SCHOOL OF MECHANICAL ENGINEERING

GALGOTIAS UNIVERSITY

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COURSE BOOK
SOME -2019
Volume-I

Curriculum and syllabus for School of Mechanical Engineering

GALGOTIAS UNIVERSITY
(Under the Uttar Pradesh Private Universities Act No. 12 of 2019)

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GALGOTIAS UNIVERSITY

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

School of Mechanical Engineering

Program: B. Tech. Mechanical Engineering

Scheme: 2019 – 2020

Curriculum

Semester 1							Assessment Pattern		
Sl. No.	Course Code	Course Title	L	T	P	C	IA	MTE	ETE
1	BMA101	Mathematics-I (Multivariable Calculus)	3	0	0	3	20	50	100
2	BMA151	Exploration with CAS-I	0	0	2	1	50	-	50
3	FENG1005	Functional English	2	0	0	2	20	50	100
4	BCS101	Fundamentals of Computer Programming	3	0	0	3	20	50	100
5	BCS151	Fundamentals of Computer Programming Lab – 1	0	0	2	1	50	-	50
6	BPH101	Engineering Physics	3	0	0	3	20	50	100
7	BPH151	Engineering Physics Lab	0	0	2	1	50	-	50
8	BME101	Elements of Mechanical Engineering	3	0	0	3	20	50	100
9	BLE101	Psychology and Sociology	2	0	0	2	20	50	100
10	BME151	Workshop Practice	0	0	2	1	50	-	50
		Total	16	0	8	20			

Semester 2							Assessment Pattern		
Sl. No.	Course Code	Course Title	L	T	P	C	IA	MTE	ETE
1	BMA201	Linear Algebra and Differential Equations	3	0	0	3	20	50	100
2	BMA251	Exploration with CAS-II	0	0	2	1	50	-	50
3	BHS251	Professional Communication Lab	0	0	2	1	50	-	50
4	BOC253	Design and Innovation	0	0	2	1	50	-	50
5	BCH102	Engineering Sciences	3	0	0	3	20	50	100
6	BCH153	Engineering Sciences Lab	0	0	2	1	50	-	50
7	BEC101	Basic Electrical and Electronics Engineering	3	0	0	3	20	50	100
8	BCS901	Disruptive Technologies	3	0	0	3	20	50	100
9	BEC151	Basic Electrical and Electronics Engineering Lab	0	0	2	1	50	-	50
10	BME152	Engineering Graphics	0	0	4	2	50	-	50
11	BCS251	Application of Programming using Python	0	0	2	1	50	-	50
		Total	12	0	16	20			

Semester 3	Assessment Pattern

Sl. No.	Course Code	Course Title	L	T	P	C	IA	MTE	ETE
1	BTME2001	Engineering Mechanics	3	0	0	3	20	50	100
2	BTME2002	Engineering Thermodynamics	3	0	0	3	20	50	100
3	BTME2003	Manufacturing Processes I	3	0	0	3	20	50	100
4	BTME2024	Material Science (PBL)	2	0	2	3	20	50	100
5	BTME2021	Artificial Intelligence and Applications	1	0	0	1	20	50	100
6	MATH2001	Functions of complex variables and Transforms	3	0	0	3	20	50	100
7	SLBT2021	English Proficiency and Aptitude Building -3	0	0	4	2	50	-	50
8	BTME2004	Manufacturing Processes I Laboratory	0	0	2	1	70	-	30
9	BTME2005	Machine Drawing Laboratory (PBL)	0	0	4	2	70	-	30
10	BTME2022	SKILL Lab (Solid Works)	0	0	2	1	70	-	30
11	BTME2023	Excel, PPT Training and Hobby class	0	0	2	1	70	-	30
		Total	15	0	16	23			

Semester 4	Assessment Pattern

Sl. No.	Course Code	Course Title	L	T	P	C	IA	MTE	ETE
1	BTME2008	Mechanics of Material	3	0	0	3	20	50	100
2	BTME2009	Fluid Mechanics (PBL)	2	0	2	3	20	50	100
3	BTME2010	Manufacturing Processes II and Metrology	3	0	0	3	20	50	100
4	MATH2003	Probability and Statistics	3	0	0	3	20	50	100
5	BTME2024	Financial Management	3	0	0	3	20	50	100
6	BTME2017	AI & Machine Learning using Python	0	0	4	2	70	-	30
7	SLBT2002	Spoken English, Empower (Cambridge university program)	0	0	4	2	50	-	50
8	BTME2012	Mechanics of Material Laboratory	0	0	2	1	70	-	30
9	BTME2013	Manufacturing Processes II and Metrology Laboratory	0	0	2	1	70	-	30
10	BTME3023	Additive Manufacturing Lab	0	0	4	2	70	-	30
11	BTME3022	Sensors & Transducers	1	0	0	1	20	50	100
		Total	15	0	18	24			

Sl. No.	Course Code	Course Title	L	T	P	C	IA	MTE	ETE
1	BTME3021	Applied Thermodynamics	3	0	0	3	20	50	100
2	BTME3002	Kinematics of Machines	3	0	0	3	20	50	100
3	BTME3025	Machine Design	2	0	2	3	20	50	100
4	BTME3026	Automobile Engineering	2	0	0	2	20	50	100

5	BTME3003	Heat and Mass Transfer	3	0	0	3	20	50	100
6	PE01	Professional Elective - 1	3	0	0	3	20	50	100
7	PE02	Professional Elective - 2	3	0	0	3	20	50	100
8	SLBT3001	Campus to Corporate	0	0	4	2	50	-	50
9	BTME3004	Applied Thermodynamics and HMT Lab	0	0	2	1	70	-	30
10	BTME3024	Structural and Fluid flow Analysis Lab	0	0	2	1	70	-	30
		Total	19	0	10	24			

Semester 6							Assessment Pattern		
Sl. No.	Course Code	Course Title	L	T	P	C	IA	MTE	ETE
1	BTME3067	Refrigeration and Air Conditioning	3	0	0	3	20	50	100
2	BTME3008	Dynamics of Machines	3	0	0	3	20	50	100
3	BTME3009	CAM and Automation	3	0	0	3	20	50	100
4	BTME3016	Mechatronics	3	0	0	3	20	50	100
5	MATH2002	Computer applications in Mechanical Engineering	2	0	2	3	20	50	100
6	PE03	Professional Elective - 3	3	0	0	3	20	50	100
7	PE04	Professional Elective - 4	3	0	0	3	20	50	100
8	PE05	Professional Elective - 5	3	0	0	3	20	50	100
9	BTME3010	Dynamics of Machines Laboratory	0	0	2	1	70	-	30
		Total	23	0	4	25			

Semester 7							Assessment Pattern		
Sl. No.	Course Code	Course Title	L	T	P	C	IA	MTE	ETE
1	BTME4001	Energy Systems and Technologies	3	0	0	3	20	50	100
2	BTME4005	Optimization Techniques and Applications	2	0	0	2	20	50	100
3	BTME4006	Quality and Reliability Engineering	2	0	0	2	20	50	100
4	BTME4010	Project Management	1	0	0	1	20	50	100
5	BTME4004	Comprehensive Examination	0	0	2	1	70	-	30
6	BTME4003	Energy Systems Lab	0	0	2	1	20	50	100
7	BTME4008	Industrial Internship	0	0	4	2	70	-	30
8	BTME9991	Capstone Project- Phase I	-	-	4	2	50	-	50
		Total	8	0	12	14			

Semester 8							Assessment Pattern		
Sl. No.	Course Code	Course Title	L	T	P	C	IA	MTE	ETE
1	BTME9992	Capstone Project- Phase II	-	-	-	9	50	-	50
		Total				9			

Elective- (Automobile and Vehicle Design)

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	BTME3101	Automotive Chassis and Body Engineering	3	0	0	3	20	50	100
2	BTME3102	Transmission system theory and design	3	0	0	3	20	50	100
3	BTME3103	Electric and Hybrid Vehicles	3	0	0	3	20	50	100
4	BTME3104	Aerodynamic Design of Vehicles	3	0	0	3	20	50	100
5	BTME3105	Hydraulics and Pneumatics	3	0	0	3	20	50	100
6	BTME3106	Alternative Fuels & Energy Systems	3	0	0	3	20	50	100
7	BTME3107	Automotive Engine & Emission	3	0	0	3	20	50	100
8	BTME3108	Engine Design	3	0	0	3	20	50	100
9	BTME3109	Simulation of automobile system	3	0	0	3	20	50	100
10	BTME3110	Automotive Safety	3	0	0	3	20	50	100
11	BTME3111	Connected cars with IoT	3	0	0	3	20	50	100

Elective-(Energy Engineering)

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	BTME3201	Energy conservation and Management	3	0	0	3	20	50	100
2	BTME3202	Renewable energy systems	3	0	0	3	20	50	100
3	BTME3203	Energy system modelling and Analysis	3	0	0	3	20	50	100
4	BTME3204	Solar Energy Systems	3	0	0	3	20	50	100
5	BTME3205	Energy Conservation Techniques	3	0	0	3	20	50	100
6	BTME3206	Optimization of various energy parameters	3	0	0	3	20	50	100
7	BTME3207	Energy Engineering and reliability	3	0	0	3	20	50	100

Elective- (Smart Manufacturing)

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	BTME3301	Earth, Environment & Design	3	0	0	3	20	50	100
2	BTME3302	Measurements and Data Analysis Practice	3	0	0	3	20	50	100
3	BTME3303	Operations and Supply chain Management	3	0	0	3	20	50	100
4	BTME3304	Sensors and Controls	3	0	0	3	20	50	100
5	BTME3305	Machine to Machine Communication Practice	3	0	0	3	20	50	100
6	BTME3306	Entrepreneurship and Management Functions	3	0	0	3	20	50	100
7	BTME3307	Robotics and Automation	3	0	0	3	20	50	100
8	BTME3308	Special Manufacturing Processes	3	0	0	3	20	50	100

9	BTME3309	Computer Aided Design and Manufacturing	3	0	0	3	20	50	100
10	BTME3310	Data Analytics	3	0	0	3	20	50	100

Elective- (Engineering Design)

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	BTME3401	Tool Design	3	0	0	3	20	50	100
2	BTME3402	Mechanical Vibrations	3	0	0	3	20	50	100
3	BTME3403	Design of Jigs and Fixtures	3	0	0	3	20	50	100
4	BTME3404	Product Design and Development	3	0	0	3	20	50	100
5	BTME3405	Finite Element Analysis	3	0	0	3	20	50	100
6	BTME3406	Robust Design	3	0	0	3	20	50	100
7	BTME3407	Design of transmission systems	3	0	0	3	20	50	100
8	BTME3408	Design of Experiments	3	0	0	3	20	50	100

Elective- (Industrial Engineering)

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	BTME3501	Analysis and Control of Manufacturing Systems	3	0	0	3	20	50	100
2	BTME3502	Quality Engineering	3	0	0	3	20	50	100
3	BTME3503	Work Design and Ergonomics	3	0	0	3	20	50	100
4	BTME3504	Facilities Planning	3	0	0	3	20	50	100
5	BTME3505	Value Engineering	3	0	0	3	20	50	100
6	BTME3506	Financial Management	3	0	0	3	20	50	100
7	BTME3507	Supply Chain Management	3	0	0	3	20	50	100
8	BTME3508	Sequencing and Scheduling	3	0	0	3	20	50	100

Elective-(Pipeline Engineering)

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	BTME3601	Pipeline Project Evaluation and Management	3	0	0	3	20	50	100
2	BTME3602	Pipeline Engineering: Design	3	0	0	3	20	50	100
3	BTME3603	Pipeline Engineering: Construction	3	0	0	3	20	50	100
4	BTME3604	Pipeline Engineering: Operations & Maintenance	3	0	0	3	20	50	100
5	BTME3605	Pipeline Risk Management	3	0	0	3	20	50	100
6	BTME3606	Pipeline System Automation & Control	3	0	0	3	20	50	100
7	BTME3607	Pipeline Economics, Regulations & Policies	3	0	0	3	20	50	100
8	BTME3601	Pipeline Network Analysis	3	0	0	3	20	50	100

Elective- (Mechatronics)

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	BTME3701	Fundamentals of Mechatronics	3	0	0	3	20	50	100
2	BTME3702	Sensors and Actuators	3	0	0	3	20	50	100

3	BTME3703	Mechatronics System	3	0	0	3	20	50	100
4	BTME3704	Automatic Control Systems	3	0	0	3	20	50	100
5	BTME3705	Design of Mechatronics System	3	0	0	3	20	50	100
6	BTME3706	Robotics	3	0	0	3	20	50	100
7	BTME3707	Fluid Power System and Factory Automation	3	0	0	3	20	50	100
8	BTME3708	Modelling and Simulation of Mechatronics System	3	0	0	3	20	50	100
9	BTME3709	Industrial Automation	3	0	0	3	20	50	100
10	BTME3710	Computer Integrated Manufacturing	3	0	0	3	20	50	100
11	BTME3711	Communication Systems	3	0	0	3	20	50	100

Elective- (Automation and Robotics)

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	BTME3901	Industrial Automation	3	0	0	3	20	50	100
2	BTME3902	Robotics: Analysis and Systems	3	0	0	3	20	50	100
3	BTME3903	Sensors Application in Manufacturing	3	0	0	3	20	50	100
4	BTME3904	Drives and Control system for Automation	3	0	0	3	20	50	100
5	BTME3905	Pneumatic & Hydraulic Control	3	0	0	3	20	50	100
6	BTME3906	Process Control & Automation	3	0	0	3	20	50	100
7	BTME3907	Flexible Manufacturing Systems	3	0	0	3	20	50	100
8	BTME3908	Machine Vision	3	0	0	3	20	50	100
9	BTME3909	Design of Mechanisms and Manipulators	3	0	0	3	20	50	100
10	BTME3910	Robotics & Control	3	0	0	3	20	50	100

Detailed Syllabus

Name of The Course	**Workshop Practice**				
Course Code	**BME151**				
Prerequisite					
Corequisite					
Antirequisite					
	L	**T**	**P**	**C**	
	0	**0**	**2**	**1**	

Course Objectives:

1. **To learn to make a product using different basic processes.**
2. **To get acquainted with assembling of two or more components to obtain a product.**
3. **To be trained to make a product out of wood.**

Course Outcomes

CO1	**Perform welded joints in work pieces by welding process.**
CO2	**Produce simple component as per given dimensions using lathe machine.**
CO3	**Develop a product out of a given sheet metal.**
CO4	**Create a mould for given pattern using sand casting technique.**
CO5	**Assemble products of wood using carpentry tools.**

Text Book (s)

1. Workshop Manualprepared by faculties of Mechanical Engineering.

Reference Book (s)

1. A.K. Hajra Choudhury, S.K. Hajra Choudhury and Nirjhar Roy (2009), Elements of Workshop Technology, Vol. – I, Media Promoters, ISBN: 978-8-185-09914-9.
2. A.K. Hajra Choudhury, S.K. Hajra Choudhury and Nirjhar Roy (2010), Elements of Workshop Technology, Vol. – II, Media Promoters, ISBN: 978-8-185-09915-6.

