Dr. Babasaheb Ambedkar Technological University (Established as 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

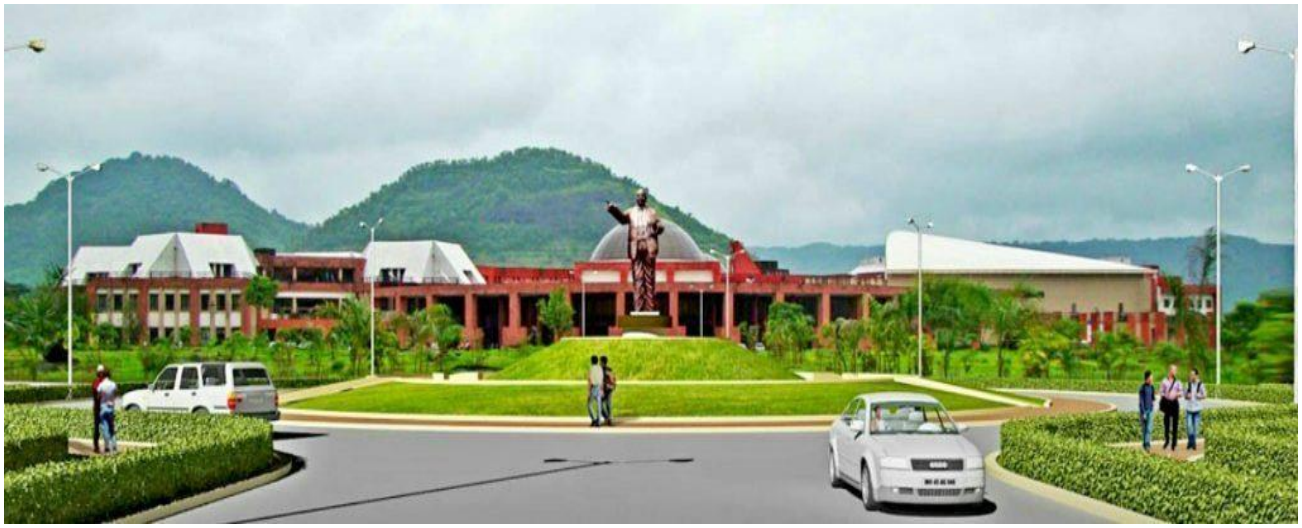
CURRICULUM

UNDER GRADUATE PROGRAMME

B.TECH.

2nd and 3rd Year AUTOMOBILE ENGINEERING

ACADEMIC YEAR
2022-2023



Abbreviations

BSC: *Basic Science Course*

ESC: *Engineering Science Course*

PCC: *Professional Core Course*

PEC: *Professional Elective Course*

OEC: *Open Elective Course*

HSSMC: *Humanities and Social Science including Management Courses*

PROJ: *Project work, seminar and internship in industry or elsewhere*

Course Structure for Semester III
B.Tech in Automobile Engineering (2022-23)

Semester III									
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**			**Credit**
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
BSC7	BTBS301	Engineering Mathematics – III	3	1	-	20	20	60	100	4
PCC 1	BTMC302	Fluid Mechanics	3	1	-	20	20	60	100	4
PCC 2	BTAC303	Thermodynamics& Heat Transfer	3	1	-	20	20	60	100	4
ESC10	BTMES304	Materials Science and Metallurgy	3	1	-	20	20	60	100	4
PCC 3	BTACL305	Automotive Component Drawing and Computer Aided Drafting Lab	-	-	4	60	-	40	100	2
PCC 4	BTACL306	Automobile Engineering Lab I	-	-	6	60	-	40	100	3
PROJ-2	BTES209P	IT – 1 Evaluation	-	-	-	-	-	100	100	1
		Total	**12**	**4**	**10**	**200**	**80**	**420**	**700**	**22**

Course Structure for Semester IV

B.Tech. in Automobile Engineering (2022-23)

Semester IV									
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**			**Credit**
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
PCC 5	BTAC401	Theory of Automotive Engines	3	1	-	20	20	60	100	4
PCC 6	BTPC402	Theory of Machines	3	1	-	20	20	60	100	4
HSSMC3	BTHM403	Basic Human Rights	3	-	-	20	20	60	100	3
ESC11	BTMES404	Strength of Materials	3	1	-	20	20	60	100	4
PEC 1	BTAPE405 / BTMPE405	Elective-I	3	-	-	20	20	60	100	3
PCC7	BTACL406	Automobile Engineering Lab II	-	-	6	60	-	40	100	3
PROJ-3	BTAI407 (IT – 2)	Field Training/Industrial Training (minimum of 4 weeks which can be completed partially in the third and fourth semester or in one semester).	-	-	-	-	-	-	-	Credits to be evaluated in V Sem.
		Total	**15**	**3**	**6**	**160**	**100**	**340**	**600**	**21**

Sr. No	**Elective I: Subject code**	**Subject Name**
1	BTAPE405A	Automotive Materials
2	BTAPE405B	Alternative Fuels for IC
3	BTMPE405A	Numerical Methods in Engineering
4	BTMPE405B	Sheet Metal Engineering
5	BTMPE405C	Fluid Machinery

Course Structure for Semester V
B. Tech in Automobile Engineering (2022-23)

Semester V										
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				**Credit**
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
PCC 8	BTPC501	Design of Machine Elements	3	1	-	20	20	60	100	4
PCC 9	BTAC502	Automotive Chassis, Suspension & Transmission Systems	3	1	-	20	20	60	100	4
PCC 10	BTAC503	Manufacturing Processes	3	1	-	20	20	60	100	4
PEC 2	BTAPE504/ BTMPE504	Elective-II	3	-	-	20	20	60	100	3
OEC 1	BTMOE505	Open Elective-I	3	-	-	20	20	60	100	3
PCC 11	BTMC 506	Applied Thermodynamics	3	-	-	20	20	60	100	3
PCC12	BTACL507	Automobile Engineering Lab III	-	-	6	60	-	40	100	3
PROJ-3	BTAI408 (IT – 2)	IT – 2 Evaluation	-	-	-	-	-	100	100	1
		Total	**18**	**3**	**6**	**180**	**120**	**500**	**800**	**25**

Elective II:

Sr. No	Subject code	Subject Name
1	BTAPE504A	Fundamental of Automobile Design
2	BTAPE504B	Automobile Tribology
3	BTAPE504C	Engines Special Purpose Vehicles
4	BTAPE504D	Automobile Engineering

Open Elective I:

Sr.No	Subject code	Subject Name
1	BTMOE505A	Solar Energy
2	BTMOE505B	Renewable Energy Sources
3	BTMOE505C	Human Resource Management
4	BTMOE505D	Product Design Engineering

Course Structure for Semester VI
B. Tech in Automobile Engineering (2022-23)

Semester VI										
Course Category	**Course Code**	**Course Title**	**Teaching Scheme**			**Evaluation Scheme**				**Credit**
			L	**T**	**P**	**CA**	**MSE**	**ESE**	**Total**	
PCC 12	BTAC601	Automobile Air Conditioning, Electricals and Electronics	3	1	-	20	20	60	100	4
PCC 13	BTAC602	Vehicle Dynamics, Emission and Control	3	1	-	20	20	60	100	4
PEC 3	BTAPE603	Elective-III	3	-	-	20	20	60	100	3
PEC 4	BTAPE604/ BTMPE604	Elective-IV	3	-	-	20	20	60	100	3
OEC 2	BTMOE605	Open Elective-II	3	-	-	20	20	60	100	3
PCC14	BTACL606	Automobile Engineering Lab IV	-	-	6	60	-	40	100	3
PROJ-4	BTAS607	B Tech Seminar	-	-	2	60	-	40	100	1
PROJ-5	BTAP 608	Mini Project			2	60		40	100	1
PROJ-6	BTAI609 (IT – 3)	Field Training/Industrial Training (minimum of 4 weeks which can be completed partially in third semester and fourth semester or in at one time).	-	-	-	-	-	-	-	Credits to be evaluated in VII Sem.
		Total	**15**	**3**	**10**	**280**	**100**	**420**	**800**	**21**

Elective III:

Sr. No	Subject code	Subject Name
1	BTAPE603A	Vehicle Architecture and Packaging
2	BTAPE603B	Computer Simulation of IC Engine Processes
3	BTAPE603C	Automobile Body Design (Pre-requisite: Automobile Design)
4	BTAPE603D	Vehicle Aerodynamics
5	BTAPE603E	E Vehicles
6	BTAPE603F	Design of Experiments

Elective IV:

Sr. No	Subject code	Subject Name
1	BTAPE604A	Transport Management
2	BTAPE604B	Computational Fluid Dynamics
3	BTAPE604C	Ergonomics in Automotive Design
4	BTAPE604D	Tractor and Farm Equipment
5	BTAPE604E	Noise and Vibration
6	BTMPE604B	Product Life Cycle Management
7	BTMPE604C	Finite Element Method

8	BTMPE604D	Robotics

Open Elective II:

Sr. No,	Subject code	Subject Name
1	BTMOE605A	Quantitative Techniques and Project Management
2	BTMOE605B	Nanotechnology
3	BTMOE605C	Energy Conservation and Management
4	BTMOE605D	Wind Energy
5	BTMOE605E	Introduction to Probability Theory and Statistics

Semester III
Engineering Mathematics-III

BTBS301	Engineering Mathematics-III	BSC 7	3L-1T-0P	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1hr/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

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. **[09 Hours]**

Unit 2: Inverse Laplace Transform

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. **[09 Hours]**

Unit 3: Fourier Transform

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. **[09 Hours]**

Unit 4: Partial Differential Equations and Their Applications

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 one dimensional wave equation (i.e.$\frac{\partial^2 y}{\partial t^2} = c^2 \frac{\partial^2 y}{\partial x^2}$). **[09 Hours]**

Unit 5: Functions of Complex Variables

Analytic functions; Cauchy- Riemann equations in Cartesian and polar forms; Harmonic functions in Cartesian form; Cauchy's integral theorem; Cauchy's integral formula; Residues; Cauchy's residue theorem (All theorems without proofs). **[09 Hours]**

Text Books

1. Higher Engineering Mathematics by B. S. Grewal, Khanna Publishers, New Delhi.
2. Higher Engineering Mathematics by H. K. Das and Er. Rajnish Verma, S. Chand & CO. Pvt. Ltd., New Delhi.

3. A course in Engineering Mathematics (Vol III) by Dr. B. B. Singh, Synergy Knowledgeware, Mumbai.
4. Higher Engineering Mathematics by B. V. Ramana, Tata McGraw-Hill Publications, New Delhi.

Reference Books

1. Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons, New York.
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 Knowledgeware, 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 batchwise. Each class should be divided into three batches for the purpose.
2. The internal 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.

Fluid Mechanics

BTMC302	Fluid Mechanics	PCC 1	3L-1T-0P	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1hr/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 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
CO8	Evaluation of performance of compressors/turbines/pumps.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Basics [06 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 [06 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 [10 Hours]

a) Introduction to boundary layer theory and its analysis.

b) 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.

c) 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.

Unit 5: Turbulent Flow and Dimensional Analysis [10 Hours]

a) 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.

b) Dimensional Analysis:Dimensional homogeneity, Raleigh's method, Buckingham's theorem, Model analysis, similarity laws and dimensionless numbers.
d) 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, 5thedition.

References:

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

Thermodynamics & Heat Transfer

BTAC303	Thermodynamics& Heat Transfer	PCC 2	3L-1T-0P	4 Credits

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

Course Contents:

Unit 1: Elementary Thermodynamics [08 Hours]
Basics of Thermodynamics, Ideal gas Laws, First Law of Thermodynamics, Steady Flow Energy Equation, Carnot Cycle, reverse Carnot Cycle, Second Law of Thermodynamics, Concept of refrigeration, Heat Pump and Heat Engine.

Unit 2: Vapor Power Cycles [08 Hours]
Vapour power cycles Steam Generation and its properties, Measurement of dryness fraction, Carnot Cycle, Application of Gas laws to vapour processes. Ideal Rankine Cycle, Calculation of Thermal Efficiency, Specific Steam Consumption, Work ratio.
Steam Turbines: Types, construction, working, compounding, velocity diagram, & diagram efficiency (No numerical).

Unit 3: Fuels and Fundamentals of Combustion [08 Hours]
Solid, Liquid and gaseous fuels, Combustion equations, analysis of product of combustion, gravimetric and volumetric analysis, theoretical air, excess air and exhaust gas produced.

Unit 4: I. C. Engines [08 Hours]
Air standard Otto, Diesel cycles(Elementary Numerical treatment), classifications of ICE and systems of I.C. engines such as fuel supply system for SI & CI engines, ignition system, cooling system, lubrication system, Performance of IC Engine –Indicated power, Brake power, Thermal efficiency, Specific fuel consumption(Elementary Numerical).

Unit 5: Heat Transfer [08 Hours]
Introduction and Basic Concepts of Conduction: Application areas of heat transfer in manufacturing and machine tools, Modes and Laws of heat transfer, thermal conductivity, thermal diffusivity, Heat conduction in plane wall, composite slab, composite cylinder, composite sphere, electrical analogy, concept of thermal resistance, overall heat transfer coefficient, conduction, critical radius of insulation for cylinders and spheres, economic thickness of insulation. (Elementary numerical)
Fundamentals of convection: Concept Laminar and turbulent flow, Reynold Number,
Prandlt number, Grashoff number, Nusselt Number. Mechanism of natural and forced convection, local and average heat transfer coefficient, concept of velocity & thermal boundary layers.
Fundamentals of Radiation: Fundamental concepts of radiation, different laws of radiation, Concept of: shape factor, radiation between two black and diffuse gray surfaces and radiation shields. (No numerical)

Texts:
1. R.K. Rajput, “Thermal Engineering”, Laxmi Publications.
2. R. S. Khurmi and Gupta, “Thermal Engineering”, S. Chand Publication.

References:
1. S.P. Sukhatme, “Heat Transfer”, Orient Longman.
2. Y.A. Cengel, “Thermodynamics – an Engineering approach” Tata McGraw Hill.
3. Eastop, A. Mc’conkey, “Applied Thermodynamics”, Pearson Publishers.
4. Holman J.P., “Heat Transfer”, Tata McGraw Hill.

Material Science and Metallurgy

BTMES304	Material Science and Metallurgy	ESC 10	3L-1T-0P	4 Credits

Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week Tutorial: 1hr/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: Fundamentals

a) Structure of Materials [15 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.

b) Mechanical Properties and their Testing

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 2: 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 3: 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 4: Metallographyn [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 5: 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.

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

Automotive Component Drawing & Computer Aided Drafting Lab

BTACL305	Automotive Component Drawing & Computer Aided Drafting Lab	PCC 3	0L-0T-4P	2 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: -- Practical:4 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[04 Hours]

Types of production drawings, size, shape and description; limits, fits and tolerances, surface roughness and surface roughness symbols,

Computer Aided Drafting [04 Hours]

Introduction to Computer Aided Design and Drafting, Advantaged of CADD, study of preliminary AutoCAD commands like drawing, dimensioning, viewing commands.Drawing3D views in AutoCAD, Introduction to Auto LISP programming.

List of Practical's/Experiments/Assignments:

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 assignments 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

Texts:

1. N.D. Bhatt, Panchal, ―Engineering Drawing‖, Charotar Publishing House, Anand, India.
2. N.D. Bhatt, Panchal, ―Machine Drawing‖, Charotar Publishing House, Anand, India
3. Ajeet Sing, ―WorkingwithAutoCAD2000‖, Tata McGraw Hill, New Delhi.
4. George Omura, ―ABC of Autolispl , BPB Publications,New Delhi.

