur gear using universal dividing head on milling machine.
4. Making a simple component by sand casting using a split pattern.
5. Cutting of a steel plate using oxyacetylene flame cutting /plasma cutting.

6. Making a butt joint on two stainless steel plates using TIG/MIG Welding.
7. An experiment on shearing operation.
8. An experiment on blanking operation.
9. An experiment on drawing operation

Theory of Machines Lab-I

BTMEL408	PCC 10	Theory of Machines Lab- I	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

Pre-Requisites: None

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

CO1	Perform graphically kinematic analysis of any planar mechanism using ICR and RV methods.
CO2	Perform graphically kinematic analysis of slider crank mechanism using Klein's construction.
CO3	Demonstrate use of graphical differentiation method for kinematic analysis of slider crank mechanism or any other planar mechanism with a slider.
CO4	Sketch polar diagram for a Hooke's joint.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												

List of Practicals/Experiments/Assignments

1. **Four sheets** (half imperial size)
   Graphical solution of problems on velocity, acceleration in mechanisms by relative velocity method, instantaneous center of rotation method and Klein's construction.Atleastone problem containing Corioli's component of acceleration.
2. **Experiments (any 2)**
   a) Experimental determination of velocity and acceleration of Hooke'sjoint.
   b) Determination of displacement of slider-crank mechanism with the help of model and to plot velocity and acceleration curves from it.
   c) Experiment on Corioli's component of acceleration.
3. **Assignment**
   Develop a computer program for velocity and acceleration of slider-crank mechanism.

Strength of Materials Lab

BTMEL409	PCC 11	Strength of Materials Lab	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

Pre-Requisites: None

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

CO1	
CO2	
CO3	
CO4	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												

List of Practicals/Experiments/Assignments (any ten experiments from the list)

1. Tension test on ferrous and non-ferrous alloys (mid steel/cast iron/aluminum, etc.
2. Compression test on mild steel, aluminum, concrete, and wood
3. Shear test on mild steel and aluminum (single and double shear tests)
4. Torsion test on mild steel and cast iron solid bars and pipes
5. Flexure test on timber and cast iron beams
6. Deflection test on mild steel and wooden beam specimens
7. Graphical solution method for principal stress problems
8. Impact test on mild steel, brass, aluminum, and cast iron specimens
9. Experiments on thermal stresses
10. Strain measurement in stress analysis by photo-elasticity
11. Strain measurement involving strain gauges/ rosettes
12. Assignment involving computer programming for simple problems of stress, strain computations.

Numerical Methods Lab

BTMEL410	BSC 9	Numerical Methods Lab	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 60 Marks External Exam: 40 Marks

Pre-Requisites: None

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

CO1	
CO2	
CO3	
CO4	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												

Student should develop the computer programme along with the results on following topics. (Any six)

1. Programme to demonstrate the effect of round off error and significant number
2. Programme to find real single root of an Equation by Bisection Method
3. Programme to find real single root of an Equation by Newton- Raphson Method
4. Programme to solve linear simultaneous algebraic equations
5. Programme to solve the integration using Multi Trapezoidal Rule
6. Programme to solve the integration using Simpson's 1/3 rule
7. Programme to solve simple practical problem using finite difference method
8. Programme to solve ODE

It is expected that student should take up the simple real life problem for writing the programme.

Student should maintain a file containing all the programmes with results in printed form and also submit a CD containing all the programmes in soft form.

Semester - V

Heat Transfer

BTMEC501	PCC 12	Heat Transfer	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Explain the laws of heat transfer and deduce the general heat conduction equation and to explain it for 1-D steady state heat transfer in regular shape bodies
CO2	Describe the critical radius of insulation, overall heat transfer coefficient, thermal conductivity and lumped heat transfer
CO3	Interpret the extended surfaces
CO4	Illustrate the boundary layer concept, dimensional analysis, forced and free convection under different conditions
CO5	Describe the Boiling heat transfer, mass transfer and Evaluate the heat exchanger and examine the LMTD and NTU methods applied to engineering problems
CO6	Explain the thermal radiation black body, emissivity and reflectivity and evaluation of view factor and radiation shields

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1			1				1			
CO2	3	2			1							
CO3	3	1			2		2		1			
CO4	3	3		1	1				1			
CO5	3	3	3		1		2					
CO6	2	3		2	2		2		1			

Course Contents:

Unit 1: Introduction

Heat transfer mechanism, conduction heat transfer, Thermal conductivity, Convection heat transfer, Radiation heat transfer, laws of heat transfer

Steady State Conduction: General heat conduction equation, Boundary and initial conditions, One-dimensional steady state conduction: the slab, the cylinder, the sphere, composite systems.

Unit 2: Overall Heat Transfer and Extended Surfaces

Thermal contact resistance, Critical radius of insulation, Electrical analogy, Overall heat

transfer coefficient, Heat source systems, Variable thermal conductivity, Extended surfaces.
Unsteady State Conduction: Lumped system analysis, Biot and Fourier number, Heisler chart **(No numerical examples)**.

Unit 3: Principles of Convection
Continuity, Momentum and Energy equations, Hydrodynamic and Thermal boundary layer for a flat plate and pipe flow. Dimensionless groups for convection, relation between fluid friction and heat transfer, turbulent boundary layer heat transfer.

Unit 4: Forced Convection
Empirical relations for pipe and tube flow, flow across cylinders, spheres, tube banks.
Free Convection: Free convection from a vertical, inclined and horizontal surface, cylinder and sphere.

Unit 5: Boiling and Condensation
Film-wise and drop-wise condensation, pool boiling regimes, forced convection boiling (Internal flows).
Introduction to Mass Transfer: Introduction, Mechanism of diffusion, Fick's law of mass transfer, mass diffusion coefficient.
Heat Exchangers: Types of heat exchangers, the overall heat transfer coefficient, Analysis of heat exchangers, the log mean temperature difference (LMTD)method, the effectiveness-NTU method, selection of heat exchangers, Introduction to TEMA standard.

Unit 6: Radiation Heat Transfer
Introduction, Thermal radiation, Black body radiation, radiation laws, Radiation properties, Atmospheric and Solar radiation, The view factor, Radiation heat transfer from black surfaces, gray surfaces, diffuse surfaces, Radiation shields and the radiation effect.

Texts:

1. F. P. Incoropera, D. P. Dewitt, "Fundamentals of Heat and Mass Transfer", John-Wiley, 5th edition, 1990.
2. S. P. Sukhatme, "A Textbook on Heat Transfer", Tata McGraw Hill Publications, 3rd edition.

References:

1. Y. A. Cengel, "Heat Transfer – A Practical Approach", Tata McGraw Hill Publications ,3rd edition, 2006.
2. J. P. Holman, "Heat Transfer", Tata McGraw Hill Publications, 9th edition, 2004.

Applied Thermodynamics - I

BTMEC502	PCC 13	Applied Thermodynamics - I	2-1-0	3 Credits

Teaching Scheme:	Examination Scheme:
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Define the terms like calorific value of fuel, stoichiometric air-fuel ratio, excess air, equivalent evaporation, boiler efficiency, etc. Calculate minimum air required for combustion of fuel.
CO2	Study and Analyze gas power cycles and vapour power cycles like Otto, Diesel, dual, Joule and Rankine cycles and derive expressions for the performance parameters like thermal efficiency, P_m
CO3	Classify various types of boiler, nozzle, steam turbine and condenser used in steam power plant.
CO4	Classify various types of IC engines. Sketch the cut section of typical diesel engine and label its components. Define the terms like TDC, BDC, r_c, etc.
CO5	Draw P-v diagram for single-stage reciprocating air compressor, with and without clearance volume, and evaluate its performance. Differentiate between reciprocating and rotary air compressors.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Fuels and Combustion
Types of fuels, calorific values of fuel and its determination, combustion equation for hydrocarbon fuel, determination of minimum air required for combustion and excess air supplied conversion of volumetric analysis to mass analysis, fuel gas analysis.

Unit 2: Steam Generators
Classification of boilers, boiler details, requirements of a good boiler; merits and demerits of fire tube and water tube boilers, boiler mountings and accessories.
Boiler Draught: Classification of draught, natural draught, efficiency of the chimney, draught losses, types of boiler draught.
Performance of Boilers: Evaporation, equipment evaporation, boiler efficiency, boiler trial and heat balance, Introduction to IBR.

Unit 3: Vapor and Gas Power Cycles
Carnot cycle, ideal Rankine cycle, Reheat and Regeneration, Stirling cycle, Joule-Brayton cycle. Calculation of thermal efficiency, specific steam/fuel consumption, work ratio for above cycles.

Unit 4: Steam Nozzles
Types of Nozzles, flow of steam through nozzles, condition for maximum discharge, expansion of steam considering friction, super saturated flow through nozzles, General relationship between area, velocity and pressure.

Unit 5: Steam Turbines

Advantages and classification of steam turbines, compounding of steam turbines, velocity diagrams, work one done and efficiencies, losses in turbines.

Condensers and Cooling Towers: Elements of steam condensing plants, advantages of using condensers, types of condensers, thermodynamic analysis of condensers, efficiencies, cooling towers.

Unit 6: Reciprocating Air Compressor

Classification constructional details, theoretical and actual indicator diagram, FAD, multi staging, condition for maximum efficiency, capacity control.

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

Texts:

1. T. D. Eastop, A. McConkey, "Applied Thermodynamics", Addison Wesley Longman.
2. Rayner Joel, "Basic engineering Thermodynamics", Addison Wesley Longman.

References:

1. Yunus A. Cengel, "Thermodynamics- An Engineering Approach", Tata McGraw Hill Publications.
2. P. K. Nag, "Basic and Applied Thermodynamics", Tata McGraw Hill Publications.
3. P. K. Nag, "Power Plant Engineering", Tata McGraw Hill Publications, 2^{nd} edition.
4. Sharma and Mathur, "Internal Combustion Engines", Tata McGraw Hill Publications.

Machine Design - I

BTMEC503	PCC 14	Machine Design - I	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Strength of Materials

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

CO1	Formulate the problem by identifying customer need and convert into design specification
CO2	Understand component behavior subjected to loads and identify failure criteria
CO3	Analyze the stresses and strain induced in the component
CO4	Design of machine component using theories of failures
CO5	Design of component for finite life and infinite life when subjected to fluctuating load
CO6	Design of components like shaft, key, coupling, screw and spring

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1						1				1
CO2	3	2		1		1		1		1		1
CO3	1	1				1		1		1		1
CO4	3	3	2	1		2		1		1		1
CO5	1	1				1		1		1		1
CO6	2	2	2	1		1		1		1		1

Course Contents:

Unit 1: Mechanical Engineering Design Process
Traditional design methods, general industrial design procedure, design considerations, phases in design, creativity in design, use of standardization, preferred series, introduction to ISO9000, use of design data book, aesthetic and ergonomic considerations in design.