List of Exercises

1. To prepare a given product using the knowledge gained in Product Manufacturing Lab while working in the lab. (To be submitted at the end of the session and evaluated in the external examination)

2. Welding Shop

Any two of the following

a. Prepare a Lap joint as per drawing using Oxy-Acetylene Gas welding
b. Prepare a T-joint as per drawing using Oxy-Acetylene Gas welding
c. Prepare a Butt-joint as per drawing using Oxy-Acetylene Gas welding
d. Prepare L- joint as per drawing using Oxy-Acetylene Gas welding
e. Prepare a Lap joint as per drawing using Electric Arc welding
f. Prepare a T-joint as per drawing using Electric Arc welding
g. Prepare a Butt-joint as per drawing using Electric Arc welding
h. Prepare L- joint as per drawing using Electric Arc welding

3. Fitting Shop

a. Prepare a Male/Female Parts as per drawing

4. Lathe Machine Shop
a. Preparation of Job as per drawing.
5. Sheet metal Shop
a. Preparation of funnel of given dimension. Use soldering to join lower part with upper and use riveting to join cylinder
6. Foundry Shop
a. Preparation of Job of aluminium as per drawing through casting.
7. Carpentry Shop
Any one of the following a) Preparation of T-Joint of given dimension. b) Preparation of Lap Joint of given dimension. c) Preparation of Cross Joint of given dimension. d) Preparation of Dove Tail Joint of given dimension.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
50	--	50	100

Name of The Course	Engineering Graphics				
Course Code	BME152				
Prerequisite					
Corequisite					
Antirequisite					
		L	T	P	C
		0	0	4	2

Course Objectives:

1. **To establish the usage of basics of engineering graphics in product design.**
2. **To introduce the concept of product design.**
3. **To introduce graphics software and apply graphics software for devloping product model.**

Course Outcomes

CO1	Sketch orthographic projection of points and lines.
CO2	Draw orthographic projection of two dimensional planes and surfaces.
CO3	Draw free hand sketching of orthographic views from isometric view.
CO4	Sketch isometric projection of solids, and learn perspective projection of solids.
CO5	Understand the concept and principles of product design using engineering graphics.

Text Book (s)

1. Venugopal K. and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, 2008
2. Natrajan K.V., “A text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai,2009.
3. Asimow, M. (1962). Introduction to design. Englewood Cliffs: Prentice-Hall.

Reference Book (s)

1. K C John (2009), Engineering Graphics for Degree, Prentice Hall of India. ISBN: 978-8-120-33788-3.
2. P N Rao (2010), CAD/CAM Principles and Applications, 3rd Edition, Tata McGraw-Hill Education, ISBN: 978-0-070-68193-4.

Course Content:

Unit I: Orthographic projection of points and lines	**12 Hours**
Basic tools for graphics, Lettering, Orthographic projection- principles, Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes – by rotating line method.	
Unit II: Orthographic projection of plane surfaces	**12 Hours**
Projection of planes- Triangle, square, rectangle, pentagon, hexagon, semicircle and circular surfaces inclined to both the principal planes by rotating object method.	
Unit III: Projection of Solids	**13 Hours**
Free hand sketching of solids from 3D to 2D as per orthographic projection, Concept of projection of simple solids like prisms, pyramids, cylinder, and cone when the axis is inclined to one of the principal planes by rotating object method.	
Unit IV: Isometric and perspective projection of solids	**13 Hours**
Principles of isometric projection – isometric scale –Isometric projections of simple solids– Prisms, pyramids, cylinders and cone, Perspective projection-concept.	
Unit V: Understanding the Concept of Product Design	**10 Hours**
Fundamentals of Design : Design by Evolution and Design by Innovation, Principles that govern any design, Morphology and Process of Design, Application of Graphics in Design, Introduction of software related to graphics-AutoCAD,Introduction of software related to design-Solid works.	

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Exam (MTE)**	**End Term Exam (ETE)**	**Total Marks**
50	**--**	**50**	**100**

Name of The Course	**Engineering Mechanics**			
Course Code	**BTME2001**			
Prerequisite				
Corequisite				
Antirequisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives:

1. To calculate the reactive forces and analyse the structures.

2. To know the geometric properties of the different shapes.
3. To learn energy and momentum methods.

Course Outcomes

CO1	**Solve the engineering problems involving equilibrium of paritcles and rigid bodies.**
CO2	**Solve the problems involving dry friction and virtual work.**
CO3	**Determine the centroid, centre of gravity and moment of inertia of various surfaces and solids.**
CO4	**Solve problems related to kinematics and kinetics of rigid body.**
CO5	**Solve problems using energy-momentum priniciple for a particle and rigid bodies in plane motion.**
CO6	**Perform static force analysis of simple machines**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	**30**	**50**	**100**

Course Content:

Unit I: Equilibrium of Particle, Rigid body and Trusses 8 Hours
Introduction to Mechanics – Fundamental Principles – Coplanar forces – Equilibrium of particles – Free body diagram – Equilibrium of particle in space – Single equivalent force - - Equilibrium of rigid bodies in two dimensions. Analysis of plane trusses – Method of joints – Method of sections – Zero-force member.
Unit II:Friction and Virtual work 7 Hours
Characteristics of dry friction – Problems involving dry friction – Ladder – Wedges – Square threaded screws. Definition of virtual work – Principle of virtual work – System of connected rigid bodies – Degrees of freedom – Conservative forces – Potential energy – Potential energy criteria for equilibrium.
Unit III: Properties of Surfaces and Solids 6 Hours
Centroid – First moment of area – Theorems of Pappus and Guldinus – Second moment of area – Moment and Product of inertia of plane areas – Transfer Theorems – Polar moment of inertia – Principal axes – Mass moment of inertia.
Unit IV: Kinematic and Kinetics 8 Hours
Position, Velocity and Acceleration – Rectilinear motion – Curvilinear motion of a particle – Tangential and Normal components – Radial and Transverse components – Rotation of rigid bodies about a fixed axis – General plane motion – Absolute and relative motion method – Instantaneous centre of rotation in plane motion. Linear momentum – Equation of motion – Angular momentum of a particle and rigid body in plane motion – D'Alembert's principle.

Unit V: Energy and Momentum Methods **8 Hours**
Principle of work and energy for a particle and a rigid body in plane motion – Conservation of energy - Principle of impulse and momentum for a particle and a rigid bodies in plane motion – Conservation of momentum – System of rigid bodies – Impact - direct and central impact – coefficient of restitution.
Unit VI : Static force analysis of simple machines **8 Hours**
Term Projects will be given to groups to analyze lifting machines for real life applications like material lifting cranes, mechanical screw jack etc.

Suggested Reading

1. J. V. Rao, D. H. Young, S. Timoshenko, Sukumar Pati (2013), Engineering Mechanics, Tata McGraw Hill Education. ISBN: 978-1-259-06266-7.
2. P. Ferdinand, E. Beer and J. Russell (2010), Vector Mechanics for Engineers, 9th Edition, McGraw-Hill International Edition. ISBN: 978-0-079-12637-5
3. Irving H. Shames (2012), Engineering Mechanics – Statics and Dynamics, 4th Edition, Prentice-Hall of India Private limited. ISBN: 978-8-131-72883-3

Name of The Course	**Engineering Thermodynamics**			
Course Code	**BTME2002**			
Prerequisite				
Corequisite				
Antirequisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives:

1. To learn the basic principles of classical thermodynamics.
2. To study the laws of thermodynamics to various systems and analyze the significance of the results.
3. To analyze the performance of thermodynamic gas and vapour power cycles.

Course Outcomes

CO1	**Outline the thermodynamic properties for different types of system.**
CO2	**Apply the first law of thermodynamics for a system undergoing a cycle.**
CO3	**Demonstrate basic understanding of the second law of thermodynamics and its application to open and closed systems.**
CO4	**Demonstrate basic understanding of entropy and its application to engineering systems.**
CO5	**Practice the basic thermal analysis of thermodynamic cycles.**
CO6	**Apply thermodynamics relations to practical cases**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks

20	**30**	**50**	**100**

Course Content:

Unit I: Basic Concepts of Thermodynamics **6 Hours**
Thermodynamics and Energy, Macroscopic and microscopic viewpoint, Closed and open systems, Thermodynamic properties of a system, State and equilibrium, Processes and cycles, Forms of energy , Temperature and its measurement, Zeroth law of thermodynamics.
Unit II: First Law of Thermodynamics **8 Hours**
Work transfer, pdV work, Types of work transfer, Net work done by a system, heat transfer, path function, Specific heat and latent heat, First law of thermodynamics for a closed system undergoing a cycle and change of state, Energy – a property of the system, enthalpy, specific heat at constant pressure and volume, PMM-I, Control volume, First law applied to steady flow process, Mass and energy balance.
Unit III: Second Law of Thermodynamics **9 Hours**
Limitations of the first law of Thermodynamics, Kelvin-Planck statement of the second law of thermodynamics, Clausius statement, Equivalence of Kelvin- Planck and Clausius statements, Heat engine, Refrigerators, Heat Pump, COP, Carnot's theorem, Corollary of Carnot's theorem, Reversible and Irreversible process, Efficiency of Reversible Heat engine, PMM-II, Carnot cycle.
Unit IV: Entropy and properties of pure sustances **8 Hours**
Introduction, Clausius theorem, Entropy – property of the system, Clausius inequality, Entropy change in irreversible process, Entropy principle, Reversible adiabatic work in steady flow system, Availability and irreversibility, Second law efficiency, p-v, p-T and T-s diagrams for a pure substance, Quality, Introduction to steam tables.
Unit V: Thermodynamic Cycles **8 Hours**
Carnot cycle, Otto cycle, Diesel and Dual cycles, Brayton and reversed Brayton Cycle, Rankine cycle.
Unit VI: 3 **Hours**
Equation of State , Gibbs – Duhem relation , Maxwel relation , legendre transform , Thermodynamics potential , Clapeyron Equation

Suggested Reading

1. P. K. Nag (2010), Basic and Applied Thermodynamics, Tata McGraw-Hill Publishing Company Ltd., ISBN 978-0-070-15131-4
2. R. K. Rajput, A Textbook of Engineering Thermodynamics, Laxmi Publications; Fifth edition, ISBN-13**:** 978-8131800584
3. Yunus A. Cengel and Michael A. Boles, Thermodynamics, An Engineering Approach, 8th Ed., McGraw Hill, 20015, ISBN: 978-9-339-22165-2.
4. Jean-Philippe Ansermet, Sylvain D. Brechet, Principles of Thermodynamics, Ist Ed., Cambridge University Press; ISBN-13: 978-1108426091

Name of The Course	**Manufacturing Processes I**			
Course Code	**BTME2003**			
Prerequisite				
Corequisite				
Antirequisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives:

1. To acquire basic knowledge about the behaviour and manufacturing properties of engineering materials and concepts of foundry and casting processes.
2. To acquire knowledge about various methods of welding, cold and hot working, and forming process.
3. To understand forging, moulding and powder metallurgy processes in detail and application of these in manufacture of a product.

Course Outcomes

CO1	**Develop a simple shape of castings by using different casting methods.**
CO2	**Prepare the weld joints by using different welding methods.**
CO3	**Develop a product by using metal forming processes.**
CO4	**Demonstrate the powder metallurgy process for making a component.**
CO5	**Apply the knowledge in manufacturing a product from plastic or composite materials.**
CO6	**Know the research scope of manufacturing technology and understand the new trends in the manufacturing sector.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	**30**	**50**	**100**

Course Content:

Unit I: Metal Casting Processes **12 Hours**
Manufacturing- selecting manufacturing process –Fundamentals of metal casting – Fluidity of molten metal – Solidification time – Sand casting – Shell mold casting - Investment casting - Plaster mold casting – Ceramic mold casting – Die casting - Centrifugal casting – Melting practice and furnaces - Defects in sand casting – Testing and inspection of casting.
Unit II: Joining Processes **10 Hours**
Metal fusion welding processes – Oxyfuel gas welding – Arc welding processes – Consumable electrode: SMAW-SAW – GMAW – FCAW – Non-consumable Electrode: GTAW- AHW- PAW – EBM – LBM – Solid state welding processes: Ultrasonic welding – Friction welding – Friction stir welding -Resistance welding – Weld quality – Testing welded joints.

Unit III: Metal Forming Processes Hours	**8**
Cold and Hot working: Rolling – Forging – Extrusion – Drawing – Sheet metal forming processes – High Energy Rate Forming Processes: Explosive Forming – Electro Hydraulic Forming – Electro Magnetic Forming.	
Unit IV: Processing of Metal Powders, Ceramics and Glass Hours	**5**
Production of metal powders: Compaction – Sintering and Finishing – Design considerations for powder metallurgy and Process capability Shaping of ceramics – Forming and shaping of glass – Design considerations for ceramics and glass – Processing of superconductors.	
Unit V: Processing of Plastics and Composite Materials Hours	**5**
Types of Plastics – Types of Molding: Injection molding – Blow molding – Compression molding – Transfer molding – Thermoforming – Reinforced plastics – Metal Matrix Composites – Ceramic Matrix Composites.	
Unit VI: Hours	**3**
To study of research framework and industrial needs modernization of conventional machines and its scope in manufacturing sector.	