References:

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

Automobile Engineering Lab I

BTACL306	Automobile Engineering Lab I	PCC 4	0L-0T-6P	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 6hrs/week	Continuous Assessment: 60 Marks Mid Semester Exam: -- End Semester Exam: 40 Marks

Thermal Engineering Lab (PART –A)

List of Practicals/Experiments/Assignments (Any Three)
Any Three experiments from the list:

1. Determination of dryness fraction of steam.
2. Trial on bomb calorimeter.
3. Study of MPFI and Bosh fuel injection pump
4. Study of High Pressure Boilers.
5. Test on Diesel/Petrol engine to determine BP, bsfc, Brake thermal efficiency.
6. Trial on reciprocating air compressor.
7. Determination of thermal conductivity of insulating material.
8. Test on parallel & counter flow heat exchanger.

9. Determination of Emissivity of a Test Plate.

Material Science and Metallurgy Lab (PART –B)

List of Practicals/Experiments/Assignments (Any four 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 (PART –C)
List of Practical's/Experiments/Assignments (Any Three)

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. Determinations of pressure drop in pipes of various cross-sections
5. Determinations of pressure drop 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 meta-centric height of a floating body
9. Calibration of a selected flow measuring device and Bourdon pressure gauge

Gauge and differential pressure measurements using various types of manometers, Bourdon type pressure gauge. Demonstration of measurement using these instruments.

IT – 1 Evaluation

BTES209P (Internship – 1)	Internship – 1 Evaluation	PROJ-2	0L-0T-0P	1 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: --	Continuous Assessment: -- Mid Semester Exam: -- End Semester Exam: 100 Marks

Semester IV
Theory of Automotive Engines

BTAC401	Theory of Automotive Engines	PCC 4	3L-1T-0P	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/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	Perform a primary thermodynamic analysis of Otto and Diesel cycle.
CO2	Select appropriate engine for specific application.
CO3	Select proper fuel system and sub systems for I C Engine. Compare mechanisms for variable valve timing.
CO4	Conduct performance testing of the I C Engine and portray operating characteristics of I C Engines.
CO5	Select proper lubricant and lubrication system for engine
CO6	Understand the latest developments in IC Engines and alternate fuels.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Fundamentals of IC Engines [08 Hours]

Nomenclature, engine components, Engine classification, firing order 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, deviation of actual cycles from ideal cycles.

Unit 2: Combustion[08 Hours]

Introduction, important qualities and ratings of SI and CI Engines 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: Engine Valve Mechanism[08 Hours]

Theoretical and actual valve timing diagram for 2 stroke/ 4 stroke and Petrol/Diesel Engines, Conventional Valve Mechanisms, Mechanisms for variable valve timings.

Unit 4: Various Engine Systems [08 Hours]

Starting systems, fuel supply systems, engine cooling system, ignition system, engine friction and lubrication systems, governing systems.

Unit 5: Engine Testing and Performance of SI and CI Engines [12 Hours]

Parameters, Type of tests and characteristic curves, Effect of load and Speed on mechanical, indicated thermal, break thermal and volumetric efficiencies, Heat balance sheet.

Super charging in IC Engine: Effect of attitude on power output, types of supercharging.

Alternative Potential Engines

Stratified charge engine, VCR engine, Dual fuel engines, HCCI Engine, Green Engine,Engine Emissions & its effect on human being and environment. EURO and BHARAT emission norms,

Modern Trends in I C Engines.

Texts:

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

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 and 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.

Theory of Machines

BTPC402	Theory of Machines	PCC 6	3L-1T-0P	4 Credits

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

Pre-Requisites: Applied Mechanics and Engineering Graphics

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

CO1	Select appropriate mechanism to design and develop a machine for an application
CO2	Analyze the mechanisms to determine velocity and acceleration of various links of the mechanism
CO3	Design and draw profile of the cam to obtain specified follower motion for an application
CO4	Analyze the governor to determine its height for the corresponding change in speed and sleeve displacement
CO5	Explain lower pair mechanisms and select them to meet the need where they are suitable
CO6	Explain and apply friction concepts in automotive and mechanical applications.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	2		2	1								
CO2	1	2			1	1						
CO3	1		1	1								
CO4	1	2	1		1	1						
CO5	2											
CO6	2		2		2			1				

Course Contents:

Unit 1 [06 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, Steering system & mechanism, suspension.

Unit 2[06 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[06 Hours]
Classification of gears, Terminology of spur gears, Conjugate action, Involute and cycloidal profile. Path of contact, contact ratio, Interference, Undercutting, Internal gears. Helical gear terminology, Normal and transverse module, Torque transmitted by helical gears, Spiral gears, Efficiency of spiral gears, Worm and Bevel gear terminology.

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

Unit 4[06 Hours]
Cams and Followers: Types of cams and followers, Analysis of motion, Jump and ramp of cam, Determination of cam profiles for a given follower motion.

Flywheel: Turning moment diagram, Fluctuation of energy and speed, Determination of flywheel size for different types of prime movers and machines.

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.

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

Unit 5 [10 Hours]
Friction Clutches: Principle, Functions, General requirements, Torque capacity, Types of clutches, Cone clutch, Single-plate clutch, Diaphragm spring clutch, Multi-plate clutch, Centrifugal clutch, Electromagnetic clutch, Lining materials, Over-running clutch, Clutch

control systems.

Brakes& Braking System : Function and requirements of braking system, Types of brakes, Elementary theory of shoe brake, drum brake arrangement, disc brake arrangement, self-energizing, brake friction material. brake linkages, hydraulic brake system and components, hydraulic brake fluids, air brakes, vacuum servo assisted brake, engine exhaust brake, parking brakes, dual power brake system, regenerative brake system, fail-safe brake, anti – lock brakes, anti-skid brakes, brake efficiency and testing, weight transfer, braking ratio,ABS System.

Belt and Rope Drives: Flat belts, Effect of slip, Centrifugal tension, Crowing of pulley, Initial tension in belts. V- Belts Geometric relationship, analysis of belt tensions, condition form a maximum power, Selection of flat and V-belts from manufacturer's catalogue, Adjustment of belt tensions.

Text Books:

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

Reference Books:

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

Basic Human Rights

BTHM403	Basic Human Rights	HSSMC3	3L-0T-0P	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 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								2	1	1		

CO2								2	1	2		
CO3								2	1	1		
CO4								2	3	3	2	1
CO5								2			1	
CO6								2	1	2		2

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 [08 Hours]

i) The constitution of India: Preamble
ii) Fundamental rights.
iii) Directive principles of state policy.
iv) Fundamental duties.
v) Some other provisions.

UDHR and Indian Constitution

Universal declaration of human rights and provisions of India. Constitution and law.National human rights commission and state human rights commission.

Texts/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.

Strength of Materials

BTMES404	Strength of Materials	ESC11	3L-1T-0P	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3 hrs/week Tutorial: 1hr/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	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 multi-axial 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1					1					
CO2	1	2	2	1	1	2						
CO3	1	3	1	1		1	2					
CO4	1	2	2		1	2						
CO5	2	2	1		1							
CO6	2	2	1	1								

Course Contents:

Unit 1: Simple Stresses and Strains [12 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.

Principal Stresses and Strains

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

Unit 2: Strain energy, resilience and Combined Stresses [10 Hours]

Strain energy, resilience: 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 3: 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 4: 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.

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.

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.

Elective I
Automotive Materials

BTAPE405A	Automotive Materials	PEC 1	3L-0T-0P	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: Material science and metallurgy

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

CO1	The student shall gain appreciation and understanding Material properties chart and all parameters of chart.
CO2	Shall be able to know different types of electric and magnetic materials also non-metallic materials.
CO3	Student shall gain knowledge of various surface treatment used in automobile industries
CO4	Student shall gain knowledge of modern materials comes such as shape memory alloy etc.
CO5	Ability to select material of material from the material properties chart with considering such parameter modulus density, strength density and modulus strength.
CO6	Ability to select material for the automotive components

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit-I: Material Property Charts and Selection Criteria
Material Property Charts: Modulus-density, strength-density, modulus strength, specific stiffness and specific strength, fracture toughness, modulus fracture.
Selection Criteria- Shape factor, elastic extrusion, elastic body and twisting, failure, bending and twisting, efficiency of standard sections, material limits and shape factors.

Unit-II: Polymers
Physical and Mechanical properties of polymers and their composites, effect of processing on properties. Applications in engineering.
High Polymers: Classification of High polymers- production of high polymers- general methods- Some important plastics, their production, properties and uses- Polyethylene
PVC, Polystyrene, Teflon, Acrylics, Nylon, Polyesters, Phenol Formaldehyde Resins, Urea Formaldehyde Resins and silicones-compounding and moulding of High polymers.

Unit-III: Composite Materials
Composite Materials: Introduction, Types of composite materials, properties, advantages, orthotropic and anisotropic behaviour, Micromechanical and micromechanical analysis of composite material, Applications of composite materials

Unit-IV: Surface Modification of Materials
Mechanical surface treatment and coating - case hardening and hard facing, thermal spraying, vapor deposition, ion implantation, diffusion coating, electroplating and electro-less, conversion coating, ceramic and organic coatings, diamond coating.

Unit-V: Modern Materials and Alloys
Super alloys, refractory metals, shape memory alloys, dual phase steels, micro alloyed, high strength low alloy steel, transformation induced plasticity (trip) steel, merging steel, smart materials, metallic glass, quasi crystal and Nano crystalline materials., metal foams.
Materials selection for automotive components : Criteria of selecting materials for automotive components viz cylinder block, cylinder head, piston, piston ring, gudgeon pin, connecting rod, crank shaft, crank case, cam, cam shaft, engine valve, gear wheel, clutch plate axle, bearings, chassis, spring, body panel - radiator, brake lining etc. application of non-metallic materials such as composite, ceramic and polymers in automobile.

Reference Books:

1. "Material Science and Engineering- An introduction", Callister W.D. (2006), Wiley – Eastern.
2. "Physical Metallurgy", Raghavan, V., (2003), Prentice Hall of India.
3. "Materials Selection in Mechanical Design", Michael F. Ashby, Butterworth Heinemann,2005.
4. "Mechanical Behavior of Materials", Thomas H. Courtney, (2000) McGraw Hill.
5. "Engineering Materials and their Applications", Flinn R. A. and Trojan P. K. (1999), Jaico.
6. "Surface Engineering for wear resistance", Kenneth Budinski– (1988) Prentice Hall.
7. "Introduction to physical metallurgy", Avner S.H., (2006) –Tata McGraw Hill.
8. Materials Science and Metallurgy", DanielYesudianC, Scitech Publications (Indian ,2004.)

Alternative Fuels for IC Engine

BTAPE405B	Alternative Fuels for IC Engine	PEC 1	3L-0T-0P	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	Modify automotive engine to operate by using various alternative fuels.
CO2	Analyze engine performance and emission characteristics by using alternative fuels.
CO3	Suggest advance engine technology for alternative fuels.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit-1:
Conventional Fuels and Need for alternative fuels

Need for alternative fuels, applications, various alternate fuels etc.
Comparison of properties of fuels, quality rating of SI and CI engine fuels, fuel additives for SI and CI engines,

Unit-2:
Alternative Fuels I – Gaseous Fuels
Introduction to CNG, LPG, Study of availability, manufacture, properties, storage, handling and dispensing, safety aspects, and engine/vehicle modifications required.

Unit-3:
Biofuels
Biodiesel, Biogas, ethanol, Methanol. Study of availability, manufacture, properties, storage, handling and dispensing, safety aspects, engine/vehicle modifications required.

Unit–4:
Hydrogen
Study of availability, manufacture, properties, storage, handling and dispensing, safety aspects, engine/vehicle modifications required.

Unit-5:
Fuel Cell Technology
Operating principles, Types, construction, working, application, advantages and limitations.

Texts:

1. AyhanDemirbas, "*Biodiesel A Realistic Fuel Alternative for Diesel Engines"*, Springer-Verlag London Limited 2008, ISBN-13: 9781846289941

References:

1. "Alternative Fuels", Dr. S. S. Thipse, Jaico publications.
2. "Engine Emission", B.P Pundir, Narosa publication.
3. "Internal Combustion Engines", V. Ganesan, Tata McGraw Hill.
4. "Automotive Emission Control", Crouse, W.M. and. Anglin, A.L, McGraw Hill.
5. "IC Engines", Dr. S. S. Thipse, Jaico publications.
6. "Engine Emissions, pollutant formation", G. S. Springer and D.J. Patterson, Plenum Press.
7. ARAI vehicle emission test manual.
8. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, "The Biodiesel Handbook", AOCS Press
   Champaign, Illinois 2005.
9. Richard L Bechtold P.E., Alternative Fuels Guide book, Society of Automotive Engineers,
   1997, ISBN 0-76-80-0052-1.
10. Transactions of SAE on Biofuels (Alcohols, vegetable oils, CNG, LPG, Hydrogen, Biogas etc.).
11. Science direct Journals (Biomass & Bio energy, Fuels, Energy, Energy conversionManagement, Hydrogen Energy, etc.) on biofuels.
12. Devaradjane. Dr. G., Kumaresan. Dr. M., "Automobile Engineering", AMK Publishers, 2013.

Numerical Methods in Mechanical Engineering

BTMPE405A	Numerical Methods in Mechanical Engineering	PEC1	3L-0T-0P	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)

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'srule, 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 and Computer Programming [12 Hours]

Motivation, Least Square Regression: Linear Regression, Polynomial regression.
Interpolation: Newton's Divide Difference interpolation, engineering applications.
Solution to Ordinary Differentiation Equations: Motivation**,** Euler'sand Modified Euler's Method, Heun's method, Runge–Kutta Method, engineering applications.

Computer Programming

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", Tata McGraw Hill Publications,2010.
2. E. Balagurusamy, "Numerical Methods",Tata McGraw HillPublications,1999.

References:

1. V. Rajaraman, "FundamentalofComputers",PrenticeHallofIndia,NewDelhi,2003.
2. S. S. Sastri,"IntroductoryMethodsofNumericalMethods",PrenticeHallofIndia,NewDelhi, 3rd edition,2003.
3. K. E. Atkinson, "AnIntroductionto NumericalAnalysis",Wiley,1978.
4. M.J. Maron, "Numerical Analysis: A Practical Approach", Macmillan, New York, 1982

Sheet Metal Engineering

BTMPE405B	Sheet Metal Engineering	PEC 1	3L-0T-0P	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	Recognize common manufacturing processes of Sheet Metal Fabrication
CO2	Understand the principles of design and fabricate of sheet metal products and recognize common material used in the industry
CO3	Distinguish Shearing, Drawing and Pressing etc. processes.
CO4	Know types of dies and formability.
CO5	Select mechanical or hydraulic presses for the given 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	1	1	1	3	2				2	1		1
CO2	3			1	3	2	3					2
CO3	1	1		3	3	2	1		3		1	3
CO4	3	3	1	1	3		1	1	1			
CO5	3	2			3	3	2				1	3

Course Contents:

Unit1: Introduction
Importanceofsheetmetalengineering,materialsused,desirableproperties of materials in sheet metal products

Unit2: Basic Applications
Shearing processes like blanking, piercing, and punching.

Unit3: Drawing Processes
Shallow and deep drawing of cylindrical and rectangular bodies, forming and bending including spring-back.

Unit4: TypesofDies and Mechanical Presses
Dies: Compound dies, progressive dies, and combination dies
Mechanical Presses
Mechanical and hydraulic presses, modern developments in press tools, formability.