Unit 2: Design of Machine Elements against Static Loading
Theories of Failure (Yield and Fracture Criteria): Maximum normal stress theory, Maximum shear stress theory, Maximum distortion energy theory, comparison of various theories of failure, Direct loading and combined loading, Joints subjected to static loading e.g. cotter and knuckle joint, turnbuckle, etc. introduction to fluctuating loads.

Unit 3: Design against Fluctuating Loads
Stress concentration, stress concentration factors, fluctuating stresses, fatigue failure, endurance limit, notch sensitivity, approximate estimation of endurance limit, design for finite life and finite life under reversed stresses, cumulative damage in fatigue, Soderberg and Goodman diagrams, fatigue design under combined stresses.

Unit 4: Design of Shafts Keys and Couplings
Various design considerations in transmission shafts, splined shafts, spindle and axles strength, lateral and torsional rigidity, ASME code for designing transmission shaft.
Types of Keys: Classification and fitment in keyways, Design of various types of keys.
Couplings: Design consideration, design of rigid, muff and flange type couplings, design of flexible couplings.

Unit 5: Design of Threaded Joints
Stresses in screw fasteners, bolted joints under tension, torque requirement for bolt tightening, preloading of bolt under static loading, eccentrically loaded bolted joints.
Power Screws: Forms of threads used for power screw and their applications, torque analysis for square and trapezoidal threads, efficiency of screw, collar friction, overall efficiency, self-locking in power screws, stresses in the power screw, design of screw and nut, differential and compound screw, re-circulating ball screw.
Welded Joints: Type of welded joints, stresses in butt and fillet welds, strength of welded joints subjected to bending moments.

Unit 6: Mechanical Springs
Stress deflection equation for helical spring, Wahl's factor, style of ends, design of helical compression, tension and torsional spring under static loads, construction and design consideration in leaf springs, nipping, strain energy in helical spring, shot peening.

Texts:

1. V. B. Bhandari, "Design of Machine Elements", Tata McGraw Hill Publications, New Delhi, 2008.
2. R. L. Nortan, "Machine Design: An Integrated Approach", Pearson Education Singapore, 2001.

References:

1. R. C. Juvinall, K. M. Marshek, "Fundamental of machine component design", John Wiley & Sons Inc., New York, 3rd edition, 2002.
2. B. J. Hamrock, B. Jacobson and Schmid Sr., "Fundamentals of Machine Elements", International Edition, New York, 2nd edition, 1999.
3. A. S. Hall, A. R. Holowenko, H. G .Langhlin, "Theory and Problems of Machine Design", Schaum's Outline Series, Tata McGraw Hill book Company, New York, 1982.
4. J. E. Shigley and C. Mischke, "Mechanical Engineering Design", Tata McGraw Hill Publications, 7th edition, 2004.
5. M. F. Spotts, "Design of Machine Elements", Prentice Hall of India, New Delhi.

Theory of Machines - II

BTMEC504	PCC 15	Theory of Machines - II	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Engineering Mechanics, TOM - I

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

CO1	Identify and select type of belt and rope drive for a particular application
CO2	Evaluate gear tooth geometry and select appropriate gears, gear trains
CO3	Define governor and select/suggest an appropriate governor
CO4	Characterize flywheels as per engine requirement
CO5	Understand gyroscopic effects in ships, aeroplanes, and road vehicles.
CO6	Understand free and forced vibrations of single degree freedom systems

Mapping of course outcomes with program outcomes

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

CO5	2	3		2								3
CO6	2	3		3								3

Course Contents:

Unit 1: Belt and Rope Drives
Flat belts, Effect of slip, Centrifugal tension, Creep, Crowing of pulley, Initial tension in belts. V- Belts, Virtual coefficient of friction, Effect of V-groove on torque transmitted. Rope drives, Rope constructions, Advantages of rope drives.

Unit 2: Toothed Gears
Classification of gears, Terminology of spur gears, Conjugate action, Involute and cycloidal profiles, Path of contact, Contact ratio, Interference, Undercutting, Rack shift, Effect of center distance variations, Friction between gear teeth, Internal gears.
Helical gear terminology, Normal and transverse module, Virtual number of teeth, Torque transmitted by helical gears, Spiral gears, Efficiency of spiral gears, Worm gears, Bevel gear terminology, Tooth forces and geometric relationship, Torque capacities.

Unit 3: Gear Trains
Velocity ratios, Types of gear trains, Tooth load, Torque transmitted and holding torque.

Unit 4: Governor and Flywheel
Governors: Function of governor, Inertia and centrifugal type of governors, Controlling force analysis, Governor Effort and governor power, Sensitivity, stability, Isochronisms and Hunting, Friction insensitiveness.
Flywheel: Turning moment diagram, Fluctuation of energy and speed, Determination of flywheel size for different types of prime movers and machines.

Unit 5: Gyroscope
Gyroscope: Principles of gyroscopic action, Precession and gyroscopic acceleration, gyroscopic couple, Effect of the gyroscopic couple on ships, aeroplanes and vehicles, inclined rotating discs, gyroscopic stabilization.

Unit 6: Vibration
Basic concepts and definitions; vibration measuring parameters - displacement, velocity, and acceleration.
Mechanical Vibration: Single degree of freedom system, SHM, Undamped free vibrations, damped free vibrations, Types of damping.
Forced Vibration: Effect of excitation, Excitation due to reciprocating and rotating unbalance, Vibration isolation and transmissibility.
Critical Speeds: Whirling of vertical and horizontal shaft carrying single rotor with damped and un-damped system, Whirling speed of multi rotor shafts.
Torsional Vibrations: Single degree of freedom system Forced an free damped and undampedvibratins, Two rotor and three rotor system, Geared rotor system , Natural frequency , Modes of vibrations, Torsional dampers, Introduction to Holzer’s method for multi rotor system.

Texts:
1. S. S. Rattan, “Theory of Machines”, Tata McGraw Hill Publications, New Delhi.
2. Thomas Beven, “Theory of machines”, CBS Publishers, Delhi, 1984.

3. Kelly, Graham S., "Mechanical Vibrations", Schaum's Outline Series, McGraw Hill, New York, 1996.
4. Rao, J.S., "Introductory Course on Theory and Practice of Mechanical Vibration", New age International (P) Ltd, New Delhi, 2nd edition, 1999.

References:

1. Rao Singiresu, "Mechanical Vibrations", Pearson Education, New Delhi, 4th edition 2004.
2. J. E. Shigley, J. J. Vicker, "Theory of Machines and Mechanisms", Tata McGraw Hill International.

Metrology and Quality Control

BTMEC505	PCC 16	Metrology and Quality Control	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Identify techniques to minimize the errors in measurement
CO2	Identify methods and devices for measurement of length, angle, and gear and thread parameters, surface roughness and geometric features of parts.
CO3	Choose limits for plug and ring gauges.
CO4	Explain methods of measurement in modern machineries
CO5	Select quality control techniques and its applications
CO6	Plot quality control charts and suggest measures to improve the quality of product and reduce cost using Statistical tools.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				3								2
CO2		2	2		2							
CO3			2	3	2							
CO4						3						
CO5	1					2		3	3		3	2
CO6	1					2		3	3		2	2

Course Contents:

Unit 1: Measurement Standard and Comparators

Measurement Standard, Principles of Engineering Metrology, Line end, wavelength, Traceability of Standards. Types and Sources of error, Alignment, Temperature, Plastic deformation, Slip gauges and gauge block, Linear and Angular Measurement (Sine bar, Sine center, Autocollimator, Angle Décor and Dividing head), Calibration. Comparator: Mechanical, Pneumatic, Optical, Electronic (Inductive), Electrical (LVDT).

Unit 2: Interferometry and Limits, Fits, Tolerances
Principle, NPL Interferometer, Flatness measuring of slip gauges, Parallelism, Laser Interferometer, Surface Finish Measurement: Surface Texture, Measuring Surface Finish by Stylus probe, Tomlinson and Talysurf, Analysis of Surface Traces: Methods.
Design of Gauges: Types of Gauges, Limits, Fits, Tolerance; Terminology for limits and Fits. Indian Standard (IS 919-1963) Taylor's Principle.

Unit 3: Metrology of Screw Thread
Gear Metrology: Gear error, Gear measurement, Gear Tooth Vernier; Profile Projector, Tool marker's microscope. Advancements in Metrology: Co-ordinate Measuring Machine, Universal Measuring Machine, Laser in Metrology.

Unit 4: Introduction to Quality and Quality Tools
Quality Statements, Cost of Quality and Value of Quality, Quality of Design, Quality of Conformance, Quality of Performance, Seven Quality Tools: Check sheet, Flow chart, Pareto analysis, cause and effect diagram, scatter diagram, Brain storming, Quality circles.

Unit 5: Total Quality Management
Quality Function Deployment, 5S, Kaizan, Kanban, JIT, Poka yoke, TPM, FMECA, FTA, Zero defects.

Unit 6: Statistical Quality Control
Statistical Quality Control: statistical concept, Frequency diagram, Concept of Variance analysis, Control chart for variable & attribute, Process Capability.
Acceptance Sampling: Sampling Inspection, OC curve and its characteristics, sampling methods.
Introduction to ISO 9000: Definition and aims of standardizations, Techniques of standardization, Codification system, Varity control and Value Engineering.

Texts:

1. I. C. Gupta, "Engineering Metrology", Dhanpat and Rai Publications, New Delhi, India.
2. M. S. Mahajan, "Statistical Quality Control", Dhanpat and Rai Publications.

References:

1. R. K. Jain, "Engineering Metrology", Khanna Publications, 17th edition, 1975.
2. K. J. Hume, "Engineering Metrology", McDonald Publications, 1st edition, 1950.
3. A. W. Judge, "Engineering Precision Measurements", Chapman and Hall, London, 1957.
4. K. L. Narayana, "Engineering Metrology", Scitech Publications, 2nd edition.
5. J. F. Galyer, C. R. Shotbolt, "Metrology for Engineers", Little-hampton Book Services Ltd., 5th edition, 1969.
6. V. A. Kulkarni, A. K. Bewoor, "Metrology & Measurements", Tata McGraw Hill Co. Ltd., 1st edition, 2009.
7. Amitava Mitra, "Fundamental of Quality Control and Improvement", Wiley Publication.