Suggested Reading

1. Manufacturing Technology – Foundry, Forging and Welding (Vol-1), P.N.Rao. (2008), 3rd Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi,ISBN: 978-0-070-08798-9.
2. A.K. Hajra Choudhury, S.K. Hajra Choudhury and Nirjhar Roy (2009), Elements of Workshop Technology, Vol. – I, Media Promoters, ISBN: 978-8-185-09914-9.
3. W.A.J.Chapman (2001), Workshop Technology, Vol 1, 5th Edition, CBS Publishers, ISBN: 978-8-123-90401-6.

Name of The Course	**Materials Science**				
Course Code	**BTME2024**				
Prerequisite					
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		2	**0**	**1**	**3**

Course Objectives:

1. **The main objective of this course is to provide the basic knowledge needed to explore the discipline of materials science and engineering.**
2. **To develop the knowledge of how the structure of materials is described technically, including crystallography, microstructure, defects, and phase diagrams**
3. **To develop the knowledge of how the properties of materials are described technically and how material failure is analyzed**
4. **To introduce the concepts of structure-property relationships**
5. **To develop knowledge in various class of materials and their applications**

Course Outcomes

CO1	Explain how materials are formed and their classification based on atomic arrangement.
CO2	Draw the phase diagrams for different combination of metals.
CO3	Choose the heat treatment process for material based on the application.
CO4	Describe the mechanical behaviour of metallic systems and its importance.
CO5	Illustrate the different class of materials and their applications.
CO6	Analyze the micro-structural features of different materials.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	30	50	100

Course Content:

Unit I: Crystal Structure **7 Hours**
Introduction to materials science – Primary and Secondary bonding in materials- Crystalline and amorphous materials –Single crystal and polycrystalline materials – Space Lattice-Module cell –Crystal systems – Bravais Lattice- Miller indices – Closed packed structures- Principal Metallic crystal structures stacking sequence and stacking faults and crystal defects- Point, Line, Planar and volume; Volume, planar and Linear density calculations- Polymorphism and allotropy.
Unit II: Phase Diagrams **8 Hours**
Basics of Solidification mechanism – Cooling curve of pure metal and alloy – Phase –Phase Diagram– Gibbs's Phase rule – Interpretation of mass fractions using Lever's rule – Hume Rothery rules-Binary Iso-morphous system- Binary Eutectic alloy system (Lead-Tin System) –Binary Peritectic alloy system (Iron-Nickel System) – Invariant reactions – Iron-Iron carbide phase diagram- Slow cooling of Hypo and hyper eutectoid steels – Temperature-Time-Transformation (TTT) and Continuous Cooling Transformation (CCT) Diagrams – Effect of alloying elements in steel – types of stainless steel and cast iron.
Unit III: Heat Treatment **7 Hours**
Heat Treatment – Annealing and its types, Normalizing, Hardening tempering, Aus-tempering and Mar-tempering – Microstructure observation – Surface Heat treatment processes – Carburizing, Nitriding, cyaniding, carbonitriding, flame and induction hardening.
Unit IV: Mechanical Properties of Materials and Testing 10 Hours
Mechanical properties of materials – Strengthening mechanism –- Plastic deformation of single and poly-crystalline materials – Effect of Slip and twinning – Stress-strain curves of various ferrous and non-ferrous metals –Engineering stress strain – true stress strain relations –problems - Tensile test of ductile material – properties evaluation- Hardness measurement tests – Fracture of metals – Ductile and Brittle fracture; Fatigue – Endurance limit of ferrous and non-ferrous metals – Fatigue test ; Creep and stress rupture– mechanism of creep – stages of creep and creep test – SEM, XRD.
Unit V: Advanced materials and Applications **8 Hours**
Composites – Fiber reinforced, Metal Matrix, Ceramic Matrix – properties and applications; Ceramics – Alumina, Zirconia, Silicon Carbide, Sialons, Reaction Bonded Silicon Nitride(RBSN), Glasses– properties and applications- Magnetic materials – Hard and soft magnets – Ferromagnetic Hysteresis – properties of magnetic

materials – Intermetallic compounds-Polymers – thermosetting and thermoplastics – mechanical properties of polymers-Material selection procedure (two case studies)
Materials Science: List of Experiments **20 hours**
1. To study crystal structures of materials. 2. To study crystal imperfections in given specimens. 3. To study Bravais lattices with the help of models. 4. Specimen preparation and micro-structural examination. 5. Comparative study of microstructures of given specimens (mild steel, gray C.I., brass, copper etc.) 6. Heat treatment experiments such as annealing, normalizing, quenching, case hardening and comparison of hardness before and after. 7. To study microstructure of heat-treated steel. 8. To study thermo-setting of plastics. 9. To study the creep behavior of a given specimen 10. To study the properties of various types of plastics

Suggested Reading

1. V. Raghavan. Materials science and Engineering: A First Course 5E, ISBN 9788120324558.
2. William D. Callister , David G. Rethwisch, Fundamentals of materials science and Engineering: An integrated approach 3e : An Integrated Approach 3E ISBN 0470125373 (0-470-12537-
3. William F. Smith and Javad Hashemi (2004), Foundations of materials science and Engineering 4th ed., Mc Graw Hill. Isbn: 978-0-073-52924-0

Name of The Course	**Functions of complex variables and transforms**			
Course Code	**MATH 2001**			
Prerequisite	**BMA101, BMA201**			
Corequisite				
Antirequisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives:

The objective of the course is to familiarize the prospective engineers with techniques in calculus of complex variable functions and various types of transforms. It aims to enhance the problem solving skills using standard concepts and tools at an intermediate to advance level that will serve them well towards tackling more advanced level of Mathematics and application that they would find useful in their discipline.

Course Outcomes

CO1	**To understand the behavior of complex valued functions such as continuity/differentiability and analyticity.**
CO2	**To evaluate complex integral, singularities, residue of an analytic function, contour integral and an integral over the real line.**

CO3	**To apply Laplace transforms for solving initial value problems**
CO4	**To apply Fourier transforms for solving one dimensional heat and wave equations.**
CO5	**To apply Z-transforms for solving difference equations.**
CO6	**To discuss the application of conformal mapping.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	**30**	**50**	**100**

Course Content:

Unit I: Complex Differentiation **12 Hours**
Complex number system(A review), Limit, Continuity, Differentiability of function, Cauchy-Riemann Equations in Cartesian and Polar coordinates, Analytic function, elementary analytic functions (exponential, trigonometric, logarithm),Harmonic functions, harmonic conjugate, Conformal mappings and mobius transformations with their properties.
Unit II: Complex Integration **10 Hours**
Contour integral, Cauchy theorem (without proof), Cauchy Integral formula (withoutproof), Maximum-Modulus theorem (without proof), Taylor's and Laurent's series: radius and circle of convergence, Zeroes and singularities of analytic functions, Residues, Residue theorem (without proof), Evaluation of definite integrals involving sine and cosine, and real definite integrals around unit and semi circles.
Unit III: **Laplace Transform** **10 Hours**
Definition, existence condition, Properties, Laplace transform of Periodic, Unit step and Dirac Delta functions, Laplace transforms of derivatives and integrals, Evaluation of integrals using Laplace transforms, Convolution theorem, Inverse Laplace transform, Application of Laplace Transform in solving initial value problems.
Unit IV: Fourier Transform **7 Hours**
Fourier integrals, Complex Fourier transforms, Fourier sine and cosine transforms, Properties of Fourier transforms, Convolution theorem, Fourier transforms of derivatives, Applications of Fourier transform in solving one dimensional Heat and Wave equations.
Unit V: Z Transform **6 Hours**
Definition and Elementary properties of Z-transform (Unilateral, Bilateral), Inverse Z–transform, Convolution theorem, Solution of difference equations using Z - transform.
Unit VI: Application of Conformal mappin **4 Hours**

Steady temperature in a half plane, Temperature in a quadrant, Electrostatic potential, Potential in a Cylindrical Space.

Suggested Reading

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley &Sons.
2. J W Brown and R V Churchill, Complex Variables and Applications ,7th Ed., Mc-GrawHill,2004
3. Michael D. Greenberg, Advanced Engineering Mathematics, 2nd Edition, PearsonEducation
4. Peter V. O'Neil,Advanced Engineering Mathematics, 6th Edition, CengageLearning.
5. R. K. Jain and S. R. K. IyengarAdvanced Engineering Mathematics, 4th Edition, NarosaPublishers

Name of The Course	**Manufacturing Processes I Laboratory**			
Course Code	**BTME2004**			
Prerequisite				
Corequisite				
Antirequisite				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course Objectives:

1. To learn to give initial shapes to a metal in foundry shop and to be processed further to make a product.

2. To train to join metal pieces using different welding techniques.

Course Outcomes

CO1	**Prepare sand mould and it further used to produce casting.**
CO2	**Determine the characteristics of sand permeability number and fine grainness number.**
CO3	**Produce simple casting components using sand mould casting technique.**
CO4	**Prepare a weld joint by using different welding techniques.**
CO5	**Illustrate the relationship between cutting parameters of cutting speed, feed rate and depth of cut on forces generated in oblique cutting.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
70	**-**	**30**	**100**

Course Content:

List of Experiments
1. Preparation of green sand mould using wooden pattern. **2. Determination of grain fineness number.** **3. Determination of permeability number.** **4. Determination of compressive and shear strength of moulding sand.** **5. Preparation of casting using non-ferrous metals with the help of tilting furnace.** **6. Preparation of butt joint using gas oxy acetylene gas welding.** **7. Welding of stainless steel specimen using TIG welding.** **8. Preparation of butt joint with V-groove using MIG welding.**

9. To establish the relationship between cutting parameters of cutting speed, feed rate and depth of cut on forces generated in oblique cutting. **10. Study and identification of various types of flames generated in oxy-acetylene gas welding.**

Suggested Reading

1. Manufacturing Processes I Lab manual prepared by faculties of School of Mechanical Engineering
2. A.K. Hajra Choudhury, S.K. Hajra Choudhury and Nirjhar Roy (2009), Elements of Workshop Technology, Vol. – I, Media Promoters, ISBN: 978-8-185-09914-9.
3. W.A.J.Chapman (2001), Workshop Technology, Vol 1, 5th Edition, CBS Publishers, ISBN: 978-8-123-90401-6.
4. P.N.Rao. (2008), Manufacturing Technology – Foundry, Forging and Welding (Vol-1), 3rd Edition, McGraw Hill Publishing Company Ltd., New Delhi, ISBN: 978-0-070-08798-9.

Name of The Course	**Machine Drawing Laboratory**			
Course Code	**BTME2005**			
Prerequisite				
Corequisite				
Antirequisite				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course Objectives:

1. To introduce the students to the basics and standards of engineering drawing related to machine elements.
2. To enable the students to draw sectioned views, development of surfaces and orthographic views of machine elements.
3. To train the students technical skills regarding part drawings, production and assembly drawings.

Course Outcomes

CO1	**Draw and interpret sectioned solids and development of surfaces.**
CO2	**Explain various standards and specifications related to standard machine components.**
CO3	**Apply the knowledge of fits and tolerances for various applications.**
CO4	**Draw orthographic views of machine elements.**
CO5	**Select, configure and synthesize mechanical components into assemblies.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
70	**-**	**30**	**100**

Course Content:

Unit I: Sectioning of Solids and Development of Surfaces **6 Hours**

Selection of Views-Parts not usually sectioned- Development of Surfaces and application in sheet metal industry.
Unit II: Machine Drawing Conventions 4 Hours
Need for drawing conventions- introduction to BIS conventions-Reference to hand book for the selection of standards-Conventional representation of material, common machine elements and parts -Methods and general rules of dimensioning of holes, centers, curved and tapered features.
Unit III: Limits, Fits and Tolerances 4 Hours
Limits, Fits and tolerances – Allocation of fits for various mating parts – Tolerance data sheet – Tolerance table preparation –Geometric tolerance.
Unit IV: Drawing of Machine Elements 10 Hours
Drawing of the following machine elements: threaded fasteners and joints, keys, cotters and pin joints, welded and riveted joints, pipe joints, shaft coupling and pulleys, journals and bearings.
Unit V: Assembly Drawings 4 Hours
Drawings of assembled views for the part drawings of the Engine parts and and other machine parts- Screw jack, Machine Vice, single tool post. Valves: Steam stop valve, feed check valve.

Suggested Reading

1. N.D. Bhatt (2011), Machine Drawing, Published by R.C.Patel, 46th Edition, Charotar PublishingHouse Book Stall, ISBN: 978-9-380-35846-8.
2. K C John (2009), Engineering Graphics for Degree, Prentice Hall of India. ISBN: 978-8-120-33788-3.
3. Warren Luzadder and Jon M. Duff (2009), Fundamentals of Engineering Drawing with an Introduction to Interactive Computer Graphics for Design and Production, 11th Edition, PHI Learning, ISBN: 978-8-120-30885-5.
4. P.S. Gill (2012), Machine Drawing, S. K. Kataria& Sons, ISBN: 978-8-185-74979-2.
5. Ajeet Singh (2012), Machine Drawing (with AutoCAD), 2nd Edition, Tata Mcgraw Hill Education, ISBN: 978-0-071-07294-6.
6. Barclay James and Griffiths Brian (2002), Engineering Drawing for Manufature, Butterworth-Heinemann, ISBN: 978-1-857-18033-6.

Name of The Course	**Skill (Solid Works)**			
Course Code	**BTME2022**			
Prerequisite				
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course Objectives:

1. To enable students to use a modern CAD software package for solid modeling.
2. To draw 3D views of various machine elements.
3. To apply the knowledge of software package to model any chosen prototype.