Unit 5: Case Studies
Case studies for manufacturing of sheet metal products in various engineering applications

Texts:

1. Donaldson et al., "Tool Design", Tata McGraw-Hill Publications, New Delhi, 1998.

References:

1. P.N.Rao,"ManufacturingTechnology,Foundry,FormingandWelding",Vol.I,Tata McGraw Hill Publishing Co. Ltd, New Delhi, 3rd edition, 2004.
2. ASMHandbook, "MetalForming",Vol.XV,ASMPublication,Metals Park, Ohio,10th edition,1989.
3. A. S.Deshpande, "DieDesignHandbook",ASTME.
4. SheetMetalEngineeringNotes,IITBombay,1999.

Fluid Machinery

BTMPE405C	Fluid Machinery	PEC 1	3L-0T-0P	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	Understand and apply momentum equation
CO2	Understand and explain Hydrodynamic Machines
CO3	Explain difference between impulse and reaction turbines
CO4	Find efficiencies, draw velocity triangles
CO5	Explain governing mechanisms for hydraulic turbines
CO6	Explain working of various types of pumps, draw velocity diagrams, do simple calculations
CO7	Design simple pumping 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	3	2	1									1
CO2	3		3				2					1
CO3	3	2										1
CO4	3	3	2									1
CO5			3									1
CO6	3	3	3	1	1							1
CO7	3	3		3								1

Course Contents:

Unit 1: Momentum Equation and its Applications
Impulse momentum, Principle, Fixed and moving flat inclined plates, Curved vanes, Series of plates and vanes, Velocity triangle and their analysis, Water wheels. Hydrodynamic Machines: Classification, General theory, Centrifugal head, Fundamental equations, and Euler's equation, Degree of reaction, Head on machine, various efficiencies, Condition for maximum hydraulic efficiency.

Unit 2: Impulse Turbines
Impulse principle, Construction of Pelton wheel, Velocity diagrams and its analysis, Number of buckets, Jets, Speed ratio, Jet ratio.
Reaction Turbines: Constructional details of Francis, Kaplan and Propeller turbine, Deciaz turbine, and Draft tube types, Efficiencies, Cavitation.

Unit 3: Governing of Turbines
Methods of governing, Performance characteristics, Safety devices, Selection of turbines, Unit quantities, Specific speed, Principles of similarity and model testing.

Unit 4: Centrifugal Pump
Construction, Classification, Terminology related to pumps, Velocity triangle and their analysis, Cavitation, NPSH, Thoma's cavitation factor, Priming, Methods of priming, Specific speed, Performance characteristics, Actual thrust and its compensation, Troubleshooting.
Multistage Pumps: Pump H-Q characteristics and system H-Q Characteristics, Series and parallel operation of pumps, Systems in series and parallel, Principle of model testing and similarity.

Unit 5: Special Purpose Pumps
Chemical pumps, nuclear pumps, Sewage pumps, Submersible deep well pumps, Pump installation, Energy efficient pumps.
Failure of Pumping System: Pump failures, Remedies, Source failure, Causes and remedies, Trouble shooting.
Miscellaneous Pumps: Reciprocating pump, Gear pump, Vane pump, Lobe pump, etc., Application field (no mathematical treatment).

Texts:

1. P. N. Modi, S. M. Seth, "Hydraulics and Fluid Mechanics including Hydraulic Machines", Standard Book House, Rajsons Publications Pvt. Ltd., 20th edition.
2. R. K. Bansal, "A Text Book of Fluid Mechanics and Hydraulic Machines", Lakshmi Publications Pvt. Ltd., 9th edition.

References:

1. Yunus A. Çengel, John M. Cimbala, Fluid Mechanics: Fundamentals and Applications", McGraw Hill, 3rd edition, 2014.

Automobile Engineering Lab II

BTACL406	Automobile Engineering Lab II	PCC 7	0L-0T-6P	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 6hrs/week	Continuous Assessment: 60 Marks Mid Semester Exam: -- End Semester Exam: 40 Marks(Duration 03 hrs)

Theory of MachinesLab (Part A)

List of Practical's /Experiments/Assignments

1. **Four sheets** (half imperial size)
   Graphical solution of problems on velocity, acceleration in mechanisms by relative, velocity method, instantaneous centre of rotation method and Klein's construction. At least one problem containing Coriolis component of acceleration.

2. **Experiments (Any2)**
   a) Experimental determination of velocity and acceleration of Hooke's joint.
   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 Coriolis component of acceleration.

Strength of Material Lab (Part B) (Any Four)

List of Practicals/Experiments/Assignments (any Four 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.

Theory of Automotive Engines Lab (Part C)

List of Practical's/Experiments/Assignments

A. Demonstration of physical systems in terms of constructional details and functions

1. 2 Stroke and 4 Stroke Engines
2. Carburetor.
3. Ignition system.
4. Fuel injection system.
5. Cooling System
6. 2 stage / 3 stage pressurised gas supply system. (LPG/CNG/Biogas/Hydrogen)
7. Visit to Industry related to automotive service station.

B. I C Engines (Any **TWO** experiments from the list)

1. Trial on Diesel engine- variable speed/load test and energy balance.
2. Trial on Petrol engine- variable speed/load test and energy balance.
3. Trial on Petrol Engine- Morse Test.
4. Measurements of exhaust emissions of Petrol engine / Diesel engine.
5. Heat Balance test on diesel or petrol engines.
6. Experimental determination of Air fuel ratio.

SEMESTER V
Design of Machine Elements

BTPC501	Design of Machine Elements	PCC 8	3L-1T-0P	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)

Objectives: To understand material properties, design process and various theories of failures in order to design various basic machine components and new components based on design principles.

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:

Unit1:

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 databook, aesthetic and ergonomic considerations in design.

Theories of Failure: Maximum normal stress theory,Maximum shear stress theory,

Maximum distortion energy theory, comparison of various theories of failure,

Unit2:Design of Machine Elements
Against Static Loading
Direct loading and combined loading, Joints subjected to static loading e.g. cotter and knuckle joint, turn buckle, etc. introduction to fluctuating loads.

II: 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 3:Design of Shafts, Keys, Couplings and Bearings
Various design considerations in transmission shafts, splined shafts, spindle and axles strength, lateral and torsional rigidity, ASME code for design in transmission shaft.

Types of Keys: Classification and fit men tin keyways, Design of various types of keys.
Couplings: Design consideration, design of rigid, muff and flange type couplings, design of flexible couplings.
Bearings: Types, Constructional details of roller contact and sliding contact bearings, 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, Lubrication and bearing materials.

Unit 4: 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.
PowerScrews: Formsofthreadsusedforpowerscrewandtheirapplications,torqueanalysisfor squareandtrapezoidalthreads,efficiencyofscrew,collarfriction,overallefficiency,self-lockinginpowerscrews,stressesinthepowerscrew,designofscrewandnut,differentialandcompoun d 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.

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

Unit 5:Design of Gears and Drives
Gear drives, Classification of gears, Law of gearing, Terminology of spur gear, Standard system of gear tooth for cean analysis, gear tooth failures, material selection, 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.
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

Texts:

1. V. B. Bhandari, "Design of Machine Elements", Tata McGraw Hill Publications,NewDelhi,2008.
2. R. L.Nortan, "MachineDesign:AnIntegratedApproach",PearsonEducationSingapore, 2001.

References:

1. R. C.Juvinall, K. M.Marshek, "Fundamentalofmachinecomponentdesign",John Wiley&SonsInc.,NewYork,3rdedition,2002.
2. B. J. Hamrock,B. JacobsonandSchmidSr., "FundamentalsofMachineElements", InternationalEdition,NewYork,2ndedition,1999.
3. A. S.Hall,A. R.Holowenko, H. G.Langhlin,"TheoryandProblemsofMachine Design",Schaum'sOutlineSeries, Tata McGrawHillbookCompany,NewYork,1982.
4. J. E.ShigleyandC.Mischke, "MechanicalEngineeringDesign", Tata McGrawHill Publications,7thedition, 2004.
5. M. F.Spotts, "DesignofMachineElements",PrenticeHallofIndia,NewDelhi.

Automotive Chassis, Suspension & Transmission Systems

BTAC502	Automotive Chassis, Suspension & Transmission Systems	PCC 9	3L-1T-0P	4 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/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	Elaborate the constructional details and operations of chassis systems like steering system, suspension system etc.
CO2	Interpret the underlying mechanics of the chassis systems.
CO3	Apply steering geometry for a given vehicular application.
CO4	Select/Configure components or subsystems for integration into main chassis system.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit-I: Vehicle Chassis

Introduction To chassis, chassis operating condition, chassis frame, vehicle components location. Manufacturing processes for chassis, causes of chassis failure

Unit-II: Vehicle Suspension Systems

Road irregularities and need of suspension system, Types of suspension system, Sprung and unspring mass, Suspension springs – requirements, types and characteristics of leaf spring, coils spring, rubber spring, air and torsion bar springs, Independent suspension for front and rear, Types, Hydro-elastic suspension, roll center, use of anti-roll bar and stabilizer bar, Shock absorbers – need, operating principles and types, Active suspension.

Unit – III

Gear Box

Gear Box: Necessity of gear box, Resistance to motion of vehicle, Requirements of gear box,

Functions of gear box, Types- Sliding mesh, Constant mesh, Synchromesh. Principle, construction and working of synchronizing unit, Requirements &applications of helical gears, Gear selector mechanism, Two-wheeler gear box, Lubrication of gear box, Overdrive gears, Performance characteristics.

Drive Lines

Propeller shaft-universal joints, hooks and constant velocity U.J., Drive line arrangements – Hotchkiss drive & torque tube drive, Rear wheel drive, front wheel drive and four-wheel drive layouts and its advantages & limitations.

Unit – IV

Final Drive & Rear Axle

Purpose of final drive & drive ratio, Different types of final drives, need of differential, Constructional details of differential unit, Differential lock, Differential housing, Function of rear axle, Construction, Types of loads acting on rear axle, Axle types - semi-floating, full floating, three quarter floating.

Fluid Flywheel, Torque convertor, Epicyclic Gear Boxes

Fluid Flywheel, Torque convertor: Operating principle, Construction and working of fluid flywheel, Characteristics, Advantages& limitations of fluid coupling, Torque convertor, and construction and working of torque converter, Performance characteristics, Comparison with conventional gear box. Epicyclic Gear Boxes: Simple epicyclic gear train, Gear ratios, Simple &compound planet epicyclic gearing, Epicyclic gearboxes, Wilson epicyclic gear train - Construction and operation, Advantages, Clutches and brakes in epicyclic gear train, compensation for wear, performance characteristics.

Unit –V

Automatic Transmission

Principle of semi-automatic & automatic transmission, Hydromantic transmission, Fully automatic transmission, Semi-automatictransmission, Hydraulic control system, Continuous variable transmission (CVT) – operating principle, basic layout andoperation, Advantages and disadvantages.

Text Book:

1. “Automobile Engineering” R. B. Gupta SatyaPrakashan New Delhi.
2. “Basic Automobile Engineering” C. P. NakraDhanpatRai Publishing Company (P) Ltd-New Delhi
3. “Automotive Mechanics” N.K. Giri 8th Edition Khanna Publishers New Delhi.
4. Dr. Kripal Singh, “Automobile Engineering-Vol. 1”, 13th Edition, Standard Publishers Distributors
5. N. K. Giri, “Automotive Mechanics”, Khanna Publishers, Delhi, Eighth Edition

References:

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

Publication.
5. Newton, Steed &Garrot, “Motor Vehicles”, 13th Edition, Butterworth London
6. A. W. Judge, “Modern Transmission”, Chapman & Hall Std., 1989
7. Chek Chart, “Automatic Transmission”, A Harper & Raw Publications
8. J. G.Giles, “Steering, Suspension & Tyres”, – Lliffe Book Ltd., London
9. W. Steed, “Mechanics of Road Vehicles”, Lliffe Book Ltd
10. Heisler, “Vehicle and Engine Technology”, Second Edition, SAE International Publication

Manufacturing Processes

BTAC503	Manufacturing Processes	PCC10	3L-1T-0P	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	Identify castings processes, working principles and applications and list various defects in metal casting
CO2	Understand the various sheet metal 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, drilling, boring, shaping and broaching operations
CO6	Describe the mechanical measurements techniques

Mapping of course outcomes with program outcomes

CourseOutcomes	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

Course Contents:

Unit 1: Introduction to Manufacturing

What is manufacturing? Examples of manufacturing products, Classification of manufacturing processes, Selection of materials, Types of manufacturing strategies.Importanceofsheetmetalengineering,materialsused,desirableproperties ofmaterialsin sheetmetalproducts.Shearingprocesseslikeblanking,piercing,andpunching.

Unit 2: Metal Casting Processes

Patterns, allowances, moulding sand properties and preparation, Cores, core prints, sand moulding procedure, Gating and riser design, melting practice and furnaces, solidification of

metals, casting defects and inspection, Specialized casting processes such as shell mould casting, die casting, centrifugal casting, investment casting and permanent mould casting.

Unit 3: Joining Processes

Gas welding, gas cutting, Electric arc-welding with consumable and non-consumable electrodes (MMAW, GMAW, TIG, and SAW); solid state welding: resistance welding, spot and seam welding, thermit welding, friction welding, welding defects, Brazing and soldering.

Unit 4: Turning, Shaping, Milling and Planing

Lathe and its types, constructional features, lathe operations, taper turning, methods of taper turning, work holding and cutting tool, thread cutting, machining time and power estimation, shaper, Milling machine and its types, construction, milling operations, milling cutters, Planing machine sand their types and operations.

Unit 5: Drilling, Boring, Broaching

Drilling machine, its types, construction, twist drill, drilling time and power estimates, counter boring, spot facing, boring, reaming, tapping, and broaching, broach tool, broaching machine types, construction and operations.

Mechanical Measurements

Introduction to measurements, Errors in measurements, Measurement of temperature, pressure, velocity, Measurement of heat flux, volume/mass flow rate, Measurement of thermo-physical properties, radiation properties of surfaces, vibration and noise,Measurement of length, measurement of angle, Measurement of geometric forms, straightness, flatness, roundness

Texts:

1. P. N. Rao, “Manufacturing Technology, Foundry, Forming and Welding”, Vol. 1, 3rd edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2004.
2. P.N. Rao, “Manufacturing Technology, Metal Cutting and Machine Tools”, Vol. 2, 2nd edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2002.
3. Gayler J.F. and Shotbolt C.R. Metrology for Engineers, ELBS, Fifth Edition 1990

References:

1. M. P. Groover, “Fundamentals of Modern Manufacturing: Materials, Processes and Systems”, Prentice Hall, Upper Saddle River, New Jersey, 1999.
2. S. Kalpakjian and S.R.Schmid, “Manufacturing Engineering and Technology”, Addison Wesley Longman (Singapore) Pte. India Ltd., 4th edition, 2000.

Elective II
Fundamental of Automobile Design (Product Design, PLM, CAE, Catia)

BTAPE504A	Automobile Design (Product Design, PLM, CAE, Catia)	PEC 2	3L-0T-0P	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	
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												

Course Contents:

Domain related training (Approx. 20 Hrs)

Unit 1:

Introduction to Styling, Basic of Design - Introduction to Design, Good Design & it's Examples of All Time, Industrial Design & its use. Design Process - Typical Product Life Cycle, Automotive Design Process (for production release), Design Studio (Automotive studio) Process or Product Conceptualization Process, Case Study. CAS Surfaces or Digital Clay Models, Class A Surfaces - Role of Class A surface Engineer, Requirements for a Surface to fulfill " Class A Surface" Standards, Case Studies for Class A Surfaces, Class A Surface Creation for Bonnet

Unit 2:

Introduction to Body In White: Introduction & familiarization to Body In White (BIW), various type of BIW, Types of BIW sub system, various aggregates of BIW. Bonnet Design Case Study:Function of Bonnet, Defined Input to Bonnet, Intended Input to Bonnet Design.