8. V. A. Kulkarni, A. K. Bewoor, "Quality Control", Wiley India Publication, 01st August, 2009.
9. Richard S. Figliola, D. E. Beasley, "Theory and Design for Mechanical Measurements", Wiley India Publication.
10. E. L. Grant, "Statistical Quality Control", Tata McGraw Hill Publications.
11. J. M. Juran, "Quality Planning and Analysis", Tata McGraw Hill Publications.

Product Design Engineering - II

BTID506	PCC 17	Product Design Engineering - II	1-0-2	2 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture-cum-demonstration: 1 hr/week Design Studio/Practical: 2 hrs/week	Continuous Assessment: 60 Marks End Semester Exam: 40 Marks

Pre-requisites:
Product Design Engineering: Part-I, Basic Knowledge of electronics, electrical, computer and Information Technology

- Design Studio/Practical: 2 hrs to develop design sketching and practical skills
- Continuous Assessment: Progress through a product design and documentation of steps in the selected product design
- End Semester Assessment: Product Design in Studio with final product specifications

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

1. Create prototypes
2. Test the prototypes
3. Understand the product life cycle management

Unit 1: Testing and Evaluation

Prototyping, Design Automation, Product architecture, Prototype testing and evaluation, Working in multidisciplinary teams, Feedback to design processes, Process safety and materials, Health and hazard of process operations.

Unit 2: Embedded Engineering- User Interface

Firmware and Hardware Design, UI programming, Algorithm and Logic Development, Schematic and PCB layout, Testing and Debugging.

Unit 3: Manufacturing

Design models and digital tools, Decision models, Prepare documents for manufacturing in standard format, Materials and safety data sheet, Final Product specifications sheet, Detail Engineering Drawings (CAD/CAM programming), Manufacturing for scale, Design/identification of manufacturing processes.

Unit 4: Environmental Concerns

Product life-cycle management, Disposal of product and waste.

Hands-on Activity Charts for Use of Digital Tools

		Hrs.
Activity 1	Prototyping/Assembly	4
Activity 2	Testing and evaluation	3
Activity 3	UI Programming	3
Activity 4	PCB Layout, Testing and debugging	3
Activity 5	CNC Programming	3
Activity 6	CNC Programming with CAM software	3
Activity 7	Product market and Product Specification Sheet	3
Activity 8	Documentation for the product	2

References:

1. Model Curriculum for "Product Design Engineer – Mechanical", NASSCOM (Ref. ID: SSC/Q4201, Version 1.0, NSQF Level: 7)
2. Eppinger, S., & Ulrich, K.(2015). Product design and development, McGraw-Hill Higher Education.
3. Green, W., & Jordan, P. W. (Eds.).(1999), Human factors in product design: current practice and future trends. CRC Press.
4. Sanders, M. S., & McCormick, E. J. (1993), Human factors in engineering and design. McGRAW-HILL Book Company.
5. Roozenburg, N. F., &Eekels, J. (1995), Product design: Fundamentals and Methods (Vol. 2). John Wiley & Sons Inc.
6. Lidwell, W., Holden, K., & Butler, J.(2010), Universal principles of designs, revised and updated: 125 ways to enhance usability, influence perception, increase appeal, make better design decisions, and teach through design. Rockport Publication.

Automobile Engineering

BTMEC506A	OEC 2	Automobile Engineering	3-0-0	Audit

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Audit Course

Pre-Requisites: None

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

CO1	Identify the different parts of the automobile.

CO2	Explain the working of various parts like engine, transmission, clutch, brakes etc.,
CO3	Demonstrate various types of drive systems.
CO4	Apply vehicle troubleshooting and maintenance procedures.
CO5	Analyze the environmental implications of automobile emissions. And suggest suitable regulatory modifications.
CO6	Evaluate future developments in the automobile technology.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	1	2		2		1						
CO3	1	1		1	1							
CO4	2			3	1							
CO5		2			1	1	2					
CO6	1		2			2						

Course Contents:

Unit 1: Introduction
Vehicle specifications, Classifications, Chassis layout, Frame, Main components of automobile and articulated vehicles; Engine-cylinder arrangements, Power requirements, Tractive efforts and vehicle performance curves.

Unit 2: Steering and Suspension Systems
Steering system; Principle of steering, Centre point steering, Steering linkages, Steering geometry and wheel alignment, power steering.
Suspension system: its need and types, Independent suspension, coil and leaf springs, Suspension systems for multi-axle vehicles, troubleshooting and remedies.

Unit 3: Transmission System
Clutch: its need and types, Gearboxes: Types of gear transmission, Shift mechanisms, Over running clutch, Fluid coupling and torque converters, Transmission universal joint, Propeller shaft, Front and rear axles types, Stub axles, Differential and its types, Four wheel drive.

Unit 4: Brakes, Wheels and Tyres
Brake: its need and types: Mechanical, hydraulic and pneumatic brakes, Disc and drum type: their relative merits, Brake adjustments and defects, Power brakes, Wheels and Tyres: their types; Tyre construction and specification; Tyre wear and causes; Wheel balancing.

Unit 5: Electrical Systems
Construction, operation and maintenance of lead acid batteries, Battery charging system, Principle and operation of cutout and regulators, Starter motor, Bendix drive, Solenoid drive, Magneto-coil and solid stage ignition systems, Ignition timing.

Unit 6: Vehicle Testing and Maintenance
Need of vehicle testing, Vehicle tests standards, Different vehicle tests, Maintenance:

trouble shooting and service procedure, over hauling, Engine tune up, Tools and equipment for repair and overhauling, Pollution due to vehicle emissions, Emission control system and regulations.

Texts:
1. Kripal Singh, “Automobile Engineering”, Vol. I and II, Standard Publishers.
2. G. B. S. Narang, “Automobile Engineering”, Dhanpat Rai and Sons.

References:
1. Joseph Heitner, “Automotive Mechanics”, East-West Press.
2. W. H. Crouse, “Automobile Mechanics”, Tata McGraw Hill Publishing Co.

Nanotechnology

BTMEC506B	OEC 2	Nanotechnology	3-0-0	Audit

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Audit Course

Pre-Requisites: None

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

CO1	Demonstrate the understanding of length scales concepts, nanostructures and nanotechnology.
CO2	To impart basic knowledge on various synthesis and characterization techniques involved in Nanotechnology
CO3	To educate students about the interactions at molecular scale
CO4	Evaluate and analyze the mechanical properties of bulk nanostructured metals and alloys, Nano-composites and carbon nanotubes.
CO5	To make the students understand about the effects of using nanoparticles over conventional methods

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Scientific Revolutions

Types of Nanotechnology and Nano machines: the Hybrid nanomaterial. Multiscale hierarchical structures built out of Nano sized building blocks (nano to macro). Nanomaterials in Nature: Nacre, Gecko, Teeth. Periodic table, Atomic Structure, Molecules and phases, Energy, Molecular and atomic size, Surfaces and dimensional space: top down and bottom up.

Unit 2: Forces between Atoms and Molecules
Particles and grain boundaries, strong Intermolecular forces, Electrostatic and Vander Waals forces between surfaces, similarities and differences between intermolecular and inter particle forces covalent and coulomb interactions, interaction polar molecules.
Thermodynamics of self-assembly.

Unit 3: Opportunity at the Nano Scale
Length and time scale in structures, energy landscapes, Inter dynamic aspects of inter molecular forces, Evolution of band structure and Fermi surface.

Unit 4: Nano Shapes
Quantum dots, Nano wires, Nano tubes, 2D and 3D films, Nano and mesopores, micelles, bilayer, vesicles, bionano machines, biological membranes.

Unit 5: Influence of Nano Structuring
Influence of Nano structuring on mechanical, optical, electronic, magnetic and chemical properties-gram size effects on strength of metals- optical properties of quantum dots.

Unit 6: Nano Behaviour
Quantum wires, electronic transport in quantum wires and carbon nano-tubes, magnetic behavior of single domain particles and nanostructures, surface chemistry of Tailored monolayer, self-assembling.

Texts:

1. C. Koch, "Nanostructured materials: Processing, Properties and Potential Applications", Noyes Publications, 2002.
2. C. Koch, I. A. Ovidko, S. Seal and S. Veprek, "Structural Nano crystalline Materials: Fundamentals & Applications", Cambridge University Press, 2011.

References:

1. Bharat Bhushan, "Springer Handbook of Nanotechnology", Springer, 2nd edition, 2006.
2. Laurier L. Schramm, "Nano and Microtechnology from A-Z: From Nano-systems to Colloids and Interfaces", Wiley, 2014.

Energy Conservation and Management

BTMEC506C	OEC 2	Energy Conservation and Management	3-0-0	Audit

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Audit Course

Pre-Requisites: None

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

CO1	Understand energy problem and need of energy management

CO2	Carry out energy audit of simple units
CO3	Study various financial appraisal methods
CO4	Analyse cogeneration and waste heat recovery systems
CO5	Do simple calculations regarding thermal insulation and electrical energy conservation

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Introduction
General energy problem, Energy use patterns and scope of conservation. Energy Management Principles: Need, Organizing, Initiating and managing an energy management program.

Unit 2: Energy Auditing
Elements and concepts, Types of energy audits, Instruments used in energy auditing.
Economic Analysis: Cash flows, Time value of money, Formulae relating present and future cash flows-single amount, uniform series.

Unit 3: Financial Appraisal Methods
Payback period, Net present value, Benefit-cost ratio, Internal-rate of return, Life cycle costs/benefits. Thermodynamics of energy conservation, Energy conservation in Boilers and furnaces, Energy conservation in Steam and condensate system.

Unit 4: Cogeneration
Concept, Types of cogeneration systems, performance evaluation of a cogeneration system.
Waste Heat Recovery: Potential, benefits, waste heat recovery equipment's.
Space Heating, Ventilation Air Conditioning (HVAC) and water heating of building, Transfer of heat, Space heating methods, Ventilation and air conditioning, Heat pumps, Insulation, Cooling load, Electric water heating systems, Electric energy conservation methods.

Unit 5: Insulation and Heating
Industrial Insulation: Insulation materials, Insulation selection, Economical thickness of insulation.
Industrial Heating: Heating by indirect resistance, direct resistance heating (salt bath furnace), and Heat treatment by induction heating in the electric arc furnace industry.