Course Outcomes

CO1	**Use SolidWorks software package for solid modeling.**
CO2	**Draw solid models of various machine elements in SolidWorks.**
CO3	**Apply the knowledge of SolidWorks to model any chosen prototype.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
70	-	30	100

Course Content:

	Unit	Unit Topics
Week 1(2Hours)	**1.Introduction to SOLIDWORKS**	• Introduction to SOLIDWORKS 2016 • Getting Started with SOLIDWORKS • Menu Bar and SOLIDWORKS Menus • Command Manager • Toolbar • Dimensioning Standard and Units • Important Terms and Their Definitions • Hot Keys • Color Scheme
Week 1 (2Hours)	**2. Drawing Sketches for Solid Models**	• The Sketching Environment • Starting a New Session of SOLIDWORKS 2016 • Task Panes • Starting a New Document in SOLIDWORKS 2016 • Understanding the Sketching Environment • Setting the Document Options • Learning Sketcher Terms • Drawing Sketch Entities • Drawing Display Tools • Deleting Sketched Entities
Week2(2Hours)	**3. Editing and Modifying Sketches**	• Editing Sketched Entities • Creating Patterns • Editing Patterns • Writing Text in the Sketching Environment • Modifying Sketched Entities

Week2(2Hours)	**4. Adding Relations and Dimensions to Sketches**	• Applying Geometric Relations to Sketches • Design Intent • Dimension a Sketch • Concept of a Fully Defined Sketch • Deleting Overdefined Dimensions • Opening an Existing File
Week3(2Hours)	**5. Advanced Dimensioning Techniques and Base Feature Options**	• Advanced Dimensioning Techniques • Measuring Distances and Viewing Section Properties • Creating Base Features by Extruding Sketches • Creating Base Features by Revolving Sketches • Determining the Mass Properties of Parts • Dynamically Rotating the View of a Model • Modifying the View Orientation • Restoring the Previous View • Displaying the Drawing Area in Viewports • Display Modes of a Model • Additional Display Modes • Assigning Materials and Textures to Models
Week3(2Hours)	**6. Creating Reference Geometries**	• Importance of Sketching Planes • Reference Geometry • Advanced Boss/Base Options • Modeling Using the Contour Selection Method • Creating Cut Features • Concept of Feature Scope
Week 4 (2Hours)	**7. Advanced Modeling Tools-I**	• Creating Simple Holes • Creating Standard Holes Using the Hole Wizard • Adding External Cosmetic Threads • Creating Fillets • Selection Options • Creating Fillets Using the FilletXpert • Creating Chamfers • Creating Shell Features • Creating Wrap Features
Week 4 (2Hours)	**8. Advanced Modeling Tools-II**	• Creating Mirror Features • Creating Linear Pattern Features • Creating Circular Pattern Features • Creating Sketch Driven Patterns • Creating Curve Driven Patterns

Week 5 (2Hours)		• Creating Table Driven Patterns. • Creating Fill Patterns • Creating Variable Patterns • Creating Rib Features • Displaying the Section View of a Model • Changing the Display States
Week 5 (2Hours)	**9. Editing Features**	• Editing Using the Edit Feature Tool • Editing Sketches of the Sketch-based Features • Editing the Sketch Plane Using the Edit Sketch Plane Tool • Editing Using the Instant3D Tool • Editing Features and Sketches byUsing the Cut, Copy, and Paste Options • Cutting, Copying, and Pasting Features and Sketches fromOne Document to the Other • Copying Features Using Drag and Drop • Deleting Features • Deleting Bodies • Suppressing Features • Unsuppressing the Suppressed Features • Unsuppressing Features with Dependents • Hiding Bodies • Moving and Copying Bodies • Reordering the Features • Rolling Back the Feature • Renaming Features • Creating Folders in the FeatureManager Design Tree • What's Wrong Functionality
Week 6 (2Hours)	**10. Advanced Modeling Tools-III**	• Creating Sweep Features • Creating Cut-Sweep Features • Creating Loft Features • Adding a Section to a Loft Feature • Creating Lofted Cuts
Week 6 (2Hours)		• Creating 3D Sketches • Creating Grid Systems • Editing 3D Sketches • Creating Curves • Extruding a 3D Sketch • Creating Draft Features
Week 7 (2Hours)	**11. Advanced Modeling Tools-IV**	• Advanced Modeling Tools • Creating Fastening Features • Creating Freeform Features • Dimensioning a Part Using DimXpert

Week 7 (2Hours)	**3D Modelling Project**	• Use the concept of Reverse Engineering and Redesign the parts by measuring them using the Measuring Instrument
Week 8 (2Hours)	**3D Modelling Project**	• Use the concept of Reverse Engineering and Redesign the parts by measuring them using the Measuring Instrument
Week 8 (2Hours)	**12. Assembly Modeling-I**	• Assembly Modeling • Creating Bottom-up Assemblies • Creating Top-down Assemblies • Moving Individual Components • Rotating Individual Components • Moving and Rotating Individual Components Using the Triad • Assembly Visualization
Week 9 (2Hours)	**13. Assembly Modeling-II**	• Advanced Assembly Mates • Mechanical Mates • Creating Sub-assemblies • Deleting Components and Sub-assemblies • Editing Assembly Mates • Editing Components • Editing Sub-assemblies • Dissolving Sub-assemblies • Replacing Components
Week 9 (2Hours)		• Creating Patterns of Components in an Assembly • Copying and Mirroring Components • Copying a Component along with Mates • Simplifying Assemblies using the Visibility Options • Checking Interferences in an Assembly • Checking the Hole Alignment • Creating Assemblies for Mechanism • Creating the Exploded State of an Assembly
Week 10 (2Hours)	**14. Working with Drawing Views-I**	• The Drawing Mode • Starting a Drawing Document • Types of Views • Generating Standard Drawing Views • Generating Derived Views • Working with Interactive Drafting in SOLIDWORKS • Editing and Modifying Drawing Views • Modifying the Hatch Pattern in Section Views

Week 10 (2Hours)	**15. Working with Drawing Views-II**	• Adding Annotations to Drawing Views • Adding the Bill of Materials (BOM) to a Drawing • Linking Bill of Materials • Adding Balloons to the Drawing Views • Adding Balloons Using the AutoBalloon Tool • Creating Magnetic Lines • Adding New Sheets to the Drawing Views • Editing the Sheet Format • Creating User-Defined Sheet Formats
Week 11 (2Hours)	**16. Surface Modeling**	• Creating an Extruded Surface • Creating a Revolved Surface • Creating a Swept Surface • Creating a Lofted Surface • Creating a Boundary Surface • Creating a Planar Surface • Creating a Fill Surface • Creating a Radiated Surface • Offsetting Surfaces, Trimming Surfaces • Untrimming Surfaces
Week 11 (2Hours)		• Extending Surfaces, Knitting Surfaces ,Filleting Surfaces • Creating a Mid-Surface, Deleting Holes from Surfaces • Replacing Faces, Deleting Faces • Moving and Copying Surfaces • Mirroring Surface Bodies • Adding Thickness to Surface Bodies • Creating a Thicken Surface Cut, Creating a Surface Cut
Week 12 (4Hours) + Week 13 (2Hours)	**3D Modeling, Assembly and Drafting Project (Minimum 10 parts)** **Project Display**	• Use the concept of Reverse Engineering and Redesign the parts by measuring them using the Measuring Instrument • Creating Assemblies of parts created earlier • Drafting of the assembly model created • Student needs to demonstrate his project

Suggested Reading

1. 1. Matt Lombard, :Solidworks 2013 Bible", 2013, ISBN: 978-1-118-50840-4
2. Greg Jankowski, Richard Doyle, "SolidWorks For Dummies", 2nd Edition, 2011 ISBN: 978-1-118-05147-4

Name of The Course	**Mechanics of Materials**
Course Code	**BTME2008**
Prerequisite	**BTME2001-Engineering Mechanics**
Corequisite	

Antirequisite					
		L	T	P	C
		3	0	0	3

Course Objectives

1. 1. To develop the relationship between the loads applied to a non-rigid body, the internal stresses and deformations induced in the body.
2. To study the general state of stresses and strains in a given loaded member and the magnitude and direction of the principal stresses
3. To understand the different approaches to calculate slope and deflection for various types of beams.
4. To analyze the columns with different edge conditions by using different theories.

Course Outcomes

CO1	**Understand the basics of simple stress and strain**
CO2	**Draw Mohr's circle and solve problems involving biaxial state of stress.**
CO3	**Apply theory of simple bending for analysing problems.**
CO4	**Calculate deflection of various beams of different shapes.**
CO5	**Calculate torsion in shafts and buckling load of column.**
CO6	**Able to model the system and find out deflection**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
30	20	50	100

Course Content:

Unit I: Stresses and Strains **8 Hours**
Definition/derivation of normal stress, shear stress, and normal strain and shear strain – Stress-strain diagram-Elastic constants – Poisson's ratio – relationship between elastic constants and Poisson's ratio – Generalized Hook's law – Strain energy – Deformation of simple and compound bars – thermal stresses.
Unit II: Bi-axial Stress system **8 Hours**
Biaxial state of stress – Stress at a point – stresses on inclined planes – Principal stresses andPrincipal strains and Mohr's circle of stress, Theories of failure Thin cylinders and shells – deformation of thin cylinders and shells; Thick Cylinders, Shrink fits, Compounding. Fundamentals of theory of elasticity.
Unit III: Simple Bending **8 Hours**
Types of beams: Cantilever, Simply supported, Overhanging: Shear Force and Bending Moment Diagrams. Theory of simple bending – bending stress and shear stress in beams.
Unit IV: Deflection of Beams **8 Hours**
Deflection of beams by Double integration method – Macaulay's method – Area moment theorems for computation of slopes and deflections in beams – Conjugate beam method.

Unit V: Torsion and columns **8 Hours**
Introduction to Torsion – derivation of shear strain – Torsion formula – stresses and deformations in circular and hollow shafts – Stepped shafts – shafts fixed at the both ends Theory of columns – Long column and short column - Euler's formula – Rankine's formula - Secant formula - beam column.
Unit VI: **3** **Hours**
Modeling of the system and find out deflection at various points

Suggested Reading

1. S. S. Rattan (2011) Strength of material Tata McGraw Hill Education. ISBN: 978-0-071-07256-4.

2. S.P. Timoshenko and D.H. Young (2011), Strength of Materials, 5th edition, East West Press Ltd, ISBN: 978-8-176-71019-0.

3. R.K. Bansal (2010), Strength of Materials, 5th Edition, Laxmi Publications, ISBN: 978-8-131-80814-6.

Name of The Course	**Fluid Mechanics**				
Course Code	**BTME2009**				
Prerequisite					
Corequisite					
Antirequisite					
	L	**T**	**P**	**C**	
	3	**0**	**0**	**3**	

Course Objectives

1. **Understand fluid behaviour for engineering design and control of fluid systems.**
2. **Develop competence with mass, energy and momentum balances.**
3. **Study the development of boundary layers.**

Course Outcomes

CO1	**Explain the properties of fluid and its kinematics.**
CO2	**Categorize the types of flow and applications of governing equations in a fluid flow system.**
CO3	**Examine the losses of fluid flow through pipes and study about pipe network design.**
CO4	**Calculate the dependent and independent parameters of fluid flow.**
CO5	**Examine the boundary layer and no-slip boundary condition in the fluid flow.**
CO6	**Apply the basic laws of fluid mechanics in flow measurement.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
30	20	50	100

Course Content:

Unit I: Fluid Properties and Hydrostatics **6 Hours**
Density, Viscosity, Surface tension, compressibility, capillarity, Hydrostatic forces on plane, inclined and curved surfaces, buoyancy, centre of buoyancy, metacentre
Unit II: Fluid Dynamics **6 Hours**
Control volume, Fluid Kinematics, Types of flows; Steady flow, Unsteady flow, Uniform and Non Uniform flow, Rotational flow, Irrotational flow, 1-D, 2-D, 3-D flows– Streamline and Velocity potential lines, Euler and Bernoulli's equations and their applications, moment of momentum, Momentum and Energy correction factors, Impulse, Momentum equation- Navier-Stokes Equations, Applications.
Unit III: Open & Closed Channel Flow **12 Hours**
Open Channels Flow, Laminar & turbulent flow through pipes, Darcy's law, Minor losses, Multi reservoir problems, Moody's diagram, Hagen Poiseuille equation, Turbulent flow, Specific Energy, Critical flow concept, Hydraulic jump, uniform flow and gradually varying flow concepts, Pipe network design, Measurement of pressure and flow, Measurement of pipe flow, velocity through pipes and open channels.
Unit IV: Dimensional Analysis **10 Hours**
Dimensional homogeneity, Raleigh and Buckingham π theorems, Non-dimensional numbers, Model laws and distorted models, Module quantities, Specific quantities
Unit V: Boundary layers **6 Hours**
Boundary layers, Laminar flow and Turbulent flow, Boundary layer thickness, momentum- Integral equation, Drag and lift, Separation of boundary layer, Methods of separation of boundary layer.
Unit VI: 20 **Hours**
1. Conducting experiments to verify Bernoulli's theorem. **2. Determination of the Coefficient of discharge and coefficient of velocity for the given Orifice meter.** **3. Determination of the Coefficient of discharge of given Venturi-meter.** **4. Determination of the Coefficient of discharge of given Rectangular notch.** **5. Determination of the Coefficient of discharge of given 'V' notch.** **6. Comparative study of head loss in pipes connected series and parallel.** **7. Study of fluid flow types using Reynolds apparatus.** **8. Determination of drag force at different incidence angle in wind tunnel.** **9. Determination of metacentric height.** **10. Determination of the Reynolds no. in fluid flows.**

Suggested Reading

1. R. K. Bansal (2010), A Textbook of Fluid Mechanics and Hydraulic Machines, 9thEdition, Laxmi Publication (P) Ltd., New Delhi. ISBN- 978-8-131-80815-3
2. G.K. Batchelor, An Introduction to Fluid Dynamics, Cambridge Mathematical Library, ISBN: 9780521663960
3. Yunus A. Çengel (2010), Fluid Mechanics, Tata McGraw Hill, ISBN: 978-0-070-70034-5.
4. Frank M. White (2011), Fluid Mechanics, 7th edition, Tata McGraw-Hill Education, ISBN- 978-0-071-33312-2.