Steps in Bonnet design, Study of Class A Surfaces, Hood Package Layout , Typical Sections, Block Surfaces in 3D, Dynamic Clearance Surfaces in 3D, Hood Structural Members, CAE 1(Durability, Crash), Panel Detail Design, Body Assembly Process, CAE 2(Durability, crash, individual panel level), Design Updating & Detailing Prototypes, Design Updating & Production Release

Unit 3:
Introduction to CAE & its importance in the PLM, Introduction to FEA & its applications (NVH, Durability & Vehicle Crashworthiness). Introduction of Pre-Processor, Post-Processor & Solvers. Importance of discretization & Stiffness Matrix (for automobile components). Importance of oil canning on an automobile hood with Case study related to Durability Domain. Modal analysis on the hood (Case Study related to NVH Domain). Introduction of vehicle crashworthiness & Bio-mechanics (Newtonian laws, energy management, emphasis of impulse in car crashes). Head impact analysis as a Case study on the hood of an automobile (EuroNCAP test regulation). Importance of Head performance criteria (HPC). Introduction to failure criteria (By explaining the analogy of using uni-axial test results for predicting tri-axial results in reality), Mohr's Circle, Von-Mises stress criteria, application of various failure criteria on brittle or ductile materials

Unit 4:
Introduction to CAD,CAM & CAE, FEA - Definition, Various Domains – NVH, Dura, Crash, Occupant Safety, CFD. Implicit vs. Explicit Solvers, Degree of Freedom, Stiffness Matrix, Pre-Post & Solver; Types of solvers, Animation. Durability -Oil Canning, Oil Canning on Hood, Scope of work, Loading, Boundary Conditions, Results & Conclusions. NVH – Constrained Modal Analysis, Constrained Modal Analysis on Hood, Scope of work, Loading, Boundary Conditions, Results & Conclusions. Crash – Vehicle Crashworthiness, Energy Management, Biomechanics, Head Impact Analysis on Hood, Importance of Failure Criteria, Von-Mises Stress

Unit 5:
Sheet metal design & Manufacturing Cycle, Simultaneous Engineering (SE) feasibility study, Auto Body & its parts, important constituents of an automobile, sheet metal, sheet metal processes. Type of draw dies, Draw Model development & its considerations. Forming Simulations, Material Properties, Forming Limit Curve (FLD), Pre Processing, Post-Processing, Sheet metal formability- Simulation
Die Design –Sheet metal parts, Sheet metal operations (Cutting, Non-Cutting etc.), Presses, Various elements used in die design, Function of each elements with pictures, Types of dies, Animation describing the working of dies, Real life examples of die design. **Fixture Design** - Welding (Spot/Arc Welding), Body Coordinates, 3-2-1 principle, Need for fixture, Design considerations, Use of product GD&T in the fixture design, fixture elements. Typical operations in Sheet metal Fixture (Manual/Pneumatic/Hydraulic fixture), Typical unit design for sheet metal parts (Rest/Clamp/Location/Slide/Dump units/Base), Types of fixture (Spot welding/ Arc welding/ Inspection fixture/Gauges)

Tools related training (Approx. 20 Hrs):
Depending on the tools available in the college, the relevant tool related training modules shall be enabled to the students.
AutoCAD, AutoCAD Electrical, AutoCAD Mechanical, AutoCAD P&ID, Autodesk 3ds Max, Autodesk Alias, Autodesk SketchBook, Automotive, CATIA V5, CATIA V6, FEA,

Autodesk Fusion 360, Autodesk Inventor, Autodesk Navisworks, Autodesk Ravit, Autodesk Showcase, Autodesk Simulation, PTC Creo, PTC ProENGINEER, Solid Edge, SOLIDWORKS.

Texts:

1. Notes of TATA Technologies
2. Curt Larson, " Datum Principles: Flexible Parts: Applications for Automotive Body-in-White and Interior Trim (Dimensional Management Series Book 1)", Right Tech, Inc., Kindle Edition.
3. Curt Larson, " Datum Principles: Flexible Parts: Applications for Automotive Body-in-White and Interior Trim (Dimensional Management Series Book 2)", Right Tech, Inc., Kindle Edition.
4. Vukato Boljanovic, "Sheet Metal Forming Processes and Die Design", Industrial press Inc., Kindle Edition.

References:

1. IbrahimZeid,"CAD/CAM TheoryandPractice", TataMcGrawHillPublication,
2. Mikell P. Grover "Automation, Production Systems and Computer-Integrated Manufacturing", Pearson Education, New Delhi.
3. P. Radhakrishnan & S. Subramanyan "CAD/CAM/CIM" Willey Eastern Limited New Delhi.
4. Onwubiko, C., "Foundation of Computer Aided Design", West Publishing Company. 1989
5. R.W.Heine, C. R.Loper and P.C.Rosenthal, *Principles of Metal Casting*, McGraw Hill, Newyork, 1976.
6. J. H.Dubois And W. I.Pribble, *Plastics Mold Engineering Handbook*, Van NostrandReihnhold, New York, 1987.
7. N. K. Mehta, Machine tool design, Tata Mcgraw-hill, New Delhi, 1989.
8. Geoffrey Boothroyd, Peter Dewhurst and Winston Knight, Product Design for Manufacturing and Assembly, 2nd Edition
9. C. Howard, *Modern Welding Technology*, Prentice Hall, 1979.
10. Grieves, Michael, Product Lifecycle Management, McGraw-Hill, 2006. ISBN 0071452303
11. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realization, SpringerVerlag, 2004. ISBN 1852338105

Automobile Tribology

BTAPE504B	Automobile Tribology	PEC 2	3L-0T-0P	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	Analyze the solid surfaces and their interactions
CO2	Apply lubrication, friction and wear theories in practice.
CO3	Compare liquid and gas lubrication.
CO4	Select appropriate surface treatment to reduce the friction.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit -I:

Introduction to tribology:

Friction, wear and lubrication principles of tribology, thick film lubrication, and boundary layer lubrication.

Unit -II:

Friction and wear:

Laws of friction, causes of friction, types of wear and mechanisms of wear, wear properties of friction and anti-friction metallic and non-metallic materials.

Unit -III:

Lubricants:

Solid lubricants, liquid lubricants, properties of lubricants, selection for general applications and special applications such as low temperature, high temperature, extreme pressure, corrosion resistance.

Unit -IV:

Hydrodynamic lubrication:

Basic concepts, Reynolds equation, plane bearings, Design of journal bearings- short and

finite bearings, design of bearings with steady load, varying load and varying speed.

Unit -V:

Lubrication of automobile systems:

Engine lubricating systems, lubrication of piston, piston rings and cylinder liners, lubrication of cam and followers, lubrication of involutes gears, hypoid gears and worm gears, friction aspects of clutch, brakes and belt drive.

Pneumatic tyres:

Creep and slip of an automobile tyre, functions of tyre, design features of the tyre surface, mechanism of rolling and sliding, tyre performance on wet road surface.

References

1. B. P. Pundir, “Engine Emissions”, Narosa Publications.
2. E. F. Oberts, “Internal Combustion Engine and Air Pollution”, Harper & Row Publisher, NY.
3. J.G. Giles, “Vehicle Operation & Testing” (Automotive Vehicle Technology Vol. 7)
4. C.H. Fisher, “Carburetion”, Vol. 4.
5. A.W. Judge, “Carburetion and Fuel Injection System”, Motor Manual, Vol. 2, The Caxton Pub. Co. Ltd., London.
6. H. H. Willard and Others, “Instrumental Method of Analysis”, CBS Publishers &Distributors, Delhi.

Special Purpose Vehicles

BTAPE504C	Special Purpose Vehicles	PEC 2	3L-0T-0P	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 the different type of special purpose vehicles with its applications.
CO2	Suggest various types of features for given special purpose vehicle.
CO3	Explain the constructional and working features of various special purpose vehicles.
CO4	Apply the fundamental concepts of automotive engineering related to design of special purpose vehicles.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit-I:
Classification and Requirements of Special Purpose Vehicles
Introduction, pre-test, history and overview of an off-road machines, construction layout, capacity and applications, power plants, chassis and transmission, multi-axle vehicles.

Unit-II:
Earth Moving Machines and Tractors
Different types of earth moving equipment's and their applications, Bulldozers, cable and hydraulic dozers, Crawler track, running and steering gears, scrapers, drag and self-powered types - Dump trucks and dumpers - Loaders, single bucket, multi bucket and rotary types - Power and capacity of earth moving machines.
Tractors: General description, Power take off, special implements, specification and functions, light, medium and heavy wheeled tractors, crawler tracks mounted / wheeled-bull dozers, tilt dozers and angle dozers, front end loaders, factors affecting efficiency of output of tractors, simple problems, merits and demerits.

Unit-III:

Scrappers, Graders, Shovels and Ditchers
Scrappers, elevating graders, motor graders, self-powered scrappers and graders, power shovel, revolving and stripper shovels, drag lines, ditchers, capacity of shovels.

Unit IV:
Cranes and Derricks
Types of Cranes Generally used in the Workplace, Components of cranes, Crane and Derricks configuration, Stability against overturning, Analysis of Eight Hazards, Crane safety programs

Unit-V:
Vehicle Systems and Features
Brake system and actuation – OCDB and dry disc calliper brakes. Body hoist and bucket operational hydraulics, Hydro-pneumatic suspension cylinders, Power steering system, Kinematics for loader and bulldozer operational linkages. Safety features, safe warning system for dumper. Design aspects on dumper body, loader bucket and water tank of sprinkler.
Vehicle Evaluation Mobility
Soil-Vehicle Mechanics, characteristics of soils, nominal ground pressure, mean maximum pressure, the mobility index (mi), vehicle cone index (vci) and rated cone index (rci), mobility number, dynamic behavior and traction on wet soil, traction performance and factors affecting traction performance.

Reference Books:
1. "Construction Equipment and its Management", Sharma, S.C.
2. "Farm Machines and Equipment's", Nakra C.P., Dhanpatrai Publishing company Pvt. Ltd. 2003.
3. "Theory of Ground Vehicles", Wong J Y, John Wiley and Sons, New York, 1978.
4. "Construction Planning and Equipment", Satyanarayana B., Standard publishers and distributors, New Delhi.

Automobile Engineering

BTAPE504D	PEC2	Automobile Engineering	3-0-0	

Teaching Scheme	Examination Scheme
Lecture: 3 Hrs/week	Continuous Assessment: 20 Marks Mid semester examination: 20 Marks End Semester Exam: 60 Marks (3 hrs duration)

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, brakesetc.,
CO3	Demonstrate various types of drive systems; front and rear wheel drive, Two / four wheel drive
CO4	Apply vehicle trouble shooting and maintenance procedures.
CO5	Analyze the environmental implications of automobile emissions. And suggest suitable regulatory modifications.

Mapping of course outcomes with program outcomes

CourseOutcomesC	Program Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
O1	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:

Unit1: 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.

Unit2: 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.

Unit3: 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.

Unit4: 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.

Unit5: 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.

Vehicle Testing and Maintenance
Need of vehicle testing, Vehicle test 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.

Open Elective I
Solar Energy

BTMOE505A	Solar Energy	OEC 1	3L-0T-0P	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	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											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	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.
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.

Renewable Energy Sources

BTMOE505B	Renewable Energy Sources	OEC 1	3L-0T-0P	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											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	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:

Unit1: Introduction

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

Unit2: Solar Radiations

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

Unit3: 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, Helio stat concentrator, Selection of various materials used in concentrating systems, tracking.

Unit4: Solar Energy Applications

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

Unit5: 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.
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. ChetansinghSolanki, "RenewableEnergyTechnologies",PrenticeHallofIndia, 2008.

References:

1. S. P. Sukhatme, "SolarEnergy:PrinciplesofThermalCollectionandStorage", Tata

McGrawHill Publications,NewDelhi,1992.
2. G. D.Rai, “SolarEnergyUtilization”,KhannaPublisher,Delhi,1992.

Human Resource Management

BTMOE505C	Human Resource Management	OEC 1	3L-0T-0P	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	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											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	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:

Unit1: IntroductiontoHumanResourceManagement
Conceptofmanagement,conceptofhumanresourcemanagement,personneltohuman resourcemanagement,humanresourcemanagementmodel, importantenvironmental influenceslikegovernmentregulations,policies,laborlawsandotherlegislation.Acquisitionof humanresources:Humanresourceplanning,Demandformanpower,Weaknessesofmanpowerplan ning, jobanalysis,jobspecification,recruitmentsources,recruitmentadvertising, theselection process,selectiondevices,equalopportunities:Indianandforeignpractices,socializing thenewemployee

Unit2: DevelopmentofHumanResources
EmployeeTrainingandManagementDevelopment: Training,TrainingandLearning, Identificationoftrainingneeds,trainingmethods,ManagerDevelopment,Methodsfor developingmanagers,evaluatingtrainingeffectiveness
CareerDevelopment: Conceptof career, value of effectivecareerdevelopment, externalversusinternaldimensions toacareer,careerstages,linkingcareerdimensions withstages

Unit3: Motivationof Human Resources
Definitionof motivation, Nature and CharacteristicsofMotivation,Theoriesof motivation:Maslow'sNeedHierarchy Theory,Drucker Theory,LikertTheory, Herzberg TwoFactorTheory, McClellandTheory,McGregor Theory XandY,etc., Psychologicalapproach.
JobDesignandWorkScheduling:
Design,SchedulingandExpectancyTheory,Jobcharacteristicsmodel,jobenrichment, jobrotation,workmodules,flex-time,newtrendsinworkscheduling.

Unit4: PerformanceAppraisal
Performanceappraisalandexpectancytheory;appraisalprocess,appraisalmethods, factorsthat candestroyappraisal.
RewardingtheProductiveEmployee: Rewards and expectancy theory, types of rewards, qualities of effective rewards, criterionsfor rewards.

Unit5: Maintenanceof HumanResources
CompensationAdministration:ConceptofCompensation Administration,Job evaluation,Paystructures,Incentivescompensationplans.
BenefitsandServicesBenefits: Somethingforeverybody,Services,Trendsinbenefits andservices.
Discipline: ConceptofDiscipline,typesofdisciplineproblems,generalguidelines, disciplinaryaction,employment-at-willdoctrine,discipliningspecial employeegroups
SafetyandHealth: safetyprograms,healthprograms,stress,turn out.
LaborRelations
Unions,Majorlaborlegislation,goalsof grouprepresentation.
CollectiveBargaining:
Objectives,scope,participantsofcollectivebargaining,processofcollectivebargaining, trendsin collectivebargaining
Researchandthefuture:Whatisresearch?Typesofresearch,whyresearchinhumanresourcemanagement,Secondarysources:wheretolookitup,Primarysources:relevantresearchmethods, currenttrendsandimplicationsforhumanresourcemanagement.

Texts:

1. David A. DeCenzo,StephenP. Robbins, "Personnel/HumanResources Management",Prentice Hallof IndiaPvt. Ltd,3rd edition,2002.
2. TrevorBolton, "AnIntroductiontoHuman Resource Management", InfinityBooks, 2001.

References:

1. EllenE.Kossek, "HumanResourceManagement TransformingtheWorkplace",InfinityBooks,2001.
2. G.S.Batra, R.C.Dangwal, "HumanResourceManagementNewStrategies", DeepandDeepPublicationsPvt.Ltd.,2001.
3. D.M.Silvera, "HRD: TheIndianExperience",NewIndiaPublications,2nd edition,1990.