Unit 6: Energy Conservation in Electric Utility and Industry
Energy costs and two part tariff, Energy conservation in utility by improving load factor, Load curve analysis, Energy efficient motors, Energy conservation in illumination systems,

Importance of Power factor in energy conservation, Power factor improvement methods, Energy conservation in industries

Texts:

1. Callaghan, "Energy Conservation".
2. D. L. Reeg, "Industrial Energy Conservation", Pergamon Press.

References:

1. T. L. Boyen, "Thermal Energy Recovery", Wiley Eastern.
2. L. J. Nagrath, "System Modeling and Analysis", Tata McGraw Hill Publications.
3. S. P. Sukhatme, "Solar Energy", Tata McGraw Hill Publications.

Heat Transfer Lab

BTMEL507	PCC 18	Heat Transfer Lab	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 30 Marks End Semester Exam: 20 Marks

Pre-Requisites: None

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

CO1	Understand the various heat transfer mode of heat transfer and its application and verify
CO2	Learn the experimental methodology
CO3	Describe the concept the terms like least count, calibration of the instruments

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3		3	2							
CO2	3	3		3	2		2					
CO3	3	3		3	2		2					

List of Practicals/Experiments/Assignments

Any eight experiments from the list:

1. Determination of thermal conductivity of a metal rod.
2. Determination of thermal conductivity of insulating powder.
3. Determination of conductivity of a composite slab.
4. Temperature distribution on a fin surface.
5. Determination of film heat transfer coefficient for natural convection.
6. Determination of film heat transfer coefficient for forced convection.
7. Determination of heat transfer coefficient for cylinder in cross flow in forced convection.
8. Performance of Double pipe Heat Exchanger/Shell and Tube Heat Exchanger.
9. Determination of emissivity of a metal surface.

10. Determination of Stefan Boltzman's constant.
11. Determination of critical heat flux.
12. Calibration of measuring instruments pressure gauge, thermocouple, flow-meter etc.

Applied Thermodynamics Lab

BTMEL508	PCC 19	Applied Thermodynamics Lab	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 30 Marks End Semester Exam: 20 Marks

Pre-Requisites: Thermodynamics, Applied Thermodynamics - I

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

CO1	Conduct test on Bomb calorimeter, nozzle, steam turbine, condenser, compressor etc. to study their performance.
CO2	Draw performance curves of these machines.
CO3	Analyze the results obtained from the tests.
CO4	Draw conclusions based on the results of the experiments
CO5	Based on your visit to Industry, sketch its layout and write specifications.

Mapping of course outcomes with program outcomes

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

List of Practicals/Experiments/Assignments

Experiment Number 10 and any seven experiments from 1-9 experiments from the list:

1. Determination of calorific value by Bomb calorimeter
2. Measurement of dryness fraction of steam using separating & throttling calorimeter.
3. Trial on boiler
4. Trial on convergent/convergent-divergent type nozzle
5. Performance evaluation of steam turbine (Reaction / Impulse).
6. Performance evaluation of surface condenser.
7. Flue gas analysis using emission measuring instruments
8. Study & trial on single stage/two-stage reciprocating air compressor
9. Trial on centrifugal blower
10. Visit to appropriate industry to study and experience some of the above listed systems **(Compulsory).**

Machine Design Practice - I

BTMEL509	PCC 20	Machine Design Practice - I	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 30 Marks End Semester Exam: 20 Marks

Pre-Requisites: None

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

CO1	Apply design process to an open ended problem
CO2	Determine suitable material and size for structural component of machine/system
CO3	Apply iterative technique in design including making estimate of unknown values for first computation and checking or revisiting and re-computing
CO4	Choose logically and defend selection of design factors
CO5	Design of components for given part/system i.e. shaft, keys, coupling, links, screws, springs etc.
CO6	Work effectively as a part of design group/team
CO7	Have good communication skill, orally, graphically as well as in writing

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	2			2	1				
CO2	1	3	2	1			1	1				1
CO3	3	2	2	1			1	1				1
CO4	2	2	2	2			1	1				1
CO5	3	3	2	1			2	1				1
CO6						1	1	1	2	2		2
CO7								1	1	2	2	3

List of Practicals/Experiments/Assignments

1. The term work shall consist of two design projects based on the syllabus of Machine Design I. Each design project shall consist of two imperial size sheets- one involving assembly drawings with a part list and overall dimensions and other sheet involving drawings of individual components. Manufacturing tolerances, surface finish symbols and geometric tolerances should be specified, wherever necessary, so as to make it working drawing
2. A design report giving all necessary calculations for the design of components and assembly should be submitted in a separate file.
3. Two assignments based on topics of syllabus of Machine Design I.

Theory of Machines Lab - II

BTMEL510	PCC 21	Theory of Machines Lab - II	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 30 Marks End Semester Exam: 20 Marks

Pre-Requisites: None

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

CO1	Explain various types of gear boxes, gear trains, belt and rope drives
CO2	Interpreting physical principles and phenomenon of governor, gyroscopic, flywheel
CO3	Measure vibration parameters in single degree of freedom systems
CO4	Evaluating natural frequency of 1 dof

Mapping of course outcomes with program outcomes

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

List of Practicals/Experiments/Assignments

Term work should consist of total 10 experiments from the below given list.

1. Study of various types of gear boxes such as Industrial gear box, Synchromesh gear box, Differential gear box, etc.
2. To draw conjugate profile for any general shape of gear tooth
3. To generate gear tooth profile and to study the effects under cutting and rack shift using models
4. To draw cam profile for various types of follower motions
5. To study various types of lubricating systems
6. To study various types of dynamometers
7. To determine speed vs. lift characteristic curve of a centrifugal governor and to find its coefficient of insensitiveness and stability.
8. Verification of principle of gyroscope and gyroscopic couple using motorized gyroscope
9. Study of any tow gyro-controlled systems
10. To study the dynamic balancing machine and to balance a rotor such as a fan or the rotor of electric motor or disc on the machine
11. To determine the natural frequency of damped vibration of a single degree of freedom system and to find its damping coefficient
12. To verify natural frequency of torsional vibration of two rotor system and position of node
13. To determine critical speed of a single rotor system
14. To determine transverse natural frequency of a beam experimentally using frequency measurement setup

15. To determine the frequency response curve under different damping conditions for the single degree of freedom system
16. To study shock absorbers and to measure transmissibility of force and motion.
17. Study of epicyclic gear train and its dynamic behaviour.

Field Training/Internship/Industrial Training - II

BTMEF511	Project 2	Field Training/Internship/Industrial Training - II	---	1 Credit

Examination Scheme:
End Semester Exam: 50 Marks

Pre-Requisites: None

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

CO1	To make the students aware of industrial culture and organizational setup
CO2	To create awareness about technical report writing among the student.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		1	1			2		1			3	3
CO2		1	1			2		1			3	2

Students will have to undergo 4 weeks training programme in the Industry during the summer vacation after IVth semester examination. It is expected that students should understand the organizational structure, various sections and their functions, products/services, testing facilities, safety and environmental protection measures etc.

Also, students should take up a small case study and propose the possible solution(s).

They will have to submit a detailed report about the training programme to the faculty coordinator soon after joining in final year B.Tech. Programme. They will have to give a power point presentation in front of the group of examiners.

Semester - VI

Manufacturing Processes - II

BTMEC601	PCC 22	Manufacturing Processes - II	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Understand the process of powder metallurgy and its applications
CO2	Calculate the cutting forces in orthogonal and oblique cutting
CO3	Evaluate the machinability of materials
CO4	Understand the abrasive processes
CO5	Explain the different precision machining processes
CO6	Design jigs and fixtures for given application

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1			2					1
CO2	3	3										1
CO3	3	3	1	2	3							1
CO4	3	3	2									1
CO5	3	3	1	3								1
CO6	3	1	3	3	3			2				1

Course Contents:

Unit 1: Abrasive Machining and Finishing Operations
Introduction; Abrasives and Bonded Abrasives: Grinding Wheels, Bond Types, Wheel Grade and Structure; Grinding Process: Grinding-wheel wear, Grinding Ratio, Dressing, Truing and Shaping of Grinding Wheels, Grindability of Materials and Wheel Selection; Grinding Operations and Machines; Design Considerations for Grinding; Finishing Operations

Unit 2: Mechanics of Metal Cutting
Geometry of single point cutting tools, terms and definitions; chip formation, forces acting on the cutting tool and their measurement; specific cutting energy; plowing force and the "size effect"; mean shear strength of the work material; chip thickness: theory of Ernst and merchant, theory of Lee and Shaffer, friction in metal cutting

Unit 3: Thermal aspects, Tool wear, and Machinability

Temperature in Metal Cutting: Heat generation in metal cutting; temperature distribution in metal cutting, effect of cutting speed on temperatures, measurement of cutting temperatures
Tool life and tool Wear: progressive tool wear; forms of wear in metal cutting: crater wear, flank wear, tool-life criteria,
cutting tool materials: basic requirements of tool materials, major classes of tool materials: high-speed steel, cemented carbide, ceramics, CBN and diamond, tool coatings; the work material and its machinability
Cutting fluids: Action of coolants and application of cutting fluids.

Unit 4: Processing of Powder Metals
Introduction; Production of Metal Powders: Methods of Powder Production, Particle Size, Shape, and Distribution, Blending Metal Powders; Compaction of Metal Powders: Equipment,Isostatic Pressing, Sintering; Secondary and Finishing Operations; Design Considerations.

Unit 5: Processing of Ceramics and Glasses
Introduction; Shaping Ceramics: Casting, Plastic Forming, Pressing, Drying and Firing, Finishing Operations; Forming and Shaping of Glass: Flat-sheet and Plate Glass, Tubing and Rods, Discrete Glass Products, Glass Fibers; Techniques for Strengthening and Annealing Glass: Finishing Operations; Design Considerations for Ceramics and Glasses

Unit 6: Processing of Plastics
Introduction; Extrusion: Miscellaneous Extrusion Processes, Production of Polymer Reinforcing Fibers; Injection Moulding: Reaction-injection Molding; Blow Moulding; Rotational Moulding; Thermoforming; Compression Moulding; Transfer Moulding; Casting; Foam Moulding; Cold Forming and Solid-phase Forming; Processing Elastomers

Texts:

1. Serope Kalpakjian and Steven R. Schmid, "Manufacturing Engineering and Technology", Addison Wesley Longman (Singapore) Pte. India Ltd., 6thedition, 2009.
2. Geoffrey Boothroyd, Winston Knight, "Fundamentals of Machining and Machine Tools", Taylor and Francis, 3rd edition, 2006.

References:

1. Milkell P. Groover, " Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", John Wiley and Sons, New Jersey, 4th edition, 2010.
2. Paul De Garmo, J. T. Black, Ronald A. Kohser, " Materials and Processes in Manufacturing", Wiley, 10th edition, 2007.
3. M. C. Shaw, "Theory of Metal Cutting", Oxford and I.B.H. Publishing, 1st edition, 1994.