Name of The Course	**Manufacturing Processes II and Metrology**				
Course Code	**BTME2010**				
Prerequisite	**BTME2003- Manufacturing Processes I**				
Corequisite					
Antirequisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

1. **To get acquainted with the theory of metal cutting, mechanism of machining and the parameters that influences the machining processes.**
2. **To get basic idea about different conventional and non conventional machining processes.**
3. **To gain knowledge of various instruments for linear measurement, angular measurement and surface finish etc**

Course Outcomes

CO1	**Explain the mechanism of chip formation in machining.**
CO2	**Describe the various machining processes such as turning, drilling, boring, shaping, slotting, milling and grinding.**
CO3	**Illustrate the principle of gear generation process.**
CO4	**Illustrate the working principle of Non-traditional machining processes.**
CO5	**Explain the principle of different metrology instruments.**
CO6	**Able to explain the working of CNC machines and micromachining.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
30	**20**	**50**	**100**

Course Content:

Unit I: Theory of Metal Cutting **10 Hours**
Mechanism of chip formation – Tool Specification System- Tool signature for single point & Multi-point cutting Tools- Orthogonal and Oblique cutting – Single Point and Multipoint Cutting Tools-Machining forces - Merchant's Circle Diagram - Thermal aspects of metal machining - Cutting fluids - Machinability - Cutting tool materials - Tool wear and Tool life calculations.
Unit II: Lathe and Basic Machine Tools **08 Hours**
Lathe - Types - Operating Parameters - lathe operations – Tool nomenclature - Work holding devices. Shaping - Planing - Slotting – Drilling - Boring – Reaming – Tapping – Broaching.
Unit III: Milling, Grinding Machines and Gear Generation **08 Hours**
Milling machines - Cutters - Milling operations - Indexing. Grinding – Types of grinding machines - Grinding wheel designation and selection - Bond and Bonding processes.Gear generating principles - Gear Hobber - Gear finishing methods - Bevel gear generator

Unit IV: Non-traditional Machining Processes **07 Hours**
Classification of Nontraditional Machining process – Principle of AJM, WJM, USM, EDM, ECM, LBM - Process characteristics – Applications
Unit V: Metrology and Instrumentation **07 Hours**
Measurement standards - Linear, angular and form measuring instruments – Comparators – Gauge blocks – Gauges - Optical instruments – Profilometer – Coordinate measuring machine
Unit VI: **03 Hours**
CNC machining: Machining on CNC lathe, drilling and milling machines, Micromaching: Abrasive jet micromachining (AJMM), Abrasive water jet micromachining (AWJMM), Water jet micromachining (WJMM), Ultrasonic micromachining (USMM).

Suggested Reading

1. P.C. Sharma, (2008), Text book of Production Technology, 7th Edition, S. Chand & Company Ltd, New Delhi, ISBN: 978-8-121-91114-6.
2. O.P. Khanna & M. Lal (2010), A Text book of Production Technology, Dhanpat Rai Publications, New Delhi, ISBN: 978-8-189-92832-2.
3. S. Kapakjianand S.R.Schmid (2005), Manufacturing Engineering and Technology, 4th Edition, Pearson Education (Singapore) Pvt. Ltd. ISBN: 978-8-177-58170-6.

Name of The Course	**Probability and Statistics**			
Course Code	**MATH2003**			
Prerequisite				
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives

The aim of this course is to introduce students to the basic concepts of probability distributions and their applications. The course also serves as a foundation to analyze problems in Science and Engineering applications through statistical testing methods.

Course Outcomes

CO1	**Define the basic concepts of Probability theory and Random variables.**
CO2	**Identify the type of distribution and Apply it in problem solving.**
CO3	**Apply the concept of correlation and Regression.**
CO4	**Explain the concepts of sampling distributions and estimation theory and apply it to estimate the confidence intervals.**
CO5	**Apply statistical tests to solve the hypothesis testing problems.**
CO6	**Apply statistical tests to solve Large and Small samples.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
30	20	50	100

Course Content:

Unit I: Variables and probability Distributions 12 Hours
Review of Probability, Probability density function, Cumulative distribution function, Expectation and Variance. Binomial, Poisson and Geometric distributions, Probability density function, Cumulative distribution function, Expectation and Variance, Uniform, Normal, Exponential distributions, Joint distribution and joint density functions, Conditional distribution.
Unit II: Correlation and Regression 8 Hours
Curve fitting by method of least squares, Fitting of straight lines, Polynomials, Exponential curves, Correlation, Rank correlation, Regression analysis, Linear and non-linear regression, Multiple regression.
Unit III: Sampling Theory 5 Hours
Population and sample, Statistical inference, Sampling with and without replacement, Random samples, Population parameters, Sample statistics, Sampling distributions, Sample mean, Sampling distribution of means, Sample variances, Sampling distribution of variances, Case where population variances is unknown
Unit IV: Estimation Theory 5 Hours
Estimators, Point and Interval Estimation, Confidence Interval estimates of population parameters, Confidence intervals for variance of a Normal distribution, Maximum likelihood estimates.
Unit V: Tests of Hypothesis and Significance 7 Hours
Statistical hypothesis, Null and Alternate hypothesis, test of hypothesis and significance, Type I and Type II errors, Level of Significance, Tests involving the Normal distribution, One-Tailed and Two-Tailed tests, P value
Unit VI: 3 Hours
Special tests of significance for Large and Small samples (F, chi- square, z, t- test), one way ANOVA.

Suggested Reading

1. **R. E. Walpole, R. H. Mayers, S. L. Mayers and K. Ye (2007), Probability and Statistics for Engineers and Scientists, 9th Edition, Pearson Education, ISBN:978-0-321-62911-1.**
2. **Sheldon M. Ross (2011), Introduction to Probability and Statistics for Engineers and Scientists, 4th Edition, Academic Foundation, ISBN:978-8-190-93568-5.**

3. **Douglas C. Montgomery (2012), Applied Statistics and Probability for Engineers, 5th Edition, Wiley India, ISBN: 978-8-126-53719-8.**
4. **M. R. Spiegel, J. Schiller and R. A. Srinivasan(2010), Probability & Statistics, 3rd Edition, Tata-McGraw Hill, ISBN:978-0-070-15154-3.**

Name of The Course	**AI and its Applications in Mechanical Engineering**			
Course Code	**BTME2043**			
Prerequisite				
Corequisite				
Antirequisite				
	L	**T**	**P**	**C**
	1	**0**	**0**	**1**

Course Objectives:

1. To present a problem oriented in depth knowledge of Artificial Intelligence and Applications.
2. To address the underlying concepts, methods and application of different Artificial Intelligence and Applications

Course Outcomes

CO1	**Understand the scope of AI**
CO2	**Explain problem solving state space search**
CO3	**Apply knowledge representation predicate logic**
CO4	**Describe handling uncertainty and learning**
CO5	**Apply for practical cases.**

Text Book (s)

1. S. E. Rich and K. Knight, "Artificial intelligence", MH, 2nd ed., 1992.
2. N.J. Nilsson, "Principles of AI", Narosa Publ. House, 2000.

Reference Book (s)

1. Robin R Murphy, Introduction to AI Robotics PHI Publication, 2000
2. D. W. Patterson, "Introduction to AI and Expert Systems", PHI, 1992.
3. R. J. Schalkoff, "Artificial Intelligence - an Engineering Approach", McGraw Hill Int. Ed., Singapore, 1992.
4. George Lugar,. Al-Structures and Strategies for and Strategies for Complex Problem solving, 4/e, 2002, Pearson Education

Course Content:

Unit I: Scope of AI	**8 Hours**
Introduction to AI- application domains - natural language processing, vision and speech processing, robotics, expert systems, AI techniques- search knowledge, abstraction.	
Unit II: Problem solving State space search	**8 Hours**
Production systems, search space control: depth first, breadth-first search, heuristic search - hill climbing, best-first search, branch and bound. Problem Reduction, Constraint Satisfaction End, Means-End Analysis.	

Unit III: Knowledge Representation Predicate Logic	8 Hours
Unification, modus pones, resolution, dependency directed backtracking. Rule based Systems: forward reasoning, conflict resolution, backward reasoning, use of no backtracks. Structured Knowledge Representation: semantic net slots, exceptions and default frames, conceptual dependency, scripts.	
Unit IV: Handling uncertainty and learning	**8 Hours**
Non-monotonic reasoning, probabilistic reasoning, use of certainty factors, fuzzy logic, Concept of learning, learning automation, genetic algorithm, learning by inductions, neural network.	
Unit V: Applications using AI	**8 Hours**
Various Applications - Robot Classification, Robot Specification, notation Direct and Inverse Kinematics: Co-ordinates Frames, Rotations, Homogeneous Coordinates.	

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	30	50	100

Name of The Course	Mechanics of Materials Laboratory			
Course Code	BTME2012			
Prerequisite				
Co-requisite				
Anti-requisite				
	L	T	P	C
	0	0	2	1

Course Objectives

To supplement the theoretical knowledge gained in Strength of Materials with practical testing under applied loads. This would enable the student to have a clear understanding of the design for strength and stiffness.

Course Outcomes

CO1	Conduct tension and compression tests on standard specimens.
CO2	Calculate impact strength of standard specimen.
CO3	Determine spring constant of closed and open coil helical spring.
CO4	Calculate the fatigue strength of given specimens.
CO5	Calculate hardness of specimens, and determine the young's modulus of material by deflection test.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
50	-	50	100

Course Content:

COURSE CONTENT
1. To determine Brinell Hardness Number (BHN) for the given material of the specimen. 2. To determine Rockwell Hardness Number (RHN) for the given material of the specimen. 3. To determine the stiffness and modulus of rigidity of open coil helical spring. 4. To determine the stiffness and modulus of rigidity of closed coil helical spring. 5. To determine the impact strength for the given specimen using Charpy test. 6. To determine the impact strength for the given specimen using Izod test. 7. To determine the Young's modulus of the given material by conducting the deflection test. 8. To study the fatigue strength for the given specimen using Fatigue test. 9. To determine the Young's modulus by conducting tension test on a given mild steel specimen. 10. To determine the Maximum compressive strength by conducting compression test on a given specimen on UTM. 11. To study the strain aging behavior of steel (associated with the yield-point phenomena) using load-elongation curve obtained from tensile test.

Suggested Reading

1. S. S. Rattan (2011), Strength of Material, Tata McGraw Hill Education.
2. S.P. Timoshenko and D.H. Young (2011), Strength of Materials, 5th edition, East West Press Ltd.
3. R.K. Bansal (2010), Strength of Materials, 5th Edition, Laxmi Publications.

Name of The Course	**Manufacturing Processes II and Metrology Laboratory**			
Course Code	**BTME2013**			
Prerequisite				
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course Objectives

1. To learn and identify parts of a Lathe Machine and different operations on a Lathe.
2. To become skilled to handle and use drilling, lathe, milling and surface grinding machines.
3. To gain hands on practices in measurements and measuring instruments

Course Outcomes

CO1	**Develop a component using basic operations of lathe and drilling machine.**
CO2	**Produce a component using milling and shaper machine.**
CO3	**Create a single point cutting tool with various angles using tool and cutter grinder**
CO4	**Measure the different measurements using measuring instruments and analyse the errors.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
70	-	30	100

Course Content:

COURSE CONTENT
1.Lathe Exercise – Facing, Straight turning, knurling, chamfering, Thread cutting operations using Lathe Machine **2. Drilling - Countersinking and Tapping using Drilling Machine.** **3. End milling and Gear cutting using Milling Machine.** **4. Surface finishing using Surface Grinding Machine.** **5. Grinding of single point cutting tool using Tool and Cutter Grinder.** **6. Machining a block on shaper machine.** **7. Study & working of simple measuring instruments like Vernier calipers and micrometer.** **8. Measurement of effective diameter of a screw thread.** **9. Measurement of angle using sine bar & slip gauges.** **10. Study & angular measurement using bevel protector.** **11. Measurement of various angles of SPCT (Single Point Cutting Tool-HSS) using Tool maker's Microscope.** **12. Measurement of various dimensions of spur gear using Optical Profile Projector.**

Suggested Reading

1. Manufacturing Processes II and Metrology Lab manual prepared by faculties of School of Mechanical Engineering.
2. Manufacturing Practices Lab Manual, SOME, Galgotias University, Dr. P. Tamilchelvan, 2016.
3. Metrology Lab Manual, SOME, Galgotias University, Dr. P. Tamilchelvan, 2016.
4. A.K. Hajra Choudhury, S.K. Hajra Choudhury and Nirjhar Roy (2010), Elements of Workshop Technology, Vol. – II, Media Promoters, ISBN: 978-8-185-09915-6.
5. Manufacturing Engineering and Technology, S. Kapakjian and S.R. Schmid, 4th Edition, Pearson Education (Singapore) Pvt. Ltd. (2005) ISBN: 978-8-177-58170-6.

Name of The Course	Additive Manufacturing Laboratory			
Course Code	BTME3023			
Prerequisite				
Co-requisite				
Anti-requisite				
	L	T	P	C
	0	0	4	2

Course Objectives

1. To augment the theoretical knowldege of design to print the physical 3D mechanical components and prosthetics.
2. To get the hands on skill of designing to printing any mechanical or bomedical product.