Product Design Engineering

BTMOE505D	OEC1	Product Design Engineering – I	3-0-0	3 Credits

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

- **Pre-requisites:** Knowledge of Basic Sciences, Mathematics and Engineering Drawing

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

1. Understand the need for product design
2. Apply various methods of idea generation
3. Understand various types of prototypes and testing methods
4. Understand the product economics at production scale
5. Appreciate the environmental concerns in product lifecycle

Course Contents:

Unit 1: Introduction to Engineering Product Design [07 Hours]

Trigger for Product/Process/System, Problem solving approach for Product Design, Disassembling existing product(s) and understanding relationship of components with each other, identifying materials and their processing for final product, fitting of components, understanding manufacturing as scale of the components, Reverse engineering concept,

Unit 2: Ideation & Conceptualization [07 Hours]

Generation of ideas, funneling of ideas, Short-listing of ideas for product(s) as an individual or group of individuals, Market research for need, competitions, Product architecture, Designing of components, Drawing of parts and synthesis of a product from its component parts, 3-D visualization,

Unit 3: Testing and Evaluation Prototyping:

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

Unit 4: Manufacturing [07 Hours]

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 5: Environmental Concerns [07 Hours]

Product life-cycle management, Recycling and reuse of products, Disposal of product and waste. Case studies.

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.

Applied Thermodynamics

BTMC506	PCC11	Applied 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 calorific value of fuel, stoichiometric air-fuel ratio, excess air, equivalent evaporation, boiler efficiency, etc. Calculate minimum air required for combustion of fuel.
CO2	Studied and Analyze gas power cycles and vapour power cycles and derive expressions for the performance parameters like thermal efficiency.
CO3	Classify various types of boiler, nozzle, steam turbine and condenser used in steam power plant.
CO4	Classify various typescondenser, nozzle and derived equations for its efficiency.
CO5	Draw P-v diagram for single-stage reciprocating air compressor, with and without clearance volume,and evaluate itsperformance. 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									
CO5		2										

Course Contents:

Unit 1: Fuels and Combustion **[07 Hours]**

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 **[07 Hours]**

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, Steam Nozzles **[07 Hours]**

Ideal Rankine cycle, Reheat and Regeneration, Stirling cycle, Joule-Brayton cycle. Calculation of thermal efficiency, specific steam/fuel consumption, work ratio for above cycles.

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 4: Condensers, Cooling Towers and Steam Turbines **[07 Hours]**

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

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

Unit 5: Reciprocating Air Compressor **[07 Hours]**

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, 2nd edition.
4. Sharma and Mathur, “Internal Combustion Engines”, Tata McGraw Hill Publications.

Automobile Engineering Lab III

BTACL506	Automobile Engineering Lab III	PCC 11	0L-0T-6P	3 Credits

Teaching Scheme:	Examination Scheme:
Lecture: 6hrs/week	Continuous Assessment: 60 Marks Mid Semester Exam: -- End Semester Exam: 40 Marks

Machine Design Practice
Listof Practicals/Experiments/Assignments(TWO)

1. Thetermworkshallconsistoftwodesignprojectsbasedonthesyllabusof Machine Design I. Each designproject shallconsist oftwoimperial sizesheets- one involvingassemblydrawingswithapartlistandoveralldimensions andothersheet involvingdrawingsof individualcomponents.Manufacturingtolerances,surfacefinish symbolsandgeometrictolerancesshouldbespecified,wherevernecessary,soastomake itworkingdrawing
2. A designreportgivingallnecessary calculationsforthe designof componentsandassemblyshould be submittedinaseparatefile.

(Manufacturing Processes Lab)ANY FOUR
List of Practicals/ Experiments/ Assignments

Each student shall be required to submit any four 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

Automotive Chassis and Suspension Lab
ListofPractical's/Experiments/Assignments

1. Demonstration of front wheel steering geometry
2. Demonstration of steering system layout
3. Experiment on Ackerman steering geometry
4. Demonstration of power steering
5. Demonstration of hydraulic brake and air brake systems
6. Demonstration of conventional & independent suspensions
7. Demonstration of suspension dampers

8. Demonstration of wheel and tyre assembly
9. Demonstration of garage, garage equipment's & tools, preparation of different garage layouts.
10. Demonstration of washing & greasing of vehicle.

ListofPractical's/Experiments/Assignments (Any 2 Experiment)

1. Engine oil change & periodic maintenance of vehicle.
2. Dismantling & assembly of Clutch (light / heavy duty vehicle).
3. Dismantling & assembly of Constant mesh gearbox and synchromesh gearbox.
4. Dismantling & assembly of Drive line (universal joint, propeller shaft, slip joint).
5. Dismantling & assembly Final drive & differential.
6. Rear axle hub greasing.
7. Dismantling & assembly of automatic transmission.
8. Dismantling & assembly of fluid flywheel & torque converter.

IT – 2 Evaluation

BTAI408 (IT – 2)	IT – 2 Evaluation	PROJ-2	0L-0T-0P	1 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: --	Continuous Assessment: -- Mid Semester Exam: -- End Semester Exam: 100 Marks

SEMESTER VI
Automobile Air Conditioning, Electricals and Electronics

BTAC601	Automobile Air Conditioning, Electricals and Electronics	PCC12	3L-1T-0P	4 Credits

Teaching Scheme:	**Examination Scheme:**
	Continuous Assessment: 20 Marks

Lecture: 3 hrs/week 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	Apply design concept to develop refrigeration system for refrigerated vehicle.
CO2	Explain psychometric concepts in design of air-conditioning in vehicle.
CO3	Explain effects of various operating parameters on performance of A/C System.
CO4	Explain troubleshooting methods and maintenance of automotive air conditioning system.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit-I:

Introduction to air conditioning and vapour compression system, cycle diagram (Carnot cycle, Reverse Carnot cycle, Simple vapor compression cycle, bell Coleman cycle), effects of various operating parameters on performance of A/C System, Vapour absorption refrigeration system (No numerical), Applications of air conditioning.

Refrigerants and Air Conditioning Components Environmental concerns/Legislation for automotive A/C systems, types and properties of refrigerants, refrigerant oils, refrigerant piping, Future refrigerants.

Automobile Air conditioning components: Compressors, Condensers, flow control devices, evaporators – Design guidelines, types, sizing and their installation. Accumulators, receiver driers and desiccants. Refrigerant charge capacity determination.

Unit-II:

Psychrometry, Psychometric properties, tables, charts, Psychometric processes, Processes, Combinations and Calculations, ADP, Coil Condition line, Sensible heat factor, Bypass factor,

Load analysis Outside and inside design consideration, Factors forming the load on refrigeration and air conditioning systems, Load calculations for automobiles, Effect of air conditioning load on engine performance, Air conditioning electrical and electronic control, pressure switching devices, sensors and actuators.

Air distribution system Comfort conditions, Air management and heater systems, air distribution modes (Fresh/Recirculation, Face, Foot, Defrost, and Demist), A/C ducts and air filters, Blower fans, Temperature control systems (manual/semiautomatic, automatic). Vehicle operation modes and Cool-down performance.

Unit III: Introduction to automotive electrical systems

Automotive electricity generation, storage & distribution systems, wiring harness, circuit

diagrams and symbols, 12/24/42 voltsystem, positive earth and negative earth, earth return and insulated return systems, Multiplexed wiring systems,Electromagnetic compatibility & interference, Introduction of Controlled Area Networks (CAN) protocols.

Battery:

Principle of lead acid battery, Types, Constructional details, Recharging the battery, Battery ratings, Battery Performance,Battery capacities, Battery efficiency, Battery tests, Battery failures, Alkaline battery, maintenance free batteries, hybrid batteries.

Unit IV:Charging,Starting & Ignition System

Magnetos Constant current & voltage systems, Current & voltage regulator, Semiconductor type regulator, Alternator withregulator, starting system with layout, selection of motor, matching battery, Drive mechanisms, Ignition coil, Distributor, Camangle& Contact angle gap, Advance mechanisms, Ballast Resistance, Limitations of coil ignition, Transistorized Ignitionsystems, Spark plugs, types, construction.

Automotive Accessories & Lighting Systems

Vehicle lighting System: Head, Indicator, Fog lamps, Brake lights, Gas discharge, LED lighting, Dash board Indicators: Fuelgauge, oil pressure gauge, Temperature gauges, Speedometer, Warning Lights, Electric horn, Horn relay, Wind shield wipers, and Power window.

Unit V:Automotive Sensors & Actuators

Working principle of sensors, Types of sensors, Airflow rate sensor, angular position sensor, Throttle angle sensor,Temperature sensor, MAP sensors, sensors feedback control, Principle of actuator, Types of actuators, engine controlactuators, Solenoid actuators, motorized actuators.

Engine Management Control System (EMS)

Layout and working (open loop and closed loop control), ECU and microcontroller, group and sequential injection techniques, fuel system components, cold and warm start system, idle speed control, acceleration / deceleration and full load enrichment and fuel cut-off, fuel control MAPs. Electronic Ignition system and spark timing control.

Vehicle Management System

ABS system with layout and working, Electronic control of suspension – Damping control, Electric power steering, Supplementary Restraint System of air bag system, crash sensor, seat belts, Cruise control, Vehicle security systems alarms, vehicle tracking system, Collision avoidance, Radar warning system, Introduction to Global Positioning Systems.

Text Book:

1. Textbook of “Refrigeration and Air Conditioning” By R. S. Khurmi and J.K.Gupta S. Chand Publication.
2. Steven Daly: “Automotive air conditioning and Climate control systems” Butterworth-Heinemann publications.
3. P. L. Kohli, “Automotive Electrical Equipments”, Tata McGraw Hill Pub. Co. Ltd.
4. Tom Denton, “Automobile Electrical & Electronic Systems”, SAE International.

References:

1. “Principles of Refrigeration”; Roy J Dossat, Pearson Education Inc.
2. “Automotive air conditioning” William H Crouse and Donald L Anglin.
3. “Refrigeration and Air Conditioning”, Arora and Damkondwar, Dhanpatrai and Company.

4. "Refrigeration and Air Conditioning", C.P.Arora, Tata McGraw Hills Pub.
5. Steven Daly, "Automotive air conditioning and Climate control systems", Elsevier Ltd, 2011.
6. Boyce H Dwiggins, "Automotive Heating and Air Conditioning", Delmar Thomson Learning Ltd, 2001.
7. Bechfold SAE 1998, "Understanding Automotive Electronics".
8. V. A. W. Hilliers, "Fundamentals of Automotive Electronics", Hatchin, London
9. Tomwather J. R., Cland Hunter, "Automotive Computer & Control System", Prentice Inc. NJ
10. Robert N. Brandy, "Automotive Computers & Digital Instrumentation", Prentice Hall Eaglewood, Cliffs, NJ
11. Young, Griffithe, "Automobile Electrical & Electronic Equipment's", The English Language Book Co., London.

Vehicle Dynamics, Emission and Control

BTAC602	Vehicle Dynamics, Emission and Control	PCC 13	3L-1T-0P	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	Appreciate significance of vehicle dynamics for a typical road vehicle.
CO2	Calculate dynamic longitudinal and transverse axle load transfer for a vehicle in motion.
CO3	Determine the acceleration and braking performance of a vehicle when provided with specifications.
CO4	Evaluate handling characteristics of a vehicle for given set of data.
CO5	Apply ride concepts while designing a suspension system for a vehicle.
CO6	Evaluate the tire performance.

Mapping of course outcomes with program outcomes

course Outcomes	Program Outcomes											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	2	1	1	1	1		1					
CO2	2	2	2		1							
CO3	1	2	2		1							
CO4	2	2	2	1		1	1					
CO5	1	2	2		1							

Course Contents:

Unit I: Performance Characteristics of Road Vehicles

Steady State Operation: Various external forces acting on vehicle,Nature of the forces and factors affecting the forces, Tractive effort &Power available from the engine, Equation of motion, Maximum tractiveeffort, Weight distribution, Stability of vehicle on slope, Roadperformance curves, Acceleration, Gradibility& Drawbar Pull.

Transient Operation: Inertia effect, Equivalent mass, Equivalentmoment of inertia, Equivalent ungeared system, Time to producesynchronizing during gear change, Effect of engine flywheel onacceleration, Dynamics of vehicles on Banked tracks, Gyroscopic Effects,Net driving power.

Unit II:

Handling Characteristics

Low speed cornering, High speed cornering, Cornering equations, Understeer gradient, Static margin, Suspension effects on cornering, Experimental measurements of understeer gradient

Ride Characteristics

Ride dynamic system, Excitation sources, Vehicle suspension properties, Suspension isolation, Suspension stiffness, Suspension damping, Suspension non linearities, Active control, Wheel hop resonances, Rigid body bounce/pitch motions, bounce/pitch frequencies, Olley criterion, dynamic index.

Unit III:

Concept of Vibration

Definitions, Modelling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Undamped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification factor, Transmissibility, Vibration absorber, Vibration measuring instruments.

Unit-IV:

Introduction

Historical background, Pollutants-sources-formation-effects-transient operational effects on pollution. Historical background, Regulatory test procedures.

SI engine Combustion and Pollutant Formation Chemistry of SI engine Combustion, HC and CO formation in 4 stroke and 2 stroke SI engines, NO formation in SI Engines, Effect of operating variables on emission formation.

CI engine Combustion and Emissions Basic of diesel combustion-Smoke emission in diesel engines-Particulate emission in diesel engines, Colour and aldehyde emissions from diesel engines, Effect of operating variables on emission formation.

Unit-V:

Control Techniques for SI and CI

Design changes, optimization of operating factors, exhaust gas re-circulation, fumigation, air injector PCV system-Exhaust treatment in SI engines-Thermal Reactors-Catalytic converters, Catalysts, Use of unleaded petrol.

Emission Measurement, Test procedures & regulations

Test cycles for light & medium duty vehicles, test procedure for evaporative emissions, Emission standards for light and heavy duty vehicles & motor cycle emission standard. NDIR analyzers, FID, Chemiluminescence, NOx analyzer, oxygen analyzer, smoke measurement, constant volume sampling, and particulate emission measurement

Text Books

1. Gillespie T. D. (1992), Fundamentals of Vehicle Dynamics, SAE International.
2. Wong J. Y. (1979), Theory of Ground Vehicles, Willey & Sons.
3. Springer and Patterson, Engine Emission, Plenum Press, 1990.
4. Ganesan V., “Internal Combustion Engines”, Tata McGraw Hill Co., 1994.

Reference Books

1. Pacejka H. B. (2012), Tyre and Vehicle Dynamics, Butterworth Hienmann
2. N. K. Giri (2004), Automotive Mechanics, Khanna Publishers, 9th Edition.
3. G. Genta (1997), Motor Vehicle Dynamics, World Scientific.
4. Rajamani Rajesh (2011), Vehicle Dynamics and Control, Springer.
5. SAE Transactions, Vehicle emission, 1982 (3 vol).
6. Obert. E. F., “Internal Combustion Engines”, 1982.
7. Taylor C.F., “Internal Combustion Engines”, MIT Press, 1972.
8. Heywood. J.B., “Internal Combustion Engine Fundamentals”, McGraw Hill Book Co., 1995.
9. Automobiles and Pollution SAE Transaction, 1995.
10. B. P. Pundir, Engine Emissions, Narosa Publications.
11. E. F. Oberts, “Internal Combustion Engine and Air Pollution”, Harper & Row Publisher, NY

ELECTIVE III
Vehicle Architecture and Packaging

BTAPE603A	Vehicle Architecture and Packaging	PEC 3	3L-0T-0P	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	
CO2	
CO3	
CO4	

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit I:
Introduction
Brief introduction to CAM – Manufacturing Planning, Manufacturing control- Introduction to CAD/CAM – Concurrent Engineering-CIM concepts – Computerized elements of CIM system –Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance– Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In-Time Production.

Unit II:
Planning and Control and Computerized Process Planning
Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control-Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) - Simple Problems

Unit III
Cellular Manufacturing
Group Technology(GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method – Simple Problems.