Machine Design - II

BTMEC602	PCC 23	Machine Design - II	3-1-0	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Define function of bearing and classify bearings.
CO2	Understanding failure of bearing and their influence on its selection.
CO3	Classify the friction clutches and brakes and decide the torque capacity and friction disk parameter.
CO4	Select materials and configuration for machine element like gears, belts and chain
CO5	Design of elements like gears, belts and chain for given power rating
CO6	Design thickness of pressure vessel using thick and thin criteria

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1						1				1
CO2	3	2		1		1		1		1		1
CO3	1	1				1		1		1		1
CO4	3	3	2	1		2		1		1		1
CO5	1	1				1		1		1		1
CO6	3	2	2	1		1		1		1		1

Course Contents:

Unit 1: Rolling Contact Bearings
Types, Static and dynamic load carrying capacities, Stribeck's Equation, Equivalent load, load and life relationship, selection of bearing life, Load factor, selection of bearing from manufacturer's catalogue, Taper roller bearings and their selection, Cyclic loads and speeds, Design for probability of survival other than 90% Lubrication and mountings of rolling contact bearings.
Sliding Contact Bearings: Methods of lubrication, Viscosity and its measurement, Effect of temperature, viscous flow through rectangular slot, Hydrostatic step bearing, Load capacity and energy losses, Reynolds equation, Raimondi and Boyd method, temperature rise, Constructional details of bearing, Bearing material, Lubrication oils, Additives and greases, Sintered metal bearings, Comparison of rolling and sliding contact bearings.

Unit 2: Spur Gear
Gear drives, Classification of gears, Law of gearing, Terminology of spur gear, Standard system of gear tooth force analysis, gear tooth failures, Selection of materials Constructional, Number of teeth, Face with, Beam strength equation, Effective load on gear tooth, Estimation of module based on beam strength.
Design for maximum power capacity, Lubrication of gears.
Helical Gears: Terminology, Virtual number of teeth, Tooth proportions, Force analysis, Beam strength equation, Effective load on gear tooth, Wear strength equation.

Unit 3: Bevel Gears
Types of bevel gears, Terminology of straight bevel, force analysis, Beam and Wear strength, Effective load on gear tooth.
Worm Gears: Terminology, Proportions, Force analysis, Friction in worm gears, Vector

method, Selection of materials, Strength and wear rating, Thermal considerations

Unit 4: Belt and Chain Drives
Flat and V belts, Geometric relationship, analysis of belt tensions, condition for maximum power, Selection of flat and V belts from manufacturer's catalogue, Adjustment of belt tensions. Roller chains, Geometric relationship, polygonal effect, power rating of roller chain, sprocket wheels, and Silent chains.
Flywheel: Introduction, types of flywheel, stresses in disc and armed flywheel.

Unit 5: Brakes and Clutches
Types of clutches, torque capacity, single and multi-plate clutches, cone clutch, centrifugal clutch, friction materials.
Types of brakes, energy equation, block with shoe brake, pivoted brake with long shoe, internal expanding shoe brake, thermal considerations.

Unit 6: Pressure Vessel
Thin cylinders, thick cylinders, principal stresses, Lame's equation, Clavirino and Birnie's equation, cylinder with external pressure, autofrettage, compounding of cylinders, gasketed joint, unfired pressure vessel, thickness of cylindrical and spherical pressure shells, end closure, opening in pressure vessel, area compensation method

Texts:

1. V. B. Bhandari, "Design of machine Elements", Tata McGraw Hill Publications, New Delhi, 1998
2. R. L. Nortan, "Machine Design: An Integrated Approach", Pearson Education.

References:

1. J. E. Shigley, C. Mischke, "Mechanical Engineering Design", Tata McGraw Hill Inc, New York, 6th edition, 2003.
2. R. C. Juvinall, K. M. Marshek, "Fundamentals of Machine Component Design", John Wiley & Sons, Inc, New York, 2002.

Applied Thermodynamics – II

BTMEC603	PCC 24	Applied Thermodynamics – II	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Thermodynamics, Applied Thermodynamics - I

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

CO1	
CO2	
CO3	
CO4	
CO5	

CO6	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Course Contents:

Unit 1: Fundamentals of IC Engines
Applications, nomenclature, engine components, Engine classification, two and four stroke cycle engines; fundamental difference between SI and CI engines; valve timing diagrams.
Power Cycles: Air standard Otto, Diesel and Dual cycles; Valve timing diagrams, Fuel-Air cycles and deviation of actual cycles from ideal cycles.
Combustion: Introduction, important qualities and ratings of SI Engines fuels; qualities and ratings of CI Engine fuels.
Combustion in S.I. Engines, Combustion in C.I. Engines, types of SI and CI Engine combustion chambers.

Unit 2:
Various Engine Systems
Starting systems, fuel supply systems, engine cooling system, ignition system, engine friction and lubrication systems, governing systems.

Engine Testing and Performance of SI and CI Engines
Parameters, Type of tests and characteristic curves.
Super charging in IC Engine: Effect of attitude on power output, types of supercharging.
Engine Emissions and control: Pollutants from SI and CI engines and their control, emission regulations such as Bharat and Euro.
Alternate fuels for SI and CI engines: Alcohols, Biodiesels, vegetable oil extraction, Trans-esterification process, properties of alternative fuels and fuel blends.

Unit 3: Refrigeration
Fundamental of refrigeration, Unit, Applications, Methods of cooling, Refrigeration systems, Thermodynamics of Refrigeration, Air refrigeration system
Vapour Compression System
Theoretical and actual cycle, use for P-h and T-s charts for problem solving, various effects on system performance. Refrigerants
Vapour Absorption System: Introduction, comparison with vapour compression system Aqua-ammonia system, lithium bromide-water system.

Unit 4: Air Conditioning
Properties of moist air, psychometric chart, Sensible and latent heat loads SHF, GSHF, RSHF, bypass factor, air conditioning processes. Refrigeration and air conditioning controls.

Unit 5: Source of Energy for Power Plant

Fossil fuels, petroleum products, Hydel, Nuclear, Wind, Tidal and Geo-thermal energy etc.

Cycle for Steam and Gas Turbine Power Plant: Rankine cycle, Reheat cycle, Regenerative cycle, Reheat-regenerative cycle, Binary cycle, topping cycle, Cogeneration, Regeneration, and Intercooling.

Unit 5: Types of Power Plant
Thermal Power Plant: Introduction, general layout of modern thermal power plant, working, site selection and material requirements
Diesel Power Plant: Introduction, field of use, plant layout, comparison of diesel power plant with other power plants.
Gas Turbine power plant: Introduction, classification and comparison with other types, types GTPP, advantages and disadvantages over other power plants
Hydro-electric Power Plant: Introduction, general layout of hydro-electric power plant, Site selection, Classification, Advantages of hydro-electric power plant
Nuclear Power Plant: Introduction, nuclear reactions, nuclear fuels, site selection, components of reactors, types of reactors, material requirement, effect of nuclear radiation, disposal of nuclear waste, safety requirement of nuclear power plant.

Texts:

1. V. Ganeshan, "Internal Combustion Engines", Tata McGraw Hill Publications, New Delhi, 3rd edition.
2. C. P. Arora, "Refrigeration and Air Conditioning", Tata McGraw Hill Publications, New Delhi, 2nd edition, 2000.
3. W. F. Stoeker, J. P. Jones, "Principles of Refrigeration and Air Conditioning", Tata McGraw Hill Publications, New York, 2nd edition, 1982.
4. P. K. Nag, "Power Plant Engineering", Tata McGraw Publishing Hill Co.
5. El Wakil, "Power Plant Technology", Tata McGraw Hill Publishing Co.

References:

1. J. B. Heywood, "Internal Combustion Engine Fundamentals", Tata McGraw Hill Publications, New York, International Edition, 1988.
2. ASHRAE Handbook, "Fundamentals and Equipment", 1993.
3. ASHRAE Handbook – Applications, 1961.
4. ISHRAE Handbook
5. Prof. Ram Gopal, NPTL Lectures, www.nptel.com, IIT Kharagpur.
6. Carrier Handbook
7. R.C. Jordan, G. B. Priester, "Refrigeration and Air Conditioning", Prentice Hall of India Ltd., New Delhi, 1969.
8. J. L. Threlkeld, "Thermal Environmental Engineering", Prentice Hall, New York, 1970.
9. S. C. Arora, S. Domkundwar, " A Course in Power Plant Engineering", Dhanpat Rai and Sons, New Delhi.
10. Frederick T. Morse, "Power Plant Engineering", Affiliated East-West Press Pvt. Ltd. New Delhi.

Engineering Tribology

BTMEC604A	PEC 1	Engineering Tribology	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Understand the basic concepts and importance of tribology.
CO2	Evaluatethenatureofengineeringsurfaces,theirtopographyandsurface characterization techniques
CO3	Analyze the basic theories of friction and frictional behavior of various materials
CO4	Select a suitable lubricant for a specific application
CO5	Compare different wear mechanisms
CO6	Suggest suitable material combination for tribological design.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2	2	1	2	2		1						
CO3	2	3	1	2	1	1	1					
CO4	2	2	2		1	1	2		1		1	
CO5	1	1	1	1	1							
CO6	2	2	2		2	2	2		1	1	1	

Course Contents:

Unit 1: Introduction
Definition of tribology, friction, wear and lubrication; importance of the tribological studies.
Surface Topography: Methods of assessment, measurement of surface roughness- different statistical parameters (R_a, R_z, R_{max}, etc.), contact between surfaces, deformation between single and multiple asperity contact, contact theories involved

Unit 2: Friction
Coulomb and Amontons laws of friction, its applicability and limitations, comparison between static, rolling and kinetic friction, friction theories, mechanical interlocking, molecular attraction, electrostatic forces and welding, shearing and ploughing, models for asperity deformation.

Unit 3: Lubrication
Types of lubrication, viscosity, characteristics of fluids as lubricant, hydrodynamic lubrication, Reynold's equation, elasto-hydrodynamic lubrication: partial and mixed,

boundary lubrication, various additives, solid lubrication.

Unit 4: Wear

Sliding wear: Abrasion, adhesion and galling, testing methods pin-on-disc, block-on-ring, etc., theory of sliding wear, un-lubricated wear of metals, lubricated wear of metals, fretting wear of metals, wear of ceramics and polymers.

Wearing by plastic deformation and brittle fracture. Wear by hard particles: Two-body abrasive wear, three-body abrasive wear, erosion, effects of hardness shape and size of particles.