Course Outcomes

CO1	**Understand the concept of Parametric design.**
CO2	**Develop a solid model using Tinker CAD and Fusion 360 software.**
CO3	**Print different Mechanical Component**
CO4	**Print Biomedical based prothetics**
CO5	**Understand and design the basic working 3D printer**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
70	**-**	**30**	**100**

Course Content:

COURSE CONTENT
1. To Learn and make simple parametric design on TinkerCAD software. 2. To Learn and make simple parametric design on AutoDesk Fusion 360 software. 3. To study different types of 3D printer in the lab, make sketch of the printer. 4. To Learn the circuit and microcontroller of the common FDM based 3D printer available in the lab. 5. To design and print the fuel injector of IC engine. 6. To design and print the piston of IC engine. 7. To design and print the dental implant and crown. 8. To design and print the hearing aid. 9. To make Arduino or Raspberry based simple prototype of 3D printer. 10. To learn the programming of G-Code.

Suggested Reading

1. Chee Kai Chua, Kah Fai Leong(2016), 3D Printing And Additive Manufacturing: Principles And Applications, WSPC
2. Ben Redwood, Filemon Schöffer & Brian Garret(2017), The 3D Printing Handbook:Technologies, design and applications, 3D Hubs B.V
3. Hod Lipson, M.Kurman(2013) Fabricated:The New World of 3D Printing, Wiley.

Name of The Course	**Sensors & Transducers**			
Course Code	**BTME3022**			
Prerequisite				
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	1	**0**	**0**	**1**

Course Objectives

1. Students familiar with the constructions and working principle of different types of sensors and transducers
2. Aware about the measuring instruments and the methods of measurementand the use of different transducers.

Course Outcome

CO1	**Use concepts in common methods for converting a physical parameter into an electrical quantity**
CO2	**Classify and explain with examples of transducers, including those for measurement of temperature, strain, motion, position and light**
CO3	**Choose proper sensor comparing different standards and guidelines to make sensitive measurements of physical parameters like pressure, flow, acceleration, etc**
CO4	**Locate different type of sensors used in real life applications and paraphrase their importance**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
30	**20**	**50**	**100**

Course Content:

Unit I: Mechanical and Electromechanical sensor: 9 lecture hour
Definition, principle of sensing & transduction, classification.Resistive (potentiometric type): Forms, material, resolution, accuracy, sensitivity.Strain gauge: Theory, type, materials, design consideration, sensitivity, gauge factor,variation with temperature, adhesive, rosettes.Inductive sensor: common types-Reluctance change type, Mutual inductance change type, transformer action type,Magnetostrictive type, brief discussion with respect to material, construction andinput output variable, Ferromagnetic plunger type, short analysis. LVDT: Construction, material, output input relationship, I/O curve, discussion.Proximity sensor
Unit II:Capacitive sensors: 7 lecture hours
Variable distance-parallel plate type, variable area- parallel plate, serrated plate/teethtype and cylindrical type, variable dielectric constant type, calculation of sensitivity.Stretched diaphragm type: microphone, response characteristics.Piezoelectric element: piezoelectric effect, charge and voltage co-efficient, crystalmodel, materials, natural & synthetic type, their comparison, force & stress sensing,ultrasonic sensors.
Unit III:Thermal sensors and Magnetic sensors: 9 lecture hours
Material expansion type: solid, liquid, gas &vapour Resistance change type: RTD materials, tip sensitive & stem sensitive type, Thermistor material, shape, ranges and accuracy specification.Thermo EMF sensor: types, thermoelectric power, general consideration, Junctionsemiconductor type IC and PTAT type.Radiation sensors: types, characteristics and comparison.Pyroelectric type.Sensor based on Villari effect for assessment of force, torque, proximity, Wiedemanneffect for yoke coil sensors, Thomson effect, Hall effect, and Hall drive, performancecharacteristics.Radiation sensors: LDR, Photovoltaic cells, photodiodes, photo emissive cell types,materials, construction, response.Geiger counters, Scintillation detectors, Introduction to smart sensors
Unit IV:Research Topic 3 Hours
Topics in this category include *sensor* technologies, signal processing, data fusion, and autonomous system technologies. Specific areas of *research* may include the development of new detectors based on a fundamental understanding of animal-sensory systems.

1. Engineering of Materials, Concepts and Designs for New Sensors and Sensing Systems.
2. Environmental Sensors and Sensing Systems.
3. Engineering Applications of Networked Sensors; Interpretation of Data; Responsive Action.
4. Information Management of Sensing Systems.
5. Social and Behavioral Science

Suggested Reading

1. Sensor & transducers, D. Patranabis, 2nd edition, PHI
2. Instrument transducers, H.K.P. Neubert, Oxford University press.
3. Measurement systems: application & design, E.A.Doebelin, Mc Graw Hill

Name of The Course	**Applied Thermodynamics**			
Course Code	**BTME3021**			
Prerequisite	**BTME2002 Engineering Thermodynamics**			
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives

1. To apply knowledge of basic laws of thermodynamics to engineering applications.
2. To acquire knowledge about various thermodynamics cycles.
3. To understand jet propulsion systems.

Course Outcomes

CO1	**Apply thermodynamics relations for equation development of thermodynamic process.**
CO2	**Analyze combustion process at different operating parameters of combustible hydrocarbon fuels.**
CO3	**Describe steam formation and its thermodynamic behaviour for different vapour power cycles.**
CO4	**Explain the function and application of different types of steam turbines, nozzles and its selection criteria.**
CO5	**Illustrate the fundamental of gas turbine cycles and jet propulsion system with its application area.**
CO6	**Able to know about application of thermodynamic in advance level of thermodynamic**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
30	**20**	**50**	**100**

Course Content:

Unit I: Thermodynamic relations **7 Hours**

Tds equations, Maxwell relations, Clapeyron equation,Joule-Thompson coefficient and InVersion 2.1curve, General Relations for Change in Entropy,Enthalpy, Internal Energy and Specific Heats, Coefficient of volume expansion, Adiabaticand Isothermal compressibility.
Unit II: Fuels and Combustion **7 Hours**
Introduction to Combustion analysis, Classification of Fuels, Combustion Equations,Theoretical Air and Excess Air, Stoichiometric Air Fuel (A/F) Ratio , Air-Fuel Ratio fromAnalysis of Products, ConVersion 2.1of Volumetric Analysis to Weight Analysis, ConVersion 2.1ofWeight Analysis to Volumetric Analysis, Weight of Carbon in Flue Gases,Weight of FlueGases per kg of Fuel Burnt , Analysis of Exhaust and Flue Gas, Calorific or Heating Values of Fuels.
Unit III: Vapour Power Cycles **9 Hours**
Phase Change of a Pure Substance, Formation of Steam, Thermodynamic Properties of Steamand Steam Tables, Carnot Cycle, Rankine Cycle, effect of pressure and temperature onRankine cycle, Reheat Cycle, Regenerative Cycle, open and closed feed water heaters, BinaryVapour Cycle.
Unit IV: Steam Turbines and Nozzles **9 Hours**
Classification of steam turbine, Impulse and Reaction turbines, Staging, Stage and Overallefficiency, Reheat factor, Bleeding, Velocity diagram of simple and compound multistageimpulse and reaction turbines and related calculations, work done, efficiencies of reaction,Impulse reaction turbines, state point locus, Losses in steam turbines, Governing of turbines,Flow through Convergent and convergent-divergent nozzles, variation of velocity, area andspecific volume, Choked flow, throat area, Nozzle efficiency, Off design operation of nozzle,Effect of friction on nozzle, Super saturated flow.
Unit V: Gas Turbine and Jet Propulsion **8 Hours**
Gas turbine classification, Brayton cycle, Principles of gas turbine, Gas turbine cycles withintercooling, reheat and regeneration and their combinations, Stage efficiency, Polytropicefficiency, Deviation of actual cycles from ideal cycles, Introduction to the principles of jetpropulsion, Turbojet and turboprop engines and their processes, Principle of rocketpropulsion, Introduction to Rocket Engine.
Unit VI: 3 Hours
Thermodynamics of heat recovery systems, alternative refrigeration system, supercritical power cycle study

Suggested Reading

1. P. K. Nag (2010), Basic and Applied Thermodynamics, Tata McGraw-Hill PublishingCompany Ltd., ISBN 978-0-070-15131-4.
2. R. K. Rajput, Applied Thermodynamics, Laxmi Publications Pvt Ltd; Second edition.
3. Yunus A. Cengel and Michael A. Boles, Thermodynamics, Engineering Approach, 6th Ed., McGrawHill, 2006.
4. Onkar Singh (2009) Applied Thermodynamics, New Age International. ISBN:978-8-122-42583-3.

Name of The Course	**Kinematics of Machines**
Course Code	**BTME3002**
Prerequisite	**BTME2001 Engineering Mechanics**
Co-requisite	

Anti-requisite				
	L	T	P	C
	3	0	0	3

Course Objectives

1. **To familiarize students with basic types of mechanisms, joints and degrees of freedom to perform position, velocity and acceleration analysis using graphical and analytical methods.**
2. **To provide students an understanding of different types of mechanisms.**
3. **To teach the basics of synthesis of simple mechanisms.**
4. To teach students the kinematic analysis of cam-follower motion and gear train configurations.

Course Outcomes

CO1	**Understand the concepts of various mechanisms and pairs.**
CO2	**Analyze the displacement, velocity and acceleration of different links in a simple mechanism.**
CO3	**Synthesize simple mechanisms based on the given input conditions.**
CO4	**Draw the profile of cam for different types of follower motions.**
CO5	**Apply kinematics principle to gears operation.**
CO6	**Model and analysis of mechanisms**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
30	20	50	100

Course Content:

Unit I: Basics of Mechanisms **8 Hours**
Introduction to mechanisms and its terminologies - Degree of freedom – Mobility - Kutzbach criterion - Grubler's criterion for planar mechanisms - Grashoff's law - Kinematic InVersion 2.2s of 4-bar chain - Single slider and double slider crank chains - Quick return mechanism - Limiting positions - Mechanical advantage - Transmission angle - Ratchets and escapements – Indexing Mechanisms – Rocking Mechanisms – Straight line generators.
Unit II: Kinematic Analysis of Simple Mechanisms **8 Hours**
Displacement, velocity and acceleration analysis in simple mechanisms having turning, sliding and rolling pair - Coriolis acceleration using graphical relative motion method - Instantaneous center method - Four bar and slider crank mechanisms - Analytical method for four bar and slider crank mechanisms.
Unit III: Synthesis of Simple Mechanisms **8 Hours**
Classification of kinematic synthesis problems - Two position synthesis of slider crank and crank rocker mechanisms - Three position synthesis of double rocker mechanism - Chebychev spacing - Freudenstein analytical method - synthesis of function generator using three precision positions, Graphical and analytical design of a four bar linkage for body guidance, path generation by graphical method.

Unit IV: Kinematics of CAMS **8 Hours**
Types of cams and followers - Definitions related cam profile - Derivatives of follower motion – High speed cams – Undercutting - Graphical disk cam profile design - Simple harmonic motion, Constant acceleration and deceleration, constant velocity, Cycloidal motion for knife edge and roller (in-line and offset), flat faced and oscillating followers - Tangent cam with roller follower - circular arc cam with flat faced follower.
Unit V: Kinematics of Gears and Gear Train **8 Hours**
Spur gear terminology and definitions - Law of toothed and involute gearing - Interchangeable gears - Gear tooth action - Interference and undercutting - Basics of nonstandard gear teeth -Helical – Bevel – Worm - Rack and pinion gears, cycloidal tooth properties - Comparison of involute and cycloidal tooth forms.
Unit VI: **3 Hours**
Model and analysis of mechanisms for different applications.

Suggested Reading

1. S.S. Rattan (2009), "Theory of Machines", 3rd Edition, Tata McGraw-Hill. ISBN: 978-0-070-14477-4.
2. J. Uicker John, Gordon R. Pennock Jr. and Joseph E. Shigly (2011), Theory of Machines and Mechanisms, 4th Edition, Oxford University Press, ISBN: 978-0-199-77781-5.
3. Thomas Bevan (2009), Theory of Machines, 3rd Edition, Pearson Education, ISBN: 978-8-131-72965-6.
4. A. Ghosh (2009), Theory of Mechanisms and Machines, 3rd Edition, East-West Press Pvt. Ltd., New Delhi, ISBN: 978-8-185-93893-6.
5. Kenneth J Waldron and Gary L. Kinzel (2007), Kinematics, Dynamics, and Design of Machinery, 2nd Edition, John-Wiley and Sons Inc., New York, ISBN: 978-8-126-51255-3.

Name of The Course	**Machine Design**			
Course Code	**BTME3025**			
Prerequisite	**BTME2008**			
Co-requisite	**BTME3002**			
Anti-requisite				
	L	**T**	**P**	**C**
	2	**0**	**2**	**3**

Course Objectives

1. **To understand the design methodologies for various machine elements.**
2. **To understand the various standards and methods of standardization**
3. **To produce working drawings of the system involving shafts, couplings, joints and bearings.**

Course Outcomes

CO1	**Understand and implement the design process in machine elements.**
CO2	**Apply fatigue failure criteria in the analysis and design of mechanical components.**
CO3	**Design and analyze the power transmission in shafts and couplings carrying different elements under various loading conditions.**

CO4	Design and analyze the permanent and detachable structural joints under various loading conditions.
CO5	Design and analyze the sliding and rolling contact bearings.
CO6	Model and analyse gear

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
30	20	50	100

Course Content:

Unit I: Introduction to Design Process 9 Hours
Introduction to Design process – Factors – Materials selection direct - Bending and Torsional stress equation - Impact and Shock loading - - Factor of safety - Design stress - Theories of failures — Design of Levers, Problems.
Unit II: Fatigue strength and design of springs 9 Hours
Stress concentration factor - Size factor -Surface limits factor ,Variable and cyclic loads – Fatigue strength – S- N curve – Continued cyclic stress – Soderberg and Goodman equations – Design of Helical – Leaf - Disc springs under Constant loads.
Unit III:Design of Shafts and Coupling 7 Hours
Design of Shafts carrying various elements with geometrical featuresunder various loading conditions,Design and drawings of couplings – Rigid – Flexible
Unit IV:Design of Joints 9 Hours
Design and Drawings of Cotter joints - Knuckle joints, Riveted joints, Welded joints and Screwed fasteners
Unit V: Design of bearings 6 Hours
Design of sliding contact bearing using Sommerfield number – Design using Mckee'sequation – Selection of rolling contact bearings.
Unit VI: 3 Hours
Gear geometry – Kinematics – Forces on gear tooth – Stresses in Gear tooth Selection of gear material based on bending stress

Suggested Reading

1. **V.B. Bhandari (2010), Design of Machine elements, 3rd Edition, Tata McGraw Hill.ISBN: 978-0-070-68179-8.**
2. **V.B. Bhandari (2014), Machine Design Data Book, 1st Edition, Tata McGraw Hill. ISBN: 978-9-351-34284-7.**
3. **Joseph Edward Shigley and Charles, R. Mischke (2011), Mechanical Engineering Design, 9th Edition,McGraw –Hill International Editions, ISBN: 978-0-071-07783**

Name of The Course	**Automobile Engineering**			
Course Code	**BTME3051**			
Prerequisite				
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	2	**0**	**0**	**2**

Course Objectives

1. To broaden the understanding of students in the structure of vehicle chassis and engines.
2. To introduce students to steering, suspension, braking and transmission systems.
3. To introduce students to engine auxiliary systems like heating, ventilation and air-conditioning and also the importance of alternate fuels.