Unit IV
Guided Vehicle System (Agvs)
Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planningand Control– Quantitative analysis in FMS Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application Vehicle Guidance technology – Vehicle Management & Safety.

Unit V
Industrial Robotics
Robot Anatomy and Related Attributes – Classification of Robots- Robot Control systems – End Effectors – Sensors in Robotics – Robot Accuracy and Repeatability - Industrial Robot Applications – Robot Part Programming – Robot Accuracy and Repeatability – Simple Problems.

Text Books:
1. Mikell.P.Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 2008.
2. Radhakrishnan P, SubramanyanS.andRaju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.

References:
1. Kant Vajpayee S, "Principles of Computer Integrated Manufacturing", Prentice Hall India,2003.
2. Gideon Halevi and Roland Weill, "Principles of Process Planning – A Logical Approach" Chapman & Hall, London, 1995.
3. Rao. P, N Tiwari&T.K. Kundra, "Computer Aided Manufacturing", Tata McGraw Hill, Publishing Company, 2000.

Computer Simulation of IC Engines Processes

BTAPE603B	Computer Simulation of IC Engines Processes	PEC 3	3L-0T-0P	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	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

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

Course Contents:

UNIT-I:

Computer Simulation and Thermodynamics of Combustion

Introduction, Heat of Reaction, Complete Combustion In C/H/O/N Systems, Constant Volume Adiabatic Combustion, Constant Pressure Adiabatic Combustion. Calculation of Adiabatic Flame Temperature.

UNIT-II:

SI Engine Simulation with Fuel-Air as Working Medium

DeviationBetween Actual and Air Standard Cycles of Operation- Problems, SI Engine Simulation with Adiabatic Constant Volume Combustion with Fuel and Air Being Considered, Calculation of Temperature Drop Due to Fuel Vaporization, Calculation of Mean Effective Pressure, Torque and Thermal Efficiency at Full Throttle, Part Throttle and Supercharged Conditions

UNIT-III:

Actual Cycle Simulation in SI Engines

Progressive Combustion; GasExchange Process, Heat Transfer Process, Friction. Procedure of Validating Computer Code with Experimental Data Based on Performance Parameters and Pressure Crank Angle Diagram.

UNIT-IV:

Simulation of 2-Stroke SI Engine Simulation of the Process,Determination of the Pressure-Crank Angle Variation, Computation of Performance Parameters

UNIT-V:

Diesel Engine Simulation

Main Difference between SI and CI EngineSimulation, Differences Between Ideal and Actual Cycles, Mathematical Combustion Model for Diesel Engine, Heat Transfer and Gas Exchange Processes

REFERENCES:

1. Ganesan, V., "Computer Simulation of Spark Ignition EngineProcess", Universities Press (I) Ltd, Hyderabad, 1996.
2. Ganesan. V., "Computer Simulation of Compression IgnitionEngine Process", Universities Press (I) Ltd, Hyderabad, 2000.
3. AshleyCapbel, "Thermodynamic Analysis of Combustion Engine", John Wiley and Sons, New York - 1986.
4. Benson.R.S., Whitehouse. N.D., "Internal Combustion Engines",Pergamon Press, oxford, 1979.
5. Ramoss.A.L., "Modelling of Internal CombusionEngines Processes", McGraw-Hill Publishing Co., 1992.

Automobile Body Design

BTAPE603C	Automobile Body Design	PEC 3	3L-0T-0P	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: (Pre-requisite: Automobile Design)

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												

Course Contents:

Domain Related Training (Approx. 40 hrs)

Unit 1:

BIW : Requirement Specification in the Pre-Program Stage, Product Life Cycle & Important Gateways for BIW, Identification of Commodities for BIW, Design Concept & Considerations in BIW, BIW Materials & Grades, GD & T for BIW.

Unit 2:

Sheet Metal Joining – Welds, Adhesives, TWBs. DFMEA, Design Verification – CAE Methods & Gateway supports Part A & B, CAE Analysis – NVH, Crash & Durability, Test Validation & Assessment.

Unit 3:

Manufacturing – Sequence, Welding & Assembly, Future Trends in BIW, BIW: Examples & Case Studies.

Unit 4:

Trims: Requirement Specification in the Pre-Program Stage, Product Life Cycle & Important Gateways for Trims, Identification of Commodities for Trims, Design Requirements & Considerations, Trim Materials in Automotive.

Unit 5:

Design of Plastic Part, DFMEA, Design Verification – CAE Methods & Gateway supports, CAE Analysis – Moldflow, Crash & Durability, Test Validation & Assessment.

Manufacturing Process, Assembly Sequence, Future Trends & Future Material for Trims, Trims: Examples & Case Studies.

Texts:

1. Notes of TATA Technologies
2. Curt Larson, " Datum Principles: Flexible Parts: Applications for Automotive Body-in-White and Interior Trim (Dimensional Management Series Book 1)", Right Tech, Inc., Kindle Edition.
3. Curt Larson, " Datum Principles: Flexible Parts: Applications for Automotive Body-in-White and Interior Trim (Dimensional Management Series Book 2)", Right Tech, Inc., Kindle Edition.

References:

1. Vukato Boljanovic, "Sheet Metal Forming Processes and Die Design", Industrial press Inc., Kindle Edition.
2. R. D. Cook, Concepts and Applications of Finite Element Analysis; John Wiley and Sons, second edition, 1981.
3. K.J. Bathe, Finite Element Method and Procedures; Prentice hall, 1996.
4. IbrahimZeid,"CAD/CAM Theory and Practice", Tata McGraw Hill Publication,
5. J. H.Dubois And W. I.Pribble, *Plastics Mold Engineering Handbook*, Van NostrandReihnhold, New York, 1987.
6. Geoffrey Boothroyd, Peter Dewhurst and Winston Knight, Product Design for Manufacturing and Assembly, 2nd Edition
7. C. Howard, *Modern Welding Technology*, Prentice Hall, 1979.
8. Jesper Christensen and Christophe Bastien, "Nonlinear Optimization of Vehicle Safety Structures: Modeling of Structures Subjected to Large Deformations, Butterworth-Heinemann, Kindle Edition
9. Grieves, Michael, Product Lifecycle Management, McGraw-Hill, 2006. ISBN 0071452303
10. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realization, SpringerVerlag, 2004. ISBN 1852338105

Vehicle Aerodynamics

BTAPE603D	Vehicle Aerodynamics	PEC 3	3L-0T-0P	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	Apply basic principles of aerodynamics for the design of vehicle body.
CO2	Calculate lift and drag of automotive models
CO3	Describe the physics of fluid flow over vehicle body and its optimization techniques.
CO4	Use wind tunnels for testing the vehicles.
CO5	Suggest noise measurement and control techniques of a vehicle.

Mapping of course outcomes with program outcomes

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

Course Contents:

UNIT- I: Introduction
Scope, historical developments, fundamental of fluid mechanics, flow phenomenon related to vehicles, external and internal flow problem, resistance to vehicle motion, performance, fuel consumption and performance potential of vehicle aerodynamics.

UNIT -II: Aerodynamic Drag of Cars
Cars as a bluff body, flow field around car, drag force, types of drag force, analysis of aerodynamic
drag, drag coefficient of cars, strategies for aerodynamic development, low drag profiles.

UNIT-III: Shape Optimization of Cars
Front end modification, front and rear wind shield angle, boat tailing, hatch back, fast back and square back, dust flow patterns at the rear, effects of gap configuration, effect of fasteners. Case studies on modern vehicles.

UNIT- IV: Vehicle Handling
The origin of forces and moments on a vehicle, lateral stability problems, methods to calculate forces
and moments – vehicle dynamics under side winds, the effects of forces and moments, characteristics
of forces and moments, dirt accumulation on the vehicle, wind noise, drag reduction in commercial
vehicles and racing cars.

UNIT -V: Wind Tunnels for Automotive Aerodynamics
Introduction, principle of wind tunnel technology, limitation of simulation, stress with scale models, full scale wind tunnels, measurement techniques
Wind
Wind noise, measurement techniques, Control techniques. Road testing methods, numerical methods.

Text Books:

1. Hucho W.H., "Aerodynamic of Road Vehicles", Butterworths Co., Ltd., 1997

References:

1. Pope, "Wind Tunnel Testing", 2nd Edition, John Wiley & Sons New York, 1974.
2. "Automotive Aerodynamic", Update SP-706, Society of Automotive Engineers Inc, 1987
3. "Vehicle Aerodynamics", SP-1145, Society of Automotive Engineers Inc, 199

E Vehicles

BTAPE603E	E Vehicles	PEC 3	3L-0T-0P	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	
CO2	
CO3	
CO4	
CO5	

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit I:

Introduction to EV:

Past, Present & Feature of EV, Current Major Issues, Recent Development Trends, EV Concept, Key EV Technology, State-of-the Art EVs, Comparison of EV Vs IC Engine.

Unit II:

EV System:

EV Configuration: Fixed & variable gearing, single & multiple motor drive, In-wheel drives

EV Parameters:

Weight, size, force, energy & performance parameters.

Unit III:

EV Propulsion:

Electric Motor:

Choice of electric propulsion system, block diagram of EV propulsion system, concept of EV Motors, single motor and multi-motor configurations, fixed & variable geared transmission, In-wheel motor configuration, classification of EV motors, Electric motors used in current vehicle applications, Recent EV Motors, Comparison of Electirc Motors for EV applications

Required Power Electronics & Control:

Comparison of EV power devices, introduction to power electronics converter, four quadrant DC chopper, three-pase full bridge voltage-fed inverter, soft-switching EV converters, comparison of hard-switching and soft-switching converter, three-phase voltage-fed resonance dc link inverter, Basics of Microcontroller & Control Strategies

Unit IV:

EV Motor Drive:
DC Motor: Type of wound-field DC Motor, Torque speed characteristics
DC-DC Converter, Two quadrant DC Chopper, two quadrant zero voltage transition converter-fed dc motor drive, speed control of DC Motor
Induction Motor Drive: Three Phase Inverter Based Induction Motor Drive, Equal Area PWM, Three Phase Auxiliary resonant snubber (ARS) Inverter Type (ZVC & ZCS), Single Phase ARS Inverter Topology, Speed Control of Induction Motor, FOC, Adaptive Control, Model Reference Adaptive Control (MARS), Sliding mode Control,
Unit V:
Energy Sources & Charging:
Different Batteries and Ultracapacitors, Battery characteristics (Discharging &Charging) Battery Chargers: Conductive (Basic charger circuits, Microprocessor based charger circuit.Arrangement of an off-board conductive charger, Standard power levels of conductive chargers, Inductive (Principle of inductive charging, Soft-switching power converter for inductive charging), Battery indication methods
Charging Infrastructure: Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and-charge zone.

References:

1. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
3. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
4. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Design of Experiments

BTAPE603F	Design of Experiments	PEC 3	3L-0T-0P	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

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

CO1	Define Taguchi, factorial experiments, variability, orthogonal array, quality loss.
CO2	Plan and design the experimental investigations efficiently and effectively.
CO3	Understand strategy in planning and conducting experiments.
CO4	Evaluate variability in the experimental data using ANOVA.
CO5	Practice statistical software to achieve robust design of 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	1	1		1	1	1				1	1	1
CO2	3	2	1	3	2	1			1	2	1	1
CO3	3	2	1	3	2	1			1	2	1	1
CO4	3	3	1	3	2	1			1	2	1	1
CO5	2	3	1	2	3	2			1	2	1	1

Course Contents:

Unit 1: Introduction
Modern quality control, quality in engineering design, history of quality engineering, The Taguchi Approach to quality: Definition of quality, loss function, offline and online quality control, Taguchi`s quality philosophy.

Unit 2: Full Factorial Designs
traditional scientific experiments, two factor design, three factor design, replicating experiments, factoring reactions, normal plots of estimated effects, mechanical plating experiments, four factor design, Taguchi design and western design.

Unit 3: Fractional Factorial Design
Fractional factorial design base done ightrunexperiments, folding over an eight run experimental design, Fractional factorial design in sixteen run, folding over sixteen run experimental design, blocking two level designs, other two level designs, Necessity to use more than two level, factors at three and four levels.

Unit 4: Taguchi Robust Design
Construction of orthogonal array, Additive model for factor effects, Signal to noise ratios, linear graphs, Taguchi Inner and outer arrays: Noise factors, experimental designs for control and noise factors.

Unit 5: Evaluating Variability

Necessity to analyze variability, measures of variability, the normal distribution, Analysis of variance in engineering design, using estimated effects as test statistics, analysis of variance for two level designs

Computer Software for Experimental Design

Role of computer software in experimental design, summery of statistical packages, example of use of software packages.

Texts:

1. M. S. Phadke, "Quality Engineering using Robust Design", Prentice Hall, Englewood Cliffs, NewJersey,1989.
2. R.H. Lochnerand J.E. Matar, "Designing for Quality: An Introduction to the Best of Taguchi and Western Methods of Statistical Experimental Design", Chapmanand Hall, London, 1983.

References:

1. D.C. Montgomery, "Design and Analysis of Experiments", John Wiley and Sons, New York, 5th edition, 2004.
2. Peter Goos, Bradley Jones, "Optimal Design of Experiments: A Case Study Approach", Wiley Publishers, July 2011.
3. Raymond H. Myers, Douglas C. Montgomery, Christine M. Anderson-Cook, "Response Surface Methodology: Process and Product Optimization Using Designed Experiments", 4th Edition, Wiley, January 2016.

Elective IV
Transport Management

BTAPE604A	Transport Management	PEC 4	3L-0T-0P	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 3hrs/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	Describe the motor vehicle act & central motor vehicle rules.
CO2	Illustrate motor vehicle insurance & taxation.
CO3	Analyze the passenger & goods transport operations.
CO4	Identify advanced techniques in traffic management.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit I:
Motor Vehicle Act Short titles & definitions, Laws governing to use of motor vehicle & vehicle transport, Licensing of drivers & conductors, Registration of vehicle, State & interstate permits, Traffic rules, Signals & controls, Accidents, Causes & analysis, Liabilities & preventive measures, Rules & regulations, Responsibility of driver, Public & public authorities, Offences, penalties & procedures, Different types of forms, Government administration structure, Personnel, Authorities & duties, Rules regarding construction of motor vehicles.

Unit II:
Taxation Objectives, Structure & methods of laving taxation, Onetime tax, Tax exemption & tax renewal

Unit III:
Insurance types & significance, Comprehensive, Third party insurance, Furnishing of particulars of vehicles involved in accident, MACT (Motor Accident Claims Tribunal), Solatium Fund, Hit & Run case, Duty of driver in case of accident, Surveyor & Loss Assessor, Surveyors report

Unit IV:
Passenger Transport Operation Structure of passenger transport organizations, Typical depot layouts, Requirements and Problems on fleet management, Fleet maintenance, Planning - Scheduling operation & control, Personal & training-training for drivers & conductors, Public

relations, Propaganda, publicity and passenger amenities, Parcel traffic., Theory of fares-Basic principles of fare charging, Differential rates for different types of services, Depreciation & debt charges, Operation cost and Revenues, Economics & records.