Unit 5: Wear and Design

Introduction, estimation of wear rates, the systems approach, reducing wear by changing the operating variables, effect of lubrication on sliding wear, selection of materials and surface engineering. Principles and applications of tribo design.

Unit 6: Materials for Bearings

Introduction, Rolling bearings, Fluid film lubricated bearings, marginally lubricated and dry bearings, gas bearings.

Texts:

1. I. M. Hutchings, "Tribology, Friction and Wear Engineering Materials", Edward Arnold, London.
2. R. C. Gunther, "Lubrication", Baily Brothers and Swinfen Limited.
3. F. T. Barwell, "Bearing Systems, Principles and Practice", Oxford University Press.

References:

1. B. C. Majumdar, "Introduction to Tribology of Bearings", A. H. Wheeler & Co. Private Limited, Allahabad.
2. D. F. Dudley, " Theory and Practice of Lubrication for Engineers", John Willey and Sons.
3. J. Halling, "Principles of Tribology", McMillan Press Limited.
4. Cameron Alas Tair, "Basic Lubrication Theory", Wiley Eastern Limited.
5. M. J. Neale, "Tribology Handbook", Butterworth's.
6. D. D. Fuller, "Lubrication".

IC Engines

BTMEC604B	PEC 1	IC Engines	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Applied Thermodynamics – I

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

CO1	
CO2	

CO3	
CO4	
CO5	
CO6	

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												
CO6												

Course Contents:

Unit 1: Fundamentals of IC Engines
Applications, nomenclature, engine components, Engine classification, two and four stroke cycle engines; fundamental difference between SI and CI engines; valve timing diagrams.
Power Cycles: Air standard Otto, Diesel and Dual cycles; Valve timing diagrams, Fuel-Air cycles and deviation of actual cycles from ideal cycles.

Unit 2: Combustion
Introduction, important qualities and ratings of SI Engines fuels; qualities and ratings of CI Engine fuels.
Combustion in S.I. Engines, flame speed, ignition delay, normal and abnormal combustion, effect of engine variables on flame propagation and ignition delay, Combustion in C.I. Engines, combustion of a fuel drop, stages of combustion, ignition delay, combustion knock; types of SI and CI Engine combustion chambers.

Unit 3: Various Engine Systems
Starting systems, fuel supply systems, engine cooling system, ignition system, engine friction and lubrication systems, governing systems.

Unit 4: Engine Testing and Performance of SI and CI Engines
Parameters, Type of tests and characteristic curves.
Super charging in IC Engine: Effect of attitude on power output, types of supercharging.
Engine Emissions and control: Pollutants from SI and CI engines and their control, emission regulations such as Bharat and Euro.

Unit 5: Alternate fuels
Need for alternative fuels, applications, various alternate fuels etc
Gaseous Fuels, Alcohols, Biodiesels, vegetable oil extraction, Trans-esterification process, properties of alternative fuels and fuel blends.
Fuel Cell Technology: Operating principles, Types, construction, working, application, advantages and limitations.

Unit 6: Layout of Electric vehicle and Hybrid vehicles

Advantages and drawbacks of electric and hybrid vehicles, System components, Electronic control system – Different configurations of Hybrid vehicles, Power split device. High energy and power density batteries – Basics of Fuel cell vehicles

Texts & References:

1. V. Ganeshan, "Internal Combustion Engines", Tata McGraw Hill Publications, New Delhi, 3rd edition.

2. J. B. Heywood, "Internal Combustion Engine Fundamentals", Tata McGraw Hill Publications, New York, International Edition, 1988.
3. "Alternative Fuels", Dr. S. S. Thipse, Jaico publications.
4. "IC Engines", Dr. S. S. Thipse, Jaico publications.
5. "Engine Emissions, pollutant formation", G. S. Springer and D.J. Patterson, Plenum Press.
6. ARAI vehicle emission test manual.
7. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, "The Biodiesel Handbook", AOCS Press
8. Champaign, Illinois 2005.
9. Richard L Bechtold P.E., Alternative Fuels Guide book, Society of Automotive Engineers,
10. 1997, ISBN 0-76-80-0052-1.
11. Transactions of SAE on Biofuels (Alcohols, vegetable oils, CNG, LPG, Hydrogen, Biogas etc.).

Additive Manufacturing

BTMEC604C	PEC 1	Additive Manufacturing	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Understand the importance of Additive Manufacturing
CO2	Classify the different AM processes
CO3	Design for AM processes
CO4	Understand the applications of AM
CO5	Differentiate the post processing processes

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	2	2					1

CO2	2	2	3	3	3	3	1					1
CO3	2	2	3	3	3		2					1
CO4	3	3	3	2	2	2	2					1
CO5	2	3	3	2	2	2	2					1

Course Contents:

Unit 1: Introduction to Additive Manufacturing (AM)
Introduction to AM, AM evolution, Distinction between AM and CNC machining, Advantages of AM.
AM process chain: Conceptualization, CAD, conversion to STL, Transfer to AM, STL file manipulation, Machine setup, build , removal and clean up, post processing.
Classification of AM processes: Liquid polymer system, discrete particle system, molten material systems, and solid sheet system.

Unit 2: Design for AM
Motivation, DFMA concepts and objectives, AM unique capabilities, Exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers etc.

Unit 3: Guidelines for Process Selection
Introduction, selection methods for a part, challenges of selection, example system for preliminary selection, production planning and control

Unit 4: AM Applications
Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Re-manufacturing. Application examples for Aerospace, defence, automobile, Bio-medical and general engineering industries

Unit 5: Post Processing of AM Parts
Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques.

Unit 6: Future Directions of AM
Introduction, new types of products, employment and digiproneurship.

Texts:

1. Chua Chee Kai, Leong Kah Fai, “Rapid Prototyping: Principles and Applications”, World Scientific, 2003.
2. Ian Gibson, David W. Rosen, Brent Stucker, “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2nd edition, 2010.

References:

1. Ali K. Kamrani, Emand Abouel Nasr, “Rapid Prototyping: Theory and Practice”, Springer, 2006.

2. D. T. Pham, S. S. Dimov, "Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling", Springer, 2001.
3. Andreas Gebhardt, "Understanding Additive Manufacturing", Hanser Publishers, 2011.

Mechanical Measurements

BTMEC604D	PEC 1	Mechanical Measurements	2-1-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 2 hrs/week Tutorial: 1 hr/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Define measurement parameters, and Identify errors in measurement
CO2	Identify methods and devices for measurement of length, angle
CO3	Identify methods and devices for measurement of pressure, flow, force, torque, strain, velocity, displacement, acceleration, temperature

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		1	3	3	1							2
CO2	1	2	2	1	1							2
CO3	1	1	3	2	1							1

Course Contents:

Unit 1: Mechanical Measurement
Need of mechanical measurement, Basic definitions: Hysteresis, Linearity, Resolution of measuring instruments, Threshold, Drift, Zero stability, loading effect and system response. Measurement methods, Generalized Measurement system, Static performance characteristics, Errors and their classification.

Unit 2: Linear and Angular Measurements
Linear Measurement Instruments, Vernier calliper, Micrometer, Interval measurements: Slip gauges, Checking of slip gauges for surface quality, Optical flat, Limit gauges, Problems on measurements with gauge.

Unit 3: Measurement of Pressure
Gravitational, directing acting, elastic and indirect type pressure transducers. Measurement of very low pressures (high vacuum). Flow Measurement: Measurement of fluid velocity, Hot Wire Anemometry, Laser Doppler Velocimetry. Flow measuring devices, Rotameter.

Unit 4: Measurement of Force, Torque and Strain

Force measurement: load cells, cantilever beams, proving rings, differential transformers. Measurement of torque: Torsion bar dynamometer, servo controlled dynamometer, absorption dynamometers. Power measurements.

Measurement of strain: Mechanical strain gauges, electrical strain gauges, strain gauge: materials, gauge factors, theory of strain gauges and method of measurement, bridge arrangement, temperature compensation.

Unit 5: Displacement, Velocity/Speed and Acceleration Measurement

Working principal of Resistive Potentiometer, Linear variable differential transducers, Electro Magnetic Transducers, Mechanical, Electrical and Photoelectric Tachometers, Piezoelectric Accelerometer, Seismic Accelerometer,

Unit 6: Temperature Measurement

Temperature Measuring Devices: Thermocouples, Resistance Temperature Detectors, Thermistor, Liquid in glass Thermometers, Pressure Thermometers, Pyrometer, Bimetallic strip. Calibration of temperature measuring devices, Numerical Examples on Flow Measurement.

Texts:

1. I. C. Gupta, "Engineering Metrology", Dhanpat Rai and Sons.
2. R. K. Jain, "Mechanical & Industrial Measurements", Khanna Publishers.

References:

1. E. O. Doebelin, "Measurement Systems, Application and Design", Tata McGraw Hill Publications.
2. G. Beckwith and G. Thomas, "Mechanical Measurements", Pearson Education.

Quantitative Techniques in Project Management

BTMEC605A	OEC 3	Quantitative Techniques in Project Management	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: Engineering Mathematics-I/II/III

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

CO1	Define and formulate research models to solve real life problems for allocating limited resources by linear programming.
CO2	Apply transportation and assignment models to real life situations.
CO3	Apply queuing theory for performance evaluation of engineering and management systems.
CO4	Apply the mathematical tool for decision making regarding replacement of items in

	real life.
CO5	Determine the EOQ, ROP and safety stock for different inventory models.
CO6	Construct a project network and apply CPM and PERT method.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	3	2				3	1	3	1
CO2	3	1	1	3	2				3	2	3	1
CO3	3	1	1	3	2				3	2	3	1
CO4	3	1	1	3	2	1			3	2	3	1
CO5	3	1	1	3	2	1			3	2	3	1
CO6	3	1	1	3	2	2			3	2	3	1

Course Contents:

Unit 1: Introduction

Introduction to Operations Research, Stages of Development of Operations Research, Applications of Operations Research, Limitations of Operations Research Linear programming problem, Formulation, graphical method, Simplex method, artificial variable techniques.

Unit 2: Assignment and Transportation Models

Transportation Problem, North west corner method, Least cost method, VAM, Optimality check methods, Stepping stone, MODI method, Assignment Problem, Unbalanced assignment problems, Travelling salesman problem.

Unit 3: Waiting Line Models and Replacement Analysis

Queuing Theory: Classification of queuing models, Model I (Birth and Death model) M/M/I (∞, FCFS), Model II - M/M/I (N/FCFS).