Course Outcomes

CO1	**Demonstrate the knowledge of components of different automobile systems.**
CO2	**Identify different fuel supply and injection systems, and link emissions with them.**
CO3	**Perform the study of clutch and relate with modern transmission systems.**
CO4	**Classify suspension, steering and braking systems.**
CO5	**Illustrate the working of modern automobile equipments/systems.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
30	**20**	**50**	**100**

Course Content:

Unit I:Introduction to Vehicle Structure and Alternate Fuels 8 Hours
Vehicle construction, Chassis and body, Specifications, Engine, Types, Construction, Location of engine, Cylinder arrangement, Construction details, Cylinder block, Cylinder head, Cylinder liners, Piston – piston rings, Piston pin, Connecting rod, Crankshaft, Valves. Lubrication system, Types, Oil pumps, Filters, Cooling system, Types, Water pumps, Radiators, Thermostats, Anti-freezing compounds, Ignition system
Unit II:Ignition, Fuel Supply and Emission Control System 8 Hours
Coil and Magneto, Spark plug, Distributor – Electronic ignition system, Fuel system, Carburetor, Fuel pumps, Fuel injection systems, Mono point and Multi point – Module injector – Nozzle types, Electronic Fuel Injection system (EFI), Automobile Emissions, Source of formation – Effects on human health and environment, Control techniques, Exhaust Gas Recirculation (EGR), Catalytic converter, Emission tests and standards (Indian and Europe).
Unit III:Transmission System 8 Hours
Clutches, Function, Types, Single plate, Multiple plate and Diaphragm Clutch, Fluid coupling, Gearbox, Manual, Sliding, Constant, Synchromesh, Overdrive, Automatic transmission, Torque converter, Epicylic and Hydromatic

transmission, Continuously variable transmission, Universal joint, Propeller shaft, Hotchkiss drive – Final drive, Rear axle assembly, Types,Differential, Need, Construction – Non-slip differential – Differential locks, Four wheel drive.
Unit IV:Steering, Suspension and Braking System **7 Hours**
Principle of steering, Steering Geometry and wheel alignment, Steering linkages – Steering gearboxes, Power steering, front axle, Suspension system, Independent and Solid axle – coil, leaf spring and air suspensions, torsion bar, shock absorbers, Wheels and Tires, Construction, Type and specification, Tire wear and causes, Brakes, Needs – Classification –Drum and Disc Mechanical, Hydraulic and pneumatic, Vacuum assist – Retarders
Unit V:Instrumentation and Advances in Automobile Engineering 9Hours
Dash board instrumentation, Passenger comfort , Safety and security, HVAC, Seat belts, Air bags, Automotive Electronics, Electronic Control Module (ECU), Common-Rail Diesel Injection (CRDI) – Multipoint fuel injection system(MPFI), Gasoline Direct Injection (GDI), Variable Valve Timing (VVT), Active Suspension System (ASS), Anti-lock Braking System (ABS), Electronic Brake Distribution (EBD) – Electronic Stability Program(ESP) Traction Control System (TCS), Global Positioning System (GPS), X-by-wire, Electric, Hybrid vehicle

Suggested Reading

1. **William.H.Crouse (2006), Automotive Mechanics, 10th Edition, McGraw-Hill, ISBN: 978-0-07-063435-0.**
2. **Kirpal Singh (2011), Automobile Engineering, 12th edition, Standard Publications, ISBN: 978-8-180-14177-5.**
3. **Joseph Heitner (1999), Automotive Mechanics: Principles and Practices, 2nd edition, Affiliated East West Pvt. Ltd, ISBN: 978-8-176-71015-2.**
4. **Bosch Automotive Hand Book (2007), 8th Edition, SAE Publications, ISBN: 978- 0-7680-4851-3.**
5. **K. Newton and W. Steeds (2001), The motor vehicle, 13th Edition, Butterworth-Heinemann Publishing Ltd, ISBN: 978-0-080-53701-6**

Name of The Course	**Heat and Mass Transfer**			
Course Code	**BTME3003**			
Prerequisite	**BTME2002 Engineering Thermodynamics,** **BTME2009 Fluid Mechanics**			
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives

1. To understand the basic principle of heat transfer.
2. To able to analyse the system in which heat transfer takes place due to conduction, convection and radiation.

Course Outcomes

CO1	**Employ the basic modes of heat transfer and analyze problems involving steady state heat conduction in simple geometries.**
CO2	**Assess the performance of fins in different applications and develop solutions for transient heat conduction in simple geometries.**
CO3	**Apply the fundamentals of convective heat transfer process and evaluate heat transfer coefficients for forced and natural convection.**
CO4	**Calculate radiation heat transfer between black and gray body surfaces.**
CO5	**Analyze heat exchanger performance by using LMTD and NTU methods.**
CO6	**Able to understand the methodologies of calculation in the case of non-participating media through advanced radiation concepts.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
30	20	50	100

Course Content:

Unit I: Conduction – I **9 Hours**
Basic concepts, conduction, convection and radiation, Laws, General equation of heat conduction, Derivation in Cartesian, cylindrical and spherical coordinates, One dimensional steady state heat conduction in simple geometries, plane wall, cylinder and sphere, Heat transfer composite walls, composite cylinders and composite spheres, Critical thickness of insulation, Thermal contact resistance, Overall heat transfer coefficient, Electrical analogy, Heat generation in plane wall, cylinder and sphere, Extended surfaces, general equations, types and applications of fins, Fin efficiency and effectiveness, Fin performance.
Unit II: Conduction **8 Hours**
Two and Three dimensional steady state heat conduction, Analytical, Graphical and Numerical methods, Conduction shape factor, Unsteady state heat conduction, Lumped parameter system, Non-dimensional numbers in conduction, Significance of Biot and Fourier numbers, Transient heat flow in semi-infinite solid, Use of Heisler and Grober charts.
Unit III: Convection **8 Hours**
Boundary layer theory, Conservation equations of mass, momentum and energy for laminar flow over a flat plate, Turbulent flow over a flat plate, Flow over cylinders, spheres, tube bank, Internal flow through pipes, annular spaces, Analogy between momentum and heat transfer, Natural convection in vertical, inclined and horizontal surfaces, Mixed convection, Dimensional analysis.
Unit IV: Condensation, Boiling and Radiation **8 Hours**
Condensation and Boiling, Film wise and drop wise condensation, Film condensation on a vertical plate, Regimes of Boiling, Forced convection boiling, Radiation heat transfer, Thermal radiation, Laws of radiation, Black body concept, Emissive power, Radiation shape factor, Gray bodies, Radiation shields.
Unit V: Heat Exchangers and Mass Transfer **7 Hours**
Heat Exchangers, Types and practical applications, Use of LMTD, Effectiveness, NTU method, Compact heat exchangers, Plate heat exchangers, Fouling factor, Heat pipes, Types and applications, Principle of Mass

Transfer-Mass transfer by molecular diffusion, Fick's law of diffusion, Analogy of heat and mass transfer. Waste Heat recovery systems.
Unit VI:
Numerical radiation phenomena. Specific intensity of radiation. General formulation of the fundamental equation of radiation (RTE or Radiative Transfer Equation). Review of methods of analysis of radiation in non-participating media. Extension of the formulation to participating media. Introduction to numerical resolution techniques of intensity of spectral and directional radiation according to the DOM (Discrete Ordinate Methods) and FVM (Finite Volume Method) methods.

Suggested Reading

1. **R. C. Sachdeva (2005), Fundamentals of Heat and Mass Transfer, New AgeInternational (P) Ltd. ISBN: 978-8-122-40076-2.**
2. **P.K Nag, Heat and Mass Transfer, McGraw-Hill PublishingCompany Limited, ISBN: 9780070702530**
3. **J. P. Holman (2005), Heat Transfer, 9th Edition, McGraw-Hill PublishingCompany Limited. ISBN: 978-0-070-29618-3.**
4. **Dewitt Lavine, Bergmann and Incropera (2010), Fundamentals of Heat andMass Transfer, 6th Edition, John Wiley & Sons, ISBN: 978-8-126-52764-9.**

Name of The Course	**Applied Thermodynamics & HMT Lab**			
Course Code	**BTME3004**			
Prerequisite	**BTME2002 Engineering Thermodynamics**			
Co-requisite	**BTME3001 Applied Thermodynamics**			
Anti-requisite				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course Objectives

1. Identify the various parts of IC engines and explain its functions for running the engines.
2. Evaluate the performance characteristics of air compressor.
3. Study of the effect of forward, backward, curved and radial vanes of the centrifugal blower.

Course Outcomes

CO1	**Examine the performance of compressors and blower.**
CO2	**Analyze the performance of vapour compression refrigeration system at different operating conditions.**
CO3	**Demonstrate the working of air-conditioner and its psychrometric test.**
CO4	**Calcualte the heat transfer co-efficient for free and forced convection.**
CO5	**Calculate the heat transfer coefficient for parallel flow, counter flow heat exchangers, and study the radiation heat transfer phenomenon.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
70	-	30	100

Course Content:

LIST OF EXPERIMENTS
1. To find out the volumetric efficiency, isothermal power and isothermal efficiency of air Compressor. 2. To study the effect of forward, backward, curved and radial vanes and find out the discharge, head and overall efficiency of the centrifugal blower. 3. To study the different components of vapour compression refrigeration system. 4. To calculate the actual Coefficient of Performance of Vapour compression refrigeration cycle on VCR test Rig and compare with theoretical COP using p-h diagram. 5. To determine various psychrometric properties on Air conditioning test Rig. 6. To calculate total thermal resistance and thermal conductivity of composite wall. 7. To calculate the average heat transfer co-efficient of vertical cylinder under natural convection. 8. To calculate the heat transfer coefficient experimentally and theoretically for free and forced convection and compare the theoretical temperature distribution with experimentally obtained distribution. 9. To determine the value of Stefan-Boltzman constant for radiation heat transfer. 10. To study and compare temperature distribution, heat transfer rate, overall heat transfer coefficient in parallel flow and counter flow heat exchanger.

Suggested Reading

1. Lab manuals prepared by faculty.
2. NPTEL study materials

Name of The Course	**Structural and Fluid flow analysis lab**			
Course Code	**BTME3024**			
Prerequisite	**BTME2008, BTME2009**			
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course Objectives

1. Hands on experience of applying the conceptual knowledge of structural and fluid mechanics using commercial software like ANSYS, ICEMCFD and FLUENT.
2. Enable students to understand meshing methods, mesh refinement, boundary definition, solver and perform result analysis.
3. Enable the student to have a clear understanding of the design and analysis of Structural and fluid mechanics real world problem.

Course Outcomes

CO1	**Perform simulation and analysis of 2D and spatial Truss.**
CO2	**Perform simulation and analysis of beam and bar.**
CO3	**Create simple design/geometry in solidworks/design modellar**
CO4	**Use ICEMCFD/ANSYS meshing for pre-processing**
CO5	**Set up fluid flow problem in FLUENT and analyze the post process data**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks

70	**-**	**30**	**100**

Course Content:

COURSE CONTENT
• Perform simulation and structural analysis of 2D and spatial Truss. • Perform Stress and deflection analysis in beams with different support conditions. • Stress analysis of flat plates and simple shells. • Modeling and stress analysis of Bars of constant cross section area, tapered cross section area and stepped bar. • Dynamic(Mode frequency) analysis of fixed beam and bar subjected to forcing function • Design and analysis of Knuckle joint • Numerical simulation of Flow past cylinder using commercial software • Numerical simulation of Flat plate boundary layer using commercial software • Numerical simulation of Laminar flow through pipe using commercial software • Numerical simulation of Flow over a NACA 0012 airfoil using commercial software • Simulation of fluid flow in mixing elbow • Simulation of Turbulent Flow over the Ahmed Body • Simulation of Laminar Pipe Flow with Convection • Drag prediction of automobile vehicle through numerical simulation • Two mini project intended to test the holistic understanding of use and application of ANSYS

Suggested Reading

1. 1. Lab Manual prepared by SOME
2. S. S. Rattan (2011), Strength of Material, Tata McGraw Hill Education.
3. J. Z. Zhu, Olgierd Zienkiewicz, and Robert Leroy Taylor(2015). The Finite Element Method: Its Basis and Fundamentals,6th Edition, Tata McGraw Hill Education.
4. User Manual, Tutorial guide of FLUENT
5. User Manual of ICEMCFD

Name of The Course	**Refrigeration and Air-Conditioning**			
Course Code	**BTME3067**			
Prerequisite				
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives

1. To understand the principles of refrigeration and air conditioning.
2. To calculate the cooling load for different applications of Refrigeration and Air-conditioning.
3. To learn the principles of psychrometry.
4. To develop the knowledge of selecting the right equipment for a particular application of Refrigeration and Air-conditioning