Unit V:
Goods Transport Operation Structure of goods transport organizations, Scheduling of goods transport, Management Information System (MIS) in passenger / goods transport operation, Storage & transportation of petroleum products.
Advance Techniques in Traffic Management Traffic navigation, Global positioning system

References Books:

1. Motor Vehicle Act - Govt. of India Publications.
2. S.K. Shrivastava, "Economics of Transport"
3. "Transport Development in India", S. Chand & Co. Pvt. Ltd., New Delhi.
4. Santosh Sharma, "Productivity in Road Transport", 2nd Edition, Association of State Road Transport Undertakings, New Delhi.
5. P.G.Patankar, "Road Passenger Transport in India", CIRT, Pune

Computational Fluid Dynamics

BTAPE604B	Computational Fluid Dynamics	PEC 4	3L-0T-0P	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	Identify applications of finite volume and finite element methods to solve Navier-Stoke equations.
CO2	Evaluate solution of aerodynamic flows. Appraise & compare current CFD software. Simplify flow problems and solve them exactly.
CO3	Design and setup flow problem properly within CFD context, performing solid modeling using CAD package and producing grids via meshing tool
CO4	Interpret both flow physics and mathematical properties of governing Navier-Stokes equation and define proper boundary conditions for solution.
CO5	Use CFD software to model relevant engineering flow problems. Analyse the CFD results Compare with available data, and discuss the findings

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit-I: Introduction to CFD

CFD – a research and design tool, CFD as third dimension of engineering supplementing theory and experiment, Steps in CFD solution procedure, strengths and weakness of CFD, Flow modeling using control volume - finite and infinitesimal control volumes, Concept of substantial derivative, divergence of velocity, Basic governing equations in integral and differential forms – conservation of mass, momentum and energy (No derivations), Physical interpretation of governing equations, Navier-Stoke's model and Euler's model of equations.

Unit- II: Basic Discretization Techniques

Introduction to grid generation (Types of grids such as structured, unstructured, hybrid, multi-block, Cartesian, body fitted and polyhedral etc.), Need to discretize the domain and governing equations, Finite difference approximation using Taylor series, for first order (Forward Difference Approximation, Backward Difference Approximation, Central difference Approximation) and second order (based on 3 node, 4 node and 5 node points),explicit and Implicit approaches applied to 1D transient conduction equation, Couetteflow equation () using FTCS and Crank Nicholson's Method, Stability Criteria concept and physical interpretation, Thomas Tri-diagonal matrix solver.

Unit-III: Two Dimensional Steady and unsteady heat conduction
Solution of two dimensional steady and unsteady heat conduction equation with Dirichlet, Neumann, Robbins and mixed boundary condition – solution by Explicit and Alternating Direction Implicit method (ADI Method), Approach for irregular boundary for 2D heat conduction problems.

Unit-IV: Application of Numerical Methods to Convection – Diffusion system
Convection: first order wave equation solution with upwind, Lax–Wendroff, Mac Cormack scheme, Stability Criteria concept and physical interpretation **Convection –Diffusion:** 1D and 2D steady Convection Diffusion system – Central difference approach, Peclet Number, stability criteria, upwind difference approach, 1 D transient convection-diffusion system

Unit-V: Incompressible fluid flow
Solution of Navier-Stoke's equation for incompressible flow using SIMPLE algorithms and its variation (SIMPLER), Application to flow through pipe, Introduction to finite volume method.
CFD as Practical approach
Introduction to any CFD tool, steps in pre-processing, geometry creation, mesh generation, selection of physics and material properties, specifying boundary condition, Physical Boundary condition types such as no slip, free slip, rotating wall, symmetry and periodic, wall roughness, initializing and solution control for the solver, Residuals, analyzing the plots of various parameters (Scalar and Vector contours such as streamlines, velocity vector plots and animation). Introduction to turbulence models.Reynolds Averaged Navier-Stokes equations (RANS), k-ϵ, k-. Simple problems like flow inside a 2-D square lid driven cavity flow through the nozzle

Texts/References:

1. "Computational Fluid Dynamics", John D Anderson: The Basics with Applications, McGraw-Hill
2. "Computational Fluid Dynamics", J. Tu, G.-H. Yeoh and C. Liu: A practical approach, Elsevier.
3. "Introduction to Computational Fluid Dynamics", A. W. Date: Cambridge University Press
4. "Computer Simulation of Fluid flow and heat transfer", P.S.Ghoshdastidar: Tata McGraw-Hill.
5. "Numerical Simulation of internal and external flows", Vol. 1, C. Hirsch, Wiley
6. Computational Fluid Mechanics and Heat transfer, Tannehill, Anderson, and Pletcher, CRC Press.

Ergonomics in Automotive Design

BTAPE604C	Ergonomics in Automotive Design	PEC 4	3L-0T-0P	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	Use an anthropometrics and its application to vehicle ergonomics
CO2	Apply design concepts to develop driver seats for commercial vehicle.
CO3	Apply design concepts to develop driver seats for luxury vehicle.
CO4	Explain significance of visibility with blind region concepts.
CO5	Suggest interior design features to enhance comfort level of the vehicle passenger.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit- I:
Introduction to human body, Anthropometrics and its application to vehicle ergonomics.

Unit-II:
Driver comfort – seat types, visibility, man-machine system, Psychological factors – stress, attention, driver seat design, cockpit / driver worth station design.

Unit-III:
Passenger comfort - Ingress and egress, spaciousness, ventilation, temperature control, dust and fume prevention and vibration.

Unit -IV:
Introduction to filed view, types of filed view, forward field of view and evaluation, mirror design issue, methods of measuring field of view, and other visibility issues

Unit-V:
Interior features and conveniences (legroom, gang way, types of seat, head room, visibility, window rattling)—Use of modern technology for the same.
Safety issues, Ergonomic research methods / ergonomic audit

Texts/References:

1. Nikolao sGkikas, *"Automotive ergonomics Driver vehicle interaction"* CRC Press Publication, 2013
2. Mark R Lehto, James R Buck, *"Introduction to human factors and ergonomics for engineers",*Taylor and Francis Group publication, 2008.
3. Vivek D Bhise, *"Ergonomics in automotive design process"*, CRC Press Publications, 2012.
4. B. Peacock,Waldemar Karwowski, *"Automotive Ergonomics",* Taylor & Francis Publication, 1993.
5. David Meister, *"The History of Human Factors and Ergonomics",* Taylor & Francis Publication, 1999.

Tractor and Farm Equipment

BTAPE604D	Tractor and Farm Equipment	PEC 4	3L-0T-0P	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	Apply the fundamental design concepts for design of tractor and farm equipments.
CO2	Describe the important supplementary systems in the tractors.
CO3	Select the different system for particular type of farm application.
CO4	Compare the performance of tractors related to various attachments.
CO5	Describe different engine systems of a farm tractor.

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit-I:
General Design of Tractors:
Classification of tractors, Main components of tractor, Safety rules.

Unit-II:
Fundamentals of Engine Operation:
Tractor controls and the starting of the tractor engines-Basic notations and definition-Engine cycles–Operation of multi-cylinder engines-General engine design–Basic engine performance characteristics.

Unit-III:
Engine Mechanism of Tractor:
Cylinder and pistons, Connecting rods and crankshafts - Engine balancing – Construction and operation of the valve mechanism - Valve mechanism components -Valve mechanism troubles.

Unit-IV:
Cooling System, Lubrication System and Fuel System of a Tractor Engine
Cooling system -Classification -Liquid cooling system -Components, Lubricating system servicing and troubles - Air cleaner and turbo charger - Fuel tanks and filters –Fuel pumps.

Unit-V:

Farm Tractor Transmission System:

Layout, Load distribution, Transmission & Drive line, Steering, Braking system, Wheels & Tyres, Hydraulic system, Auxiliary Systems, Draw bar.

Farm Equipment's:

Working attachments of tractors - Farm equipment - Classification – Auxiliary equipment - Trailers and body tipping mechanism.

Texts/References:

1. E. L. barger, J. B. Liljedahl, W. M. Carleton, E. G. Mckibben "Tractors & their power units".
2. Rodichev and G. Rodicheva, "Tractor and Automobiles ", MIR Publishers, 1987.
3. Kolchin. A., and V. Demidov, "Design of Automotive engines for tractor", MIR Publishers,1972.

Noise and Vibration

BTAPE604E	Noise and Vibration	PEC 4	3L-0T-0P	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 basic concepts related to noise and vibration.
CO2	Formulate mathematical model for multi degree of freedom vibration system.
CO3	Select transducers for measurement of vibration in automotive systems
CO4	Select appropriate transducer for measurement of noise in automotive systems.
CO5	Identify different sources and apply methods for noise and vibration control in automobiles

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit-I:
Multi Degree of Freedom Vibrations:
Matrix formulation, eigen values and eigen formulation, matrix iteration techniques -normal modes and orthgonality, transient response of multi degree freedom system, mode superposition technique, torsional oscillations of multi-rotor systems.

Unit-II:
Torsional vibrations:
Simple systems with one or two rotor masses Multi-DOF systems-transfer matrix method Geared system Branched system

Unit-III:
Vibration Instrumentation:
Vibration measurements – Vibration measurement parameters (displacement, velocity & acceleration), instrumentation –electrodynamics exciters – impact hammers, piezoelectric accelerometers, signal conditioning and amplification, filters, preamplifiers and power amplifiers, real time analysis, FFT analysis, structural frequency response measurement, modal testing of beams, Modal parameter (natural frequency, mode shape and damping)estimation techniques

Unit-IV:
Vibration analysis:
Relevance of vibration analysis, introduction to experimental modal analysis**,** Structural

Modal analysis, mode shapes, Euler's beam equation for natural frequency, Calculation of natural frequencies - Rayleigh method, Stodala method, machine diagnostics through vibration analysis.

Unit-V:
Noise:
Introduction, causes, effects, basic terms, Noise characteristics, Sources of noise, vehicular noise level, engine noise, transmission noise, brake squeal, structural noise, noise in auxiliaries, wind noises, wave equation, noise standards etc.

Unit-VI:
Noise measurement:
Sound and Noise parameters, propagation of sound & noise in various machinery's, noise measuring parameters, noise level measurement techniques, Noise level interpolation andmapping, noise measuring instruments
Noise Control:
Mechanization of noise generation, noise control methodologies, noise control measures, environmental noise management, Road vehicle noise standards, Sound absorption by porous materials, silencer and suppression systems, Sound absorption, sound insulation, acceptance noise levels

Text Books:

1. N. L. Meirovitch, "Elements of vibration Analysis", McGraw Hill New York, 1986.
2. J.P. Den Hartog, "Mechanical Vibration, 4th edition", McGraw Hill, New York 1985.
3. "Industrial Noise & Vibration Control", Irwin &Garf.
4. "Mechanical Vibration", S. S. Rao, New Age International (P) Ltd., New Delhi.
5. "Mechanical Vibration Analysis", P. Srinivasan, Tata McGraw Hill Pub. New Delhi.
6. "Mechanical Vibration", Grover G. K., Nem Chand & Brothers, Roorkee.
7. "Engineering Vibration", Daniel J. Inman, Prentice Hall, NJ.
8. "Theory of Vibrations", W. T. Thomson, CBS Publishers, New Delhi.
9. "Noise, Pollution & Control", S. P. Singal, Narosa Publishing House, New Delhi.
10. "A text book of sound", L.P. Sharma & H.C. Saxena.
11. "Engineering Noise Control", D.A. Bies& C.H. Hausen.
12. "Noise & Vibration Control", Leo N. Beraneck.

Reference Books:

1. Harris, C. M. Handbook of Acoustical Measurements and Noise Control, Acoustical Society of America, 1998.
2. Beranek L. L. &Ver I. L., Noise and Vibration Control Engineering: Principles and Applications, 2nd ed., Wiley 2006
3. Leonard Meirovitch, Fundamentals of Vibrations, McGraw Hill New York.
4. J.S. Rao and K. Gupta, "Advanced Theory of Vibration",Willey Eastern.1992.
5. R.A. Collacott, "Vibration Monitoring and diagnosis", John Willey, New York, 1979.
6. M. Petyt, "Introduction to Finite Element Vibration Analysis", Cambridge University
7. "Fundamentals of Mechanical Vibration", S. Graham Kelly, Tata McGraw Hill.

Product Life Cycle Management

BTMPE604B	Product Life Cycle Management	PEC 4	3L-0T-0P	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	Understand the need and advantages of PLM
CO2	Describe the various PLM strategies
CO3	Describe the various steps in design and development of product
CO4	Understand the technology forecasting
CO5	Describe the importance of innovation in product design and development
CO6	Apply PLM to at least one product

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: Introduction and Strategies to PLM
Need for PLM, opportunities and benefits of PLM, different views of PLM, components of PLM, phases of PLM, PLM feasibility study, PLM visioning, Industrial strategies, strategy elements, its identification, selection and implementation, change management for PLM.

Unit 2: Product Data Management (PDM)
Human resources in product lifecycle, Information, Standards, Vendors of PLM Systems and Components, PDM systems and importance, reason for implementing a PDM system, financial Justification of PDM, barriers to PDM implementation

Unit 3: Product Design
Engineering design, organization and decomposition in product design, product design process, methodical evolution in product design, concurrent engineering, design for 'X' and design central development model. Strategies for recovery at end of life, recycling, human factors in product design. Modeling and simulation in product design.

Unit 4: New Product Development
Structuring new product development, building decision support system, Estimating market opportunities for new product, new product financial control, implementing new product development, market entry decision, launching and tracking new product program, Concept of redesign of product.

Unit 5: Technology Forecasting

Future mapping, invocating rates of technological change, methods of technology forecasting such as relevance trees, morphological methods and mission flow diagram, combining forecast of different technologies, uses in manufacture alternative.

PLM Software and Tools

Product data security. Product structure, workflow, Terminologies in workflow, The Link between Product Data and Product Workflow, PLM applications, PDM applications

Texts/References:

1. Grieves, Michael, "Product Lifecycle Management", Tata McGraw-Hill, 2006, ISBN 007145230330.
2. AnttiSaaksvuori, AnselmiImmonen, "Product Life Cycle Management", Springer, 1st edition, 2003.
3. Stark, John, "Product Lifecycle Management: Paradigm for 21st Century Product Realization", Springer-Verlag, 2004.
4. Fabio Giudice, Guido La Rosa, "Product Design for the environment-A life cycle approach", Taylor & Francis, 2006.
5. Robert J. Thomas, "NPD: Managing and forecasting for strategic processes".

Finite Element Method

BTMPE604C	Finite Element Method	PEC 4	3L-0T-0P	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	Understand the basic principle of Finite element methods and its applications
CO2	Use matrix algebra and mathematical techniques in FEA
CO3	Identify mathematical model for solution of common engineering problem
CO4	Solve structural, thermal problems using FEA
CO5	Derive the element stiffness matrix using different methods by applying basic mechanics laws
CO6	Understand formulation for two and three dimensional problems

Mapping of course outcomes with program outcomes

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

Course Contents

Unit I: Introduction
Finite element analysis and its need; Advantages and limitations of finite element analysis (FEA); FEA procedure.

Unit II: Elements of Elasticity
Stress at a point; Stress equation of equilibrium; 2-D state of stress; Strains and displacements; Stress-strain relationship for 2-D state of stress; Plane stress and plane strain approach.

Unit III:Relevant Matrix Algebra
Addition, subtraction and multiplication of matrices; Differentiation and integration of matrices; Inverse of a matrix; Eigen values and eigen vectors; Positive definite matrix; Gauss elimination.

Unit IV: One-dimensional Problems
Introduction; FE modeling; Bar element; Shape functions; Potential energy approach; Global stiffness matrix; Boundary conditions and their treatments; Examples.

Unit V: Trusses and Frames
Introduction; Plane trusses; Element stiffness matrix; Stress calculations; Plane frames; examples.
Two-dimensional Problems
Introduction and scope of 2-D FEA; FE modelling of 2-D problem; Constant strain triangle; Other finite elements (no mathematical treatment included); Boundary conditions.

Texts:

1. 1.T. R. Chandrupatla, A. D. Belegundu, ― Introduction to Finite Elements in Engineering‖, Prentice Hall of India Pvt. Ltd., 3rd edition, New Delhi, 2004.
2. 2.P. Seshu, ―A Textbook of Finite Element Analysis‖, Prentice Hall of India Pvt. Ltd., New Delhi, 2003.
3. 3.R. D. Cook, D. S. Malkus, M. E. Plesha, R. J. Witt, ―Concepts and Applications of Finite
    1. Element Analysis‖, John Wiley & Sons, Inc.