Replacement Theory, Economic Life of an Asset, Replacement of item that deteriorate with time, Replacement of items that failed suddenly.

Unit 4: Inventory Models

Inventory Control, Introduction to Inventory Management, Basic Deterministic Models, Purchase Models and Manufacturing Models without Shortages and with Shortages, Reorder level and optimum buffer stock, EOQ problems with price breaks.

Unit 5: Project Management Techniques

Difference between project and other manufacturing systems.Defining scope of a project, Necessity of different planning techniques for project managements, Use of Networks for planning of a project, CPM and PERT.

Unit 6: Time and Cost Analysis

Time and Cost Estimates: Crashing the project duration and its relationship with cost of project, probabilistic treatment of project completion, Resource allocation and Resource leveling.

Texts:

1. P. K. Gupta, D. S. Hira, “Operations Research”, S. Chand and Company Ltd., New Delhi,

1996.
2. L. C. Jhamb, “Quantitative Techniques for managerial Decisions”, Vol. I and II, Everest Publishing House, Pune, 1994.
3. N. D. Vohra, “Operations Research”, Tata McGraw Hill Co., New Delhi.

References:

1. H. Taha, “Operations Research–An Introduction”, Maxwell Macmillan, New York.
2. J. K. Sharma, “Operations Research–An Introduction”, Maxwell Macmillan, New Delhi.
3. Harvey M. Wagner, “Principles of Operations Research with Applications to Managerial Decisions”, Prentice Hall of India Pvt. Ltd., New Delhi, 2nd edition, 2005.
4. Rubin and Lewin, “Quantitative Techniques for Managers”, Prentice Hall of India Pvt. Ltd., New Delhi.

Sustainable Development

BTMEC605B	OEC 3	Sustainable Development	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Explain the difference between development and sustainable development
CO2	Explain challenges of sustainable development and climate change
CO3	Explain sustainable development indicators
CO4	Analyze sustainable energy options
CO5	Understand social and economic aspects of sustainable development

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Introduction

Status of environment, Environmental, Social and Economic issues, Need for sustainability, nine ways to achieve sustainability, population, resources, development and environment.

Unit 2: Global Warming and Climate Change

Global Warming and climate Change since industrial revolution, Greenhouse gas emission, greenhouse effect, Renewable energy, etc.

Unit 3: Challenges of Sustainable Development and Global Environmental Issues
Concept of sustainability, Factors governing sustainable development, Linkages among sustainable development, Environment and poverty, Determinants of sustainable development, Case studies on sustainable development, Population, income and urbanization Health care, Food, fisheries and agriculture , Materials and energy flows.

Unit 4: Sustainable Development Indicators
Need for indicators, Statistical procedures Aggregating indicators, Use of principal component analysis, Three environmental quality indices.

Unit 5: Environmental Assessment
National environmental policy act of 1969, Environmental Impact Assessment, Project categories based on environmental impacts, Impact identification methods, Environmental impact assessment process.

Unit 6: Environmental Management and Social Dimensions
Revisiting complex issues, Sector policies concerning the environment, Institutional framework for environmental management, Achievements in environmental management, People's perception of the environment, Participatory development, NGOs, Gender and development, Indigenous peoples, Social exclusion and analysis.

Texts:

1. J. Sayer, B. Campbell, "The Science of Sustainable Development: Local Livelihoods and the Global Environment", Biological Conservation, Restoration and Sustainability, Cambridge University Press, London, 2003.
2. J. Kirkby, P. O"Keefe, Timberlake, "Sustainable Development", Earth scan Publication, London, 1993.
3. Peter P. Rogers, Kazi F. Jalal, John A. Boyd, "An introduction to sustainable development", Glen Educational Foundation, 2008.

References:

1. Jennifer A. Elliott, "An introduction to sustainable development". London: Routledge: Taylor and Francis group, 2001.
2. Low, N. "Global ethics and environment", London, Rout ledge, 1999.
3. Douglas Muschett, "Principles of Sustainable Development", St. Lucie Press, 1997.

Renewable Energy Sources

BTMEC605C	OEC 3	Renewable Energy Sources	3-0-0	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Continuous Assessment: 20 Marks Mid Semester Exam: 20 Marks End Semester Exam: 60 Marks (Duration 03 hrs)

Pre-Requisites: None

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

CO1	Explain the difference between renewable and non-renewable energy
CO2	Describe working of solar collectors
CO3	Explain various applications of solar energy
CO4	Describe working of other renewable energies such as wind, biomass

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Introduction

Energy resources, Estimation of energy reserves in India, Current status of energy conversion technologies relating to nuclear fission and fusion, Solar energy.

Unit 2: Solar Radiations

Spectral distribution, Solar geometry, Attenuation of solar radiation in Earth's atmosphere, Measurement of solar radiation, Properties of opaque and transparent surfaces.

Unit 3: Solar Collectors

Flat Plate Solar Collectors: Construction of collector, material, selection criteria for flat plate collectors, testing of collectors, Limitation of flat plate collectors, Introduction to ETC.

Concentrating type collectors: Types of concentrators, advantages, paraboloid, parabolic trough, Heliostat concentrator, Selection of various materials used in concentrating systems, tracking.

Unit 4: Solar Energy Applications

Air/Water heating, Space heating/cooling, solar drying, and solar still, Photo-voltaic conversion.

Unit 5: Wind Energy and Biomass

Types of wind mills, Wind power availability, and wind power development in India. Evaluation of sites for bio-conversion and bio-mass, Bio-mass gasification with special reference to agricultural waste.

Unit 6: Introduction to Other Renewable Energy Sources

Tidal, Geo-thermal, OTEC; Mini/micro hydro-electric, Geo-thermal, Wave, Tidal System design, components and economics.

Texts:

1. Chetansingh Solanki, "Renewable Energy Technologies", Prentice Hall of India, 2008.

References:

1. S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", Tata McGraw Hill Publications, New Delhi, 1992.
2. G. D. Rai, "Solar Energy Utilization", Khanna Publisher, Delhi, 1992.

Biology for Engineers

BTMEC606A	OEC 4	Biology for Engineers	3-0-0	Audit

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Audit Course

Pre-Requisites: None

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

CO1	Explain origin of life and Evolution, Cells, Biomolecules-Lipids
CO2	Understand Biomolecules
CO3	Understand Cell structure and function and cell cycle
CO4	Explain Mendelian genetics
CO5	Understand and Explain DNA structure, DNA replication, Transcription, Translation

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Introduction
Origin of life and Evolution, Cells, Biomolecules-Lipids

Unit 2: Biomolecules
Carbohydrates, water, Amino acids and proteins, Enzymes, Nucleotides

Unit 3: Cell structure
Cell structure and function, Prokaryotes, Eukaryotes

Unit 4: Cell cycle
Cell division, mitosis, meiosis, culture growth,

Unit 5: Genetics
Mendelian genetics, genetic disorders, Mendelian inheritance principle, pedigree analysis, Non- Mendelian inheritance

Unit 6: DNA
Chromatin, DNA structure, DNA replication, Transcription, Translation.

Texts:

1. Arthur T. Johnson, “Biology for Engineers”, CRC Press.

References:

1. N. A. Campbell, J. B. Reece, “Biology”, International edition, Benjamin Cummings, New York, 7th edition or later, 2007 or later.
2. G. Karp, “Cell and Molecular Biology: Concepts and Experiments”, Wiley, New York, 7th edition, 2013.

Solar Energy

BTMEC606B	OEC 4	Solar Energy	3-0-0	Audit

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Audit Course

Pre-Requisites: None

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

CO1	Describe measurement of direct, diffuse and global solar radiations falling on horizontal and inclined surfaces.
CO2	Analyze the performance of flat plate collector, air heater and concentrating type collector.
CO3	Understand test procedures and apply these while testing different types of collectors.
CO4	Study and compare various types of thermal energy storage systems.
CO5	Analyze payback period and annual solar savings due to replacement of conventional systems.
CO6	Design solar water heating system for a few domestic and commercial applications.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1											
CO2	1	2				1						
CO3	2			1	1		2					
CO4	1	1										
CO5		2			1							
CO6			2	3		1	1					

Course Contents:

Unit 1: Solar Radiation

Introduction, spectral distribution, solar time, diffuse radiation, Radiation on inclined surfaces, measurement of diffuse, global and direct solar radiation.

Unit 2: Liquid Flat Plate Collectors
Introduction, performance analysis, overall loss coefficient and heat transfer correlations, collect or efficiency factor, collect or heat removal factor, testing procedures.

Unit 3: Solar Air Heaters
Introduction, types of air heater, testing procedure.

Unit 4: Concentrating Collectors
Types of concentrating collectors, performance analysis

Unit 5: Thermal Energy Storage
Introduction, sensible heat storage, latent heat storage and thermo chemical storage
Solar Pond: Solar pond concepts, description, performance analysis, operational problems.

Unit 6: Economic Analysis
Definitions, annular solar savings, payback period.

Texts:

1. J. A. Duffie, W. A. Beckman, "Solar Energy Thermal Processes", John Wiley, 1974.
2. K. Kreith,J. F. Kreider, "Principles of Solar Engineering", Tata McGrawHill Publications, 1978.

References:

1. H. P. Garg, J. Prakash, "Solar Energy: Fundamentals and Applications", Tata McGraw Hill Publications, 1997.
2. S. P. Sukhatme, "Solar Energy Principles of Thermal Collection and Storage", Tata McGraw Hill Publications, 1996.

Human Resource Management

BTMEC606C	OEC 4	Human Resource Management	3-0-0	Audit

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week	Audit Course

Pre-Requisites: None

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

CO1	Describe trends in the labor force composition and how they impact human resource management practice.
CO2	Discuss how to strategically plan for the human resources needed to meet organizational goals and objectives.
CO3	Define the process of job analysis and discuss its importance as a foundation for human resource management practice
CO4	Explain how legislation impacts human resource management practice.

CO5	Compare and contrast methods used for selection and placement of human resources.
CO6	Describe the steps required to develop and evaluate an employee training program
CO7	Summarize the activities involved in evaluating and managing employee performance.
CO8	Identify and explain the issues involved in establishing compensation systems.