Course Outcomes

CO1	**Possess the knowledge of system components of refrigeration and air conditioning.**
CO2	**Design and implement refrigeration and air conditioning systems using standards.**
CO3	**Apply the knowledge of psychrometry in calculating cooling load and heating load calculations.**
CO4	**able to know about advance refrigerants, environment protocol,**
CO5	**Able to understand about alternative or green refrigeration for commercial application**
CO6	**Able to understand about alternative refrigeration for industrial AC plant.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	30	50	100

Course Content:

Unit I: Refrigeration Cycles and Refrigerants 8 Hours
Vapour compression refrigeration cycles-Air refrigeration cycles-Simple saturated vapour compression refrigeration cycle-P-H charts - Multi stage compression –Multi evaporator system-cascade system-Vapour absorption systems.
Unit II:System Components 5 Hours
Refrigeration classification –Designation-Alternate refrigerants –Global warming and Ozone depleting aspects. Refrigerant compressors Reciprocating –Rotary - Condensers - Evaporators - Expansion devices - Cooling towers.
Unit III: Cycling Controls and System Balancing 8 Hours
Pressure temperature control range and different settings - Selection and balancing of system components - Graphical method
Unit IV : Psychrometry 9 Hours
Moist air properties - Psychrometric chart - Different Psychrometric process analysis.
Unit V: Air Conditioning 9 Hours
Air conditioning systems – classification - Cooling load calculations - different types of loads - GRSHF - ERSHF - Estimation Of total load - Air distribution patterns - Dynamic and frictional losses in air ducts - Equal friction method - Fan characteristics of duct system.
Unit VI: 3 Hours
Study of future and nano refrigerants, study of green & sustainable cooling technology and its commercial application, study of industrial ac plant & automobile ac system, solar refrigeration techniques

Suggested Reading

1. Arora, C. P., (2008), Refrigeration and Air Conditioning, Tata McGraw-Hill Publishing Company Ltd.ISBN: 978-0-070-08390-5.
2. Manohar Prasad, (2003), Refrigeration and Air conditioning, New Age International.ISBN : 978-81-224-1429-5
3. W. F. Stocker and J. W. Jones, (2002), Refrigeration and Air conditioning, McGraw Hill.ISBN: 978-0-070-66591-0.

Name of The Course	**Dynamics of Machines**			
Course Code	**BTME3008**			
Prerequisite	**BTME3002 Kinematics of Machines**			
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives

1. 1. To understand the concepts of turning moment diagrams, flywheel design and the dynamics of reciprocating engines.
2. To understand the balancing procedures for rotating and reciprocating masses, rotors and engines.
3. To understand the fundamentals of free and forced vibrations.
4. To understand the mechanisms for control.

Course Outcomes

CO1	**Conduct dynamic force analysis of various systems.**
CO2	**Describe static and dynamic balancing of high speed rotary and reciprocating machines.**
CO3	**Analyze free and forced vibrations of machines, engines and structures.**
CO4	**Calculate the frequency of transverse and torsional vibration systems.**
CO5	**Calculate gyroscopic couple and its effect on various vehicles, and apply the concept of governors for speed control.**
CO6	**Able to perform modelling and simulation of dynamic system.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
30	**20**	**50**	**100**

Course Content:

Unit I: Dynamic Force Analysis 8 Hours
D'Alembert's principle – Equivalent offset inertia force – Dynamic analysis of four bar mechanism – Dynamic Analysis of reciprocating engines – Piston effort, Crank effort, Turning moment on crankshaft, Inertia of connecting rod – Inertia force in reciprocating engines (Graphical method). Turning moment diagrams – Single and multi cylinder engines – Fluctuation of energy – Fly Wheels – Applications in engines and punching presses.
Unit II:Balancing 8 Hours
Static and Dynamic balancing of rotating masses – Balancing of reciprocating masses – Balancing of locomotives – Partial balancing of reciprocating masses – Multi cylinder Inline and radial engines.

Unit III: Vibration – Singh Degree of Freedom Systems **8 Hours**
Introduction to vibration – Terminology – Classification of vibrations –Undamped and Damped free vibration of single degree of freedom systems – Viscous damping – Introduction to coulomb damping. Forced vibration – harmonic excitation – Magnification factor – Vibration isolation and Transmissibility.
Unit IV: Transverse and Torsional Vibration Systems **8 Hours**
Transverse vibrations of shafts and beams – Rayleigh's and Dunkerley's method – Whirling of shafts. Torsional vibrations – Single rotor, two rotors and three rotors systems – Free vibration of geared systems.
Unit V: Mechanism for Control **8 Hours**
Functions of Governors – Gravity controlled and Spring controlled governor characteristics. Stability – Hunting and Isochronisms. Effect of friction – Calculation of equilibrium speeds and ranges of speed of governors. Gyroscopic couple – Gyroscopic effects on the movement of air planes and ships – Stability of two wheel drive and four wheel drive – Gyroscope stabilization.
Unit VI **3** **Hours**
Simulation of dynamic system, Balancing techniques, Modeling and Control of Vibration in Mechanical Structures, Damping mechanism, vibration isolation technologies.

Suggested Reading

1. 1. S.S. Rattan (2009), "Theory of Machines", 3rd Edition, Tata McGraw-Hill Publishing Company Ltd, ISBN: 978-0-070-14477-4.
2. J. Uicker John, Gordon R. Pennock Jr., and Joseph E. Shigly (2009), Theory of Machines and Mechanisms, 3rd Edition, Oxford University Press, ISBN: 978-0-198-06232-5.
3. J. Peter Sadler and Charles E. Wilson (2008), Kinematics and Dynamics of Machinery, 3rdPearson Education, ISBN: 978-8-131-72022-6.
4. A. Ghosh (2009), Theory of Mechanisms and Machines, 3rd Edition, East-West Press Pvt. Ltd., New Delhi, ISBN: 978-8-185-93893-6.
5. T Thomson William, Dillon Dahleh Marie and PadmanabhanChandramouli (2008), Theory of Vibration with applications, 5th Edition, Pearson Education Publishers, ISBN: 978-8-131-70482-0.

Name of The Course	**CAM & Automation**			
Course Code	**BTME3009**			
Prerequisite	**BTME3008 Machine Design**			
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives

1. To understand the importance use of computer hardware applied in an CAM environment.
2. To know about the NC and CNC machine and part programming to produce a component.
3. To get acquinted with automation of an industry and CIM.

Course Outcomes

CO1	**Explain the input and output devices of a computer.**

CO2	**Prepare a program to produce a component on CNC mahines.**
CO3	**Group the parts produced into families so that he can arrange the machines accordingly.**
CO4	**Apply advanced concepts in computer integrated manufacturing.**
CO5	**Apply the knowledge gained in CAM and automation to suggest how to make an industry automated**
CO6	**Able to identify, characterize and select the ideal materials for a given Rapid Prototyping system and intelligent information system.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
30	20	50	100

Course Content:

Unit I: Computer Hardware 8 Hours
Product Development Cycle – Introduction to CAM – Graphics input devices- cursor control devices, Digitizers, Scanners, speech oriented devices and touch panels, Graphics displaydevices – CRT, color CRT monitors, DVST, Flat- panel display, Graphics output Devices –Printers and Plotters – Graphics Standards – Neutral File formats –IGES, STEP.
Unit II: CNC Machine Tools 8 Hours
Introduction to NC, CNC, DNC- Manual part Programming – Computer Assisted PartProgramming – Examples using NC codes- Adaptive Control – Canned cycles and subroutines –CAD / CAM approach to NC part programming – APT language, machining from 3D models.
Unit III: Group Technology, CAPP and FMS 8 Hours
Introduction to part families-parts classification and cooling – group technology machine cells-benefits ofgroup technology – Process Planning – CAPP & types of CAPP – Flexible manufacturing systems (FMS)– the FMS concept-transfer systems – head changing FMS – Introduction to Rapid prototyping,Knowledge Based Engineering.
Unit IV: Automation 8 Hours
Introduction to automation-Basic Elements of an Automated System, Advanced AutomationFunctions, Levels of Automation, Industrial Control Systems, Continuous Versus Discrete Control, Computer Process Control.
Unit V: Computer Integrated Manufacturing 8 Hours
CIM wheel – CIM Database- CIM-OSI Model– Networking Standards in CIM Environment –Network structure – Network architecture –TCP/IP, MAP – Virtual Reality, Augmented Reality-Artificial Intelligence and Expert system in CIM.
Unit VI:
Reverse Engineering: Introduction to reverse engineering and its integration with rapid prototyping , industry 4.0,cyber-physical systems (CPS), the internet of things (IoT), industrial internet of things (IIOT), cloud computing, cognitive computing and artificial intelligence usage in manufacturing, Intelligent Information Systems, - Knowledge based product and process models - Applications of soft computing in product development process.

Suggested Reading

1. Mikell P. Groover (2008), Automation, Production Systems and Computer Integrated Manufacturing, 3rd Edition, Pearson Education. ISBN: 978-8-120-33418-2.
2. Ibrahim Zeid (2009), Mastering CAD/CAM, 2nd Edition, Tata McGraw Hill International Edition, ISBN: 978-0-070-15134-5.
3. P N Rao (2010), CAD/CAM Principles and Applications, 3rd Edition, Tata McGraw-Hill Education, ISBN: 978-0-070-68193-4.
4. James A. Rehg and Henry W. Kraebber (2004), Computer Integrated Manufacturing, 3rd Edition, Pearson Education, ISBN: 978-0-131-13413-3
5. Mikell P. Groover and Emory W. Zimmers (2003), CAD/CAM: Computer Aided Design and Manufacturing, Prentice Hall Edition, ISBN: 978-8-177-58416-5.

Name of The Course	**Dynamics of Machines Laboratory**			
Course Code	**BTME3010**			
Prerequisite				
Co-requisite	**BTME3008 Dynamics of Machines**			
Anti-requisite				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course Objectives

1. **To supplement the principles learnt in Kinematics and Dynamics of Machinery.**
2. **To understand how certain measuring devices are used for dynamic testing.**

Course Outcomes

CO1	**Calculate natural frequency of longitudinal vibration.**
CO2	**Determine torsional frequency of a single rotor system.**
CO3	**Measure the magnitude of gyroscopic couple in a motorized gyroscope.**
CO4	**Compare Tri–Filar / Bi-Filar system for determining moment of inertia of an object.**
CO5	**Calculate thecritical speed of a shaft and determine the performance characteristics of governors.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
50	**-**	**50**	**100**

Course Content:

LIST OF EXPERIMENTS
1. **To determine natural frequency of longitudinal vibration in spring mass system.**
2. **Determination of torsional frequency of a single rotor system.**
3. **To study nomenclature of cam and plotting the cam profile.**
4. **To determine gyroscopic couple on motorized gyroscope.**

5. **Comparative study of different types of clutches**
6. **To determine the frequency of un-damped free vibration of an equivalent spring mass system.**
7. **To perform experiment on Watt and Porter governors to determine performance**
8. **Comparative study of static and dynamic balancing in rotors.**
9. **To find out critical speed and to compare the whirling speed of a shaft.**
10. **To study TRI –FILAR / BI-FILAR System**
11. **Comparative study of different types of clutches**

Suggested Reading

1. S.S. Rattan (2009), "Theory of Machines", 3rd Edition, Tata McGraw-Hill Publishing Company Ltd, ISBN: 978-0-070-14477-4.
J. Uicker John, Gordon R. Pennock Jr., and Joseph E. Shigly (2009), Theory of Machines and Mechanisms, 3rd Edition, Oxford University Press, ISBN: 978-0-198-06232-5.

Name of The Course	**Energy systems and Technologies**			
Course Code	**BTME4001**			
Prerequisite	**BTME2002 Engineering Thermodynamics, BTME 2009 Fluid Mechanics**			
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives

1. **To apply knowledge of basic laws of thermodynamics to compressors.**
2. **Describe the operating characteristics of hydraulic machinery (pumps and turbines), and the factors affecting their operation and specifications, as well as their operation in a system..**
3. **To understand the working of key components of conventional and non conventional power plants.**

Course Outcomes

CO1	**Calculate the thermal efficiencies of blowers and compressors, and identify the common problems in compressor working.**
CO2	**Evaluate the pump output and efficiencies of different hydraulic pumps.**
CO3	**Explain working of hydraulic turbines and its perfromance evaluation.**
CO4	**Demonstrate conventinal power generation systems and their components.**
CO5	**Demonstrate non conventinal power generation systems and their components.**
CO6	**Able to learn about new trends of energy conversion systems**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
30	20	50	100

Course Content:

Unit I: Fans, Blowers and Compressors **9 Hours**

Construction details of Centrifugal fans, blowers and compressors, stage work, Stage pressure rise, Stage pressure co-efficient, Stage efficiency, Degree of reaction, Various slip factors, h-s diagram for centrifugal compressor.Axial flow Fans and Compressors, Stage velocity triangles, Blade loading and flow co- efficient, Static pressure rise, h-s diagram, Degree of reaction, Work done factors, Free and Forced Vortex flow performance, Stalling and Surging.Construction details of Reciprocating compressors, working, Effect of clearance volume, Multi staging, Volumetric efficiency, Isothermal efficiency.
Unit II: Hydraulic Pumps **8 Hours**
Centrifugal pumps, Work done, Head developed, Pump output and Efficiencies, priming, minimum starting speed, performance of multistage pumps, cavitation and methods of prevention, Pump characteristics, Constructional details of axial flow pumps, characteristics, Non-dimensional parameters, Efficiencies, Reciprocating pumps, Work done and efficiency, Vibration and Noise in hydraulic pumps.
Unit III: Hydraulic Turbines **9 Hours**
Classification of hydraulic turbines, Pelton wheel, Francis turbine, Kaplan and Propeller turbines, Velocity triangles, Specific speed, Theory of draft tube, Governing, Performance characteristics, Selection of turbines.
Unit IV: Introduction to power plants **