References:

1. K. J. Bathe, ―Finite Element Procedures‖, Prentice Hall of India Pvt. Ltd., 2006.

Robotics

BTMPE604D	Robotics	PEC 4	3L-0T-0P	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	List the various components of a typical Robot, grippers, sensors, drive system and describe their functions
CO2	Calculate the word to joint and joint to word coordinates using forward and reverse transformations
CO3	Calculate the gripper forces, drive sizes, etc.
CO4	Develop simple robot program for tasks such as pick and place, arc welding, etc. using some robotic language such as VAL-II, AL, AML, RAIL, RPL, VAL
CO5	Evaluate the application of robots in applications such as Material Handling, process operations and Assembly and inspection
CO6	Discuss the implementation issues and social aspects of robotics

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: Introduction
Variousbasic componentsofaRoboticsystem,variousconfigurations,workenvelopes, Manipulators,sensors,controllers,etc.

Unit2: MechanicalSystemin Robotics
Motion conversion,Kinematic chains, position analysis,forwardandbackward transformations,naturalandjointspacecoordinates.

Unit3: DrivesforRobot
Electricaldrives**,**Steppermotor,DCmotors,ACmotors,hydraulicandpneumaticdrives, hybriddrives,driveselectionforroboticsjoints.

Unit4: Sensorsin Robotics
Positionsensor,velocitysensor,proximitysensors,touchsensors,forcesensors,etc.

Unit5: RobotProgramming
Pathplanning,Leadthrough(manualandpowered)programming,teachpendantmode, programminglanguages,AL,AML,RAIL,RPL,VALpmentin robotics
ArtificialIntelligenceforRobots:
KnowledgeRepresentation,Problemrepresentationandproblemsolving,search techniquesinproblemsolving
RobotApplications
Applicationofrobotin:Materialhandling,assemblyandinspection,processoperations, etc.

Texts:

1. M. P. Grover, “Industrial Robotics: Technology, Programming and Applications”, Tata McGraw Hill Publication.

References:

1. Saeed B. Niku, “Introduction to Robotics, Analysis, Systems, Applications”, Pearson Education.
2. Richard D. Klafter, “Robotic Engineering: An Integrated Approach”, Prentice Hall of India.

Open Elective-II

Quantitative Techniques in Project Management

BTMOE605A	Quantitative Techniques in Project Management	OEC 2	3L-1T-0P	4Credits

Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week Tutorial:1 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											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	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.
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.
4. References:
5. H. Taha, “Operations Research–An Introduction”, Maxwell Macmillan, New York.
6. J. K. Sharma, “Operations Research–An Introduction”, Maxwell Macmillan, New Delhi.
7. Harvey M. Wagner, “Principles of Operations Research with Applications to Managerial Decisions”, Prentice Hall of India Pvt. Ltd., New Delhi, 2nd edition, 2005.
8. Rubin and Lewin, “Quantitative Techniques for Managers”, Prentice Hall of India Pvt. Ltd., New Delhi.

Nanotechnology

BTMOE605B	Nanotechnology	OEC 2	3L-1T-0P	4 credits

Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week Tutorial:1 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	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											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	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 NanoStructuring
Influence of Nano structuring on mechanical, optical, electronic, magnetic and chemical properties-gram size effects on strength of metals- optical properties of quantum dots.
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

BTMOE605C	Energy Conservation and Management	OEC 2	3L-1T-0P	4 Credits

Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week Tutorial:1 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	Understand energy problem and need of energy management
CO2	Carry out energy audit of simple units
CO3	Study various financial appraisal methods
CO4	Analyze 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											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
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:

Unit1: Introduction
Generalenergyproblem,Energyusepatternsandscopeofconservation.
EnergyManagementPrinciples:Need,Organizing,Initiatingandmanaginganenergy managementprogram.

Unit2: Energy Auditing Elementsandconcepts,Typesofenergyaudits,Instrumentsusedin energyauditing.
EconomicAnalysis:Cashflows,Timevalueofmoney,Formulaerelatingpresentand futurecashflows-single amount,uniformseries.

Unit3: FinancialAppraisalMethods
Paybackperiod,Netpresentvalue,Benefit-costratio, Internal-rateof return,Lifecyclecosts/benefits.Thermodynamicsofenergyconservation,EnergyconservationinB oilersandfurnaces, EnergyconservationinSteamandcondensatesystem.

Unit4: Cogeneration
Concept,Typesofcogenerationsystems, performanceevaluationofa cogenerationsystem.
WasteHeatRecovery:Potential,benefits,wasteheat recoveryequipment's.
SpaceHeating,VentilationAirConditioning (HVAC)andwaterheatingofbuilding, Transferofheat,Spaceheatingmethods, Ventilationandairconditioning, Heatpumps, Insulation,Cooling load,Electricwaterheatingsystems,Electricenergyconservation methods.

Unit5: Insulation and Heating
IndustrialInsulation:Insulationmaterials,Insulationselection,Economicalthicknessof insulation. IndustrialHeating:Heatingbyindirectresistance,directresistanceheating(saltbath furnace),and Heattreatmentbyinductionheatingintheelectricarcfurnaceindustry.
EnergyConservationinElectricUtilityandIndustry
Energycostsandtwopart tariff,Energyconservationinutilitybyimprovingloadfactor,Loadcurveanalysis, Energy efficientmotors,Energy conservationinilluminationsystems,Importanceof Powerfactorinenergyconservation,Powerfactorimprovement methods,Energy conservationinindustries

Texts:

1. Callaghan,"EnergyConservation".
2. D.L.Reeg,"IndustrialEnergyConservation",PergamonPress.

References:

1. T.L.Boyen,"ThermalEnergyRecovery",WileyEastern.
2. L.J.Nagrath,"SystemModelingandAnalysis",TataMcGrawHill Publications.
3. S.P.Sukhatme,"SolarEnergy",TataMcGrawHill Publications.

Wind Energy

BTMOE605D	Wind Energy	OEC 2	3L-1T-0P	4 Credits

Teaching Scheme:	Examination Scheme:
Lecture: 3 hrs/week Tutorial:1 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	Understand historical applications of wind energy
CO2	Understand and explain wind measurements and wind data
CO3	Determine Wind Turbine Power, Energy and Torque
CO4	Understand and explain Wind Turbine Connected to the Electrical Network AC and DC
CO5	Understand economics of wind energy

Mapping of course outcomes with program outcomes

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

Course Contents:

Unit 1: Introduction
Historical uses of wind, History of wind electric generations

Wind Characteristics: Metrology of wind, World distribution of wind, Atmospheric stability, Wind speed variation with height, Wind speed statistics, Weibull statistics, Weibull parameters, Rayleigh and normal distribution

Unit 2: Wind Measurements
Biological indicators, Rotational anemometers, other anemometers, Wind direction

Unit 3: Wind Turbine Power, Energy and Torque
Power output from an ideal turbine, Aerodynamics, Power output from practical turbines, Transmission and generation efficiency, Energy production and capacity factor, Torque at constant speeds, Drive train oscillations, Turbine shaft power and torque at variable speeds.

Unit 4: Wind Turbine Connected to the Electrical Network
Methods of generating synchronous power, AC circuits, The synchronous generator, Per unit calculations, The induction machine, Motor starting, Capacity credit features of electrical network

Unit 5: Wind Turbines with Asynchronous Electric Generators
Asynchronous systems, DC shunt generator with battery load, Per unit calculation, Self excitation of the induction generators, Single phase operation the induction generator, Field modulated generators, Roesel generator.
Asynchronous Load: Piston water pumps, Centrifugal pumps, Paddle wheel heaters, Batteries, Hydrogen economy, and Electrolysis cells.
Economics of Wind Systems
Capital costs, Economic concepts, Revenues requirements, Value of wind generated electricity

Texts:

1. S. Ahmad, "Wind Energy: Theory and Practice", Prentice Hall of India Pvt. Ltd.

References:

1. Garg L. Johnson, "Wind Energy Systems" Prentice Hall Inc., New Jersey, 1985.
2. Desire Le Gouriers, "Wind Power Plants: Theory and Design" Pergamon Press, 1982.

Introduction to Probability Theory and Statistics

BTMOE605D	Introduction to Probability Theory and Statistics	OEC 2	3L-1T-0P	4 Credits

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

Pre-Requisites: None

Course Objective

The objective of this course is

(i)To Acquire the knowledge of mean, median, mode, dispersion, etc.
(ii) To develop the basics of Probability theory
(iii) To get the knowledge of random variables and their expectations
(iv) To establish acquaintance with various probability distributions
(v) To Acquire the knowledge of correlation and regression.

Course Outcome

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

(i) Apply the concepts tofind the measure of the central tendency, dispersion and moments for grouped data
(ii) Make use of the correlation, and regression analyses to find the correlation and regression coefficients
(iii) Observe and analyze the behavior of various discreteand continuous probability distributions
(iv) Investigate the properties such as mathematical expectation and variance of the random variables.

Course Contents:

Unit I: Probability

Probability Theory: Definition of probability, Addition theorem of probability, Multiplication theorem of probability, Conditional probability, Bayes' theorem of inverse probability, Properties of probabilities with proofs.
[08 Hours]

Unit II: Theoretical Probability Distributions

Theoretical Probability Distributions: Binomial distribution, Poisson distribution, Normal distribution, Fitting of binomial distributions, Properties of Binomial, Poisson and normal distributions, Relation between binomial and normal distributions, Relation between Poisson and normal distributions, Importance of normal distribution, Examples. **[08 Hours]**

Unit III: Moments, Skewness and Kurtosis

Moments about mean and an arbitrary point; Skewness: positive skewness, negative skewness, symmetric frequency distribution, Bowley's coefficient of skewness, Karl Pearson's coefficient of skewness,

Measures of skewness based on moments (β_1, γ_1); Concepts of kurtosis, leptokurtic, mesokurtic and platykurtic frequency distributions.
[08 Hours]

Unit IV: Correlation and Regression
Correlation: Types of correlation, Karl Pearson's correlation coefficient (Covariance Method), Spearman's rank correlation method, Regression: lines of regression, fitting of lines of regression by the least squares method, interpretation of slope and intercept, properties of regression coefficients.
[08 Hours]

Unit V: Sampling Theory and Testing of Hypothesis

Introduction to sampling distributions, Population and sample, Null hypothesis and Alternative hypothesis, Single and two tailed test, Testing of hypothesis, Level of significance, Critical region, Procedure for testing of hypothesis. **[08 Hours]**

Text Books:

1. Fundamentals of Statistics by S. C. Gupta, Himalaya Publishing House Pvt. Ltd., New Delhi.
2. Probability and Statistics by Dr. B. B. Singh, Synergy Knowledgeware, Mumbai.
3. Mathematical Statistics by P. Mukhopadhyay, New Central Book Agency, Kolkata.
4. Fundamentals of Mathematical Statistics by S. C. Gupta and V. K. Kapoor, S. Chand and Sons, New Delhi.
5. An Introduction to Probability and Statistics by V. K. Rohatgi and A. K. Md. Ehsanes Saleh,Wiley Interscience Publication, New York.
6. Introduction to Probability and Statistical Applications by P. L. Meyer, Addison Wesley Publishing Co., Massachusetts.

Reference Books:

1. Probability, Statistics with Reliability, Queuing and Computer Science Applications by KishorS. Trivedi, Wiley India Pvt. Ltd., Mumbai.
2. Probability, Queuing Theory and Reliability Engineering by G. Haribaskaran, Laxmi Publications, New Delhi.
3. Probability and Statistics by R. S. Murray, J. S. John, R. Alu Srinivasan and D. Goswami,
   Schaum's Outlines series, McGraw Hill Publications, New Delhi.
4. Introduction to Theory of Statistics by A. M. Mood, F. A. Graybill and D. C. Boes, TataMcGraw – Hill Publications, Pune.

Automobile Engineering Lab IV

BTACL606	Automobile Engineering Lab III	PCC 14	0L-0T-6P	3 Credits

Teaching Scheme:	**Examination Scheme:**
Lecture: 6hrs/week	Continuous Assessment: 60 Marks Mid Semester Exam: -- End Semester Exam: 40 Marks(Duration 03 hrs)

Vehicle Dynamics (Part A)
ListofPractical's/Experiments/Assignments (Any THREE)

1. Determination of the center of gravity location for a vehicle.
2. Determination of brake force distribution for a vehicle.
3. Demonstration of steering system and measurement of steering geometry angle and their impact on vehicle performance.
4. Multi body simulation for steering and suspension components using any FEA or MBD software.
5. Analysis of vehicle vibration signature using any analysis software.
6. To study the shock absorber and plot the transmissibility curve.
7. To verify analytically and experimentally traction requirementfor a vehicle.
8. To plot the torque requirement of a vehicle with respect to change ingradability.
9. To study Low speed maneuverability parameters of a vehicle.
10. To perform modal analysis of a suspension system.
11. To determine the natural frequency of damped vibration of single degree freedom system and to find it's damping coefficient.
12. To determine the frequency response curve under different damping conditions for single degree freedom system of vibration

Automobile Air Conditioning (Part B)(Any Four)
List of Experiments: -

1. Demonstration of different components with the help of cut sections/models/charts-Compressor, Condenser, Evaporators, Expansion device, Blower fans, Hating systems etc.
2. Test on vapor compression test rig.
3. Test on air conditioning test rig.
4. Demonstration of various methods of goods transport refrigeration systems.
5. Study and demonstration on car and bus air conditioning system.
6. Study of latest trends in automotive refrigeration systems.
7. Study and demonstration of controls in refrigeration.
8. Study of installation/operations/maintenance practices for refrigeration systems.
9. Study of leak testing and leak detection methods.
10. Visit to maintenance shop of automotive air conditioning and prepare report on it.

Electricals and Electronics Lab (Part C)
ListofPractical's/Experiments/Assignments(**ANY THREE**.)

1. Demonstration of automotive electrical and electronic systems layout.
2. Study/Demonstration and testing of battery performance parameter.
3. Demonstration and testing of alternators.
4. Demonstration and testing of starting motors & Electronic ignition system.
5. Demonstration of dash board panel instruments & controls.
6. Demonstration of headlight beam alignment.
7. Testing of auto electrical components on multifunctional tester.
8. Testing of CDI coil, spark plug and armature.
9. Study of ECU diagnostic system for fault finding.
10. Visit to any authorized service station for On Board Diagnosis.

B. Tech Seminar

BTAS607	Seminar II	PROJ-3	0L-0T-2P	1 Credits

Teaching Scheme:	**Examination Scheme:**
Practical: hrs/week	Continuous Assessment: 60 Marks Mid Semester Exam: -- End Semester Exam: 40 Marks

Objective:

- To expose and make students aware with latest research and research publications
- To understand the research and research publication, references, citation
- To enhance the presentation skill
- To enhance the report writing
- To make the student aware about research publication sites

Students are expected to prepare a seminar report on the chosen topic/area selected with the discussion of chosen guide based on the available literature on the chosen topic.

Mini Project

BTAP608	Mini Project	PROJ-4	0L-0T-2P	1 Credits

Teaching Scheme:	**Examination Scheme:**
Practical: 2 hrs/week	Continuous Assessment: 60 Marks Mid Semester Exam: -- End Semester Exam: 40 Marks(Duration 03 hrs)

Students are expected to carry out a mini project under a project guide based on the chosen area. The project may be prototype/software based which may demonstrate Engineering application or community service. After completion the project work it is necessary that student should prepare a project report under the supervision of the assign guide and present before the committee.