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1					2						1	
CO2											3	
CO3										2		
CO4								2		2		
CO5									2	3		
CO6										1		3
CO7										2	2	
CO8											2	

Course Contents:

Unit 1: Introduction to Human Resource Management

Concept of management, concept of human resource management, personnel to human resource management, human resource management model, important environmental influences like government regulations, policies, labor laws and other legislation. **Acquisition of human resources:** Human resource planning, Demand for manpower, Weaknesses of manpower planning, job analysis, job specification, recruitment sources, recruitment advertising, the selection process, selection devices, equal opportunities: Indian and foreign practices, socializing the new employee

Unit 2: Development of Human Resources

Employee Training and Management Development: Training, Training and Learning, Identification of training needs, training methods, Manager Development, Methods for developing managers, evaluating training effectiveness

Career Development: Concept of career, value of effective career development, external versus internal dimensions to a career, career stages, linking career dimensions with stages

Unit 3: Motivation of Human Resources

Definition of motivation, Nature and Characteristics of Motivation, Theories of motivation: Maslow's Need Hierarchy Theory, Drucker Theory, Likert Theory, Herzberg Two Factor Theory, McClell and Theory, McGregor Theory X and Y, etc., Psychological approach.

Job Design and Work Scheduling: Design, Scheduling and Expectancy Theory, Job characteristics model, job enrichment, job rotation, workmodules, flex-time, new trends in work scheduling.

Unit 4: Performance Appraisal

Performance appraisal and expectancy theory; appraisal process, appraisal methods, factors that can destroy appraisal.

Rewarding the Productive Employee: Rewards and expectancy theory, types of rewards, qualities of effective rewards, criterions for rewards.

Unit 5: Maintenance of Human Resources

Compensation Administration: Concept of Compensation Administration, Job evaluation, Pay structures, Incentives compensation plans.

Benefits and Services Benefits: Something for everybody, Services, Trends in benefits and services.

Discipline: Concept of Discipline, types of discipline problems, general guidelines, disciplinary action, employment-at-will doctrine, disciplining special employee groups **Safety and Health:** safety programs, health programs, stress, turn out.

Unit 6: Labor Relations

Unions, Major laborl egislation, goals of group representation.

Collective Bargaining: Objectives, scope, participants of collective bargaining, process of collective bargaining, trends in collective bargaining

Research and the future: What is research? Types of research, why research in human resource management, Secondary sources: where to look it up, Primary sources: relevant research methods, current trends and implications for human resource management.

Texts:

1. David A. DeCenzo, Stephen P. Robbins, "Personnel/Human Resources Management", Prentice Hall of India Pvt. Ltd, 3rd edition,2002.
2. Trevor Bolton, "An Introduction to Human Resource Management", Infinity Books, 2001.

References:

1. Ellen E. Kossek, "Human Resource Management – Transforming the Workplace", Infinity Books, 2001.
2. G.S.Batra, R.C.Dangwal, "Human Resource Management New Strategies", Deep and Deep Publications Pvt. Ltd., 2001.
3. D. M. Silvera, "HRD: The Indian Experience", New India Publications, 2nd edition, 1990.

Metrology and Quality Control Lab

BTMEL607	PCC 25	Metrology and Quality Control Lab	0-0-2	1 Credit

Practical Scheme:	Examination Scheme:
Practical: 2 hrs/batch	Continuous Assessment: 30 Marks End Semester Exam: 20 Marks

Pre-Requisites: None

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

CO1	Measure linear, angular circular features, dimensional and geometric features
CO2	Measure surface roughness of components
CO3	Calibration of metrological equipment

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	3	1							2
CO2			2	2		1		1				2
CO3			3	2		1						2

List of Practicals/Experiments/Assignments

A] Any Four from experiment No. 1 to 5 and Any Four from experiment No. 6 to 10

1. Determination of linear and angular dimensions of given composite part using precision/non precision measuring instruments.
2. Error determination with linear / angular measuring instruments.
3. Calibration of measuring instrument. Example – Dial gauge, Micrometer, Vernier (any one)
4. Verification of dimensions & geometry of given components using Mechanical & Pneumatic comparator.
5. Machine tool alignment testing on any two machines.
6. Identification of surfaces using optical flat/interferometers and measure surface roughness using surface roughness tester.
7. Determination of geometry & dimensions of given composite object using profile projector and measurement of various angles of single point cutting tool using tool maker's microscope.
8. Measurement of thread parameters using floating carriage diameter measuring machine.
9. Measurement of spur gear parameters using Gear Tooth Vernier, Span, Gear Rolling Tester.
10. Determination of given geometry using coordinate measuring machine (CMM).

B] Statistical Quality Control (SQC) (Any Two)
Note - Use of computational tools are recommended

1. Analyze the fault in given batch of specimens by using seven quality control tools for engineering application.
2. Determination of process capability from given components and plot variable control chart/ attribute chart.
3. Case study on various tools in Total Quality Management (TQM).

C] Industrial visit to Calibration lab /Quality control lab / Gear manufacturing unit / Automotive Industry / Engineering Industry.

Machine Design Practice - II

BTMEL608	PCC 26	Machine Design Practice - II	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 30 Marks

	End Semester Exam: 20 Marks

Pre-Requisites: None

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

CO1	Apply design process to an open ended problems
CO2	Determine suitable material and size for structural component of machine/system
CO3	Apply iterative technique in design including making estimate of unknown values for first computation and checking or revisiting and re-computing
CO4	Choose logically and defend selection of design factors
CO5	Design of components for given part/system i.e shaft, keys, coupling, links, screws, springs etc.
CO6	Work effectively as a part of design group/team
CO7	Have good communication skill, orally, graphically as well as in writing

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	2			2	1				
CO2	1	3	2	1			1	1				1
CO3	3	2	2	1			1	1				1
CO4	2	2	2	2			1	1				1
CO5	3	3	2	1			2	1				1
CO6						1	1	1	2	2		2
CO7								1	1	2	2	3

List of Practicals/Experiments/Assignments

1. The term work shall consist of 2 design projects based on syllabus of Machine Design-II. Each design project shall consist of 2 full imperial size sheets-one involving assembly drawings with a partlist and overall dimensions and other sheet involving drawings of individual components. Manufacturing tolerances, surface finish symbols and geometric tolerances should be specified, wherever necessary, so as to make it a working drawing.
   A design report giving all necessary calculations for the design of components and assembly should be submitted in a separate file. Sheets for one of the projects will be drawn using AutoCAD and computer printouts using plotter of the same will be attached along with the design report.
2. At least two assignments based on topics of syllabus of Machine Design-II.

IC Engine Lab

BTMEL609	PCC 27	IC Engine Lab	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 30 Marks End Semester Exam: 20 Marks

Pre-Requisites: None

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

CO1	Conduct test on IC Engines to study their performance.
CO2	Draw performance curves of these machines/systems.
CO3	Analyse the results obtained from the tests.
CO4	Draw conclusions based on the results of the experiments

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		2		2	1							
CO2	1	1			1							
CO3		1			1							
CO4				2								

List of Practicals/Experiments/Assignments (Any Six from the list and Industrial Visit)

1. Study of Carburetor, Fuel Injector
2. Study of Ignition System
3. Trial on Diesel engine- variable load test and energy balance.
4. Trial on Petrol engine- variable speed test and energy balance.
5. Trial on Petrol Engine- Morse Test.
6. Measurements of exhaust emissions of Petrol engine & Diesel engine.
7. Measurement of smoke density using smoke meter
8. Measurement of flash point of fuel sample
9. Oil extraction by using Soxhelet apparatus
10. Production of Biodiesel using Homogeneous/Heterogeneous catalysts
11. Visit to Large Vehicle Service Center/Industry related Automobiles/Components.

Refrigeration and Air Conditioning Lab

BTMEL610	PCC 28	Refrigeration and Air Conditioning Lab	0-0-2	1 Credit

Practical Scheme:	**Examination Scheme:**
Practical: 2 hrs/batch	Continuous Assessment: 30 Marks End Semester Exam: 20 Marks

Pre-Requisites: None

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

CO1	Conduct test on Refrigeration and air conditioning test units to study their performance.
CO2	Draw performance curves of these machines/systems.
CO3	Analyse the results obtained from the tests.

CO4	Draw conclusions based on the results of the experiments

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		2		2	1							
CO2	1	1			1							
CO3		1			1							
CO4				2								

List of Practicals/Experiments/Assignments

- **Refrigeration (Any Six** from the list**) and Air-conditioning (Any Three** from the list**)**

1. Trial on vapour compression Refrigeration system
2. Trial on Ice Plant
3. Trial on Window Air Conditioner
4. Trial on Water to Water Heat Pump
5. Trial on Air to Water Heat Pump
6. Trial on Vortex Tube Refrigeration system
7. Trial on Electrolux Vapour Absorption Refrigeration system
8. Study and practice of sensible heating and cooling Air- conditioning process
9. Study and practice of cooling and dehumidification Air- conditioning process
10. Study and practice of heating and humidification Air- conditioning process
11. Study and practice of adiabatic air mixing Air- conditioning process
12. Study and practice of reheating Air- conditioning process
13. Study and practice of direct Evaporative cooling Air- conditioning system
14. Study and practice of indirect – direct Evaporative cooling Air- conditioning system
15. Field visit to Central Air-conditioning plant/Ice plant/Refrigeration plant

Technical Project for Community Services

BTMEM611	Project 3	Technical Project for Community Services	0-0-4	2 Credits

Examination Scheme: Continuous Assessment: 30 Marks End Semester Exam: 20 Marks

Pre-Requisites: None

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

CO1	Visit nearby places to understand the problems of the community
CO2	Select one of the problems for the study, state the exact title of the project and define scope of the problem
CO3	Explain the motivation, objectives and scope of the project

CO4	Evaluate possible solutions of the problem
CO5	Design, produce, test and analyze the performance of product/system/process
CO6	Modify, improve the product/system/process

Mapping of course outcomes with program outcomes

Course Outcomes	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						2	1	1		2		1
CO2		2								2	1	
CO3						1				2	1	
CO4		1	2				1	2				
CO5	1	1	2	3	1	1	1	2	1	1	1	
CO6			2	1	1		1	1				

Rationale

The role of technical institutes in giving technical and advisory services to the surrounding community need not be emphasized. It is desirable that each faculty member and student be involved in rendering services to community and economy. Moreover, as per Section (4) of the Act of this University, technical services to community, particularly the backward areas, is one of the basic objects of the University. In view of this, “Technical Project related to Community Services” has been included in the curriculum. This will ensure the participation of each student as well as faculty in this activity.

The weekly contact hours and the evaluation scheme for this project are as stated above. The nature of project work should be as given below in the course contents.

List of Practicals/Experiments/Assignments

The projects may be of varying nature such as a technical study/survey, design/development of a technology solution for an identified need, infusion/transfer of technology, etc. All this will be within the ambit of technology and expertise available within the University.

The student may form small groups, typically of 2 to 3 students, and carry out the project under the supervision of a faculty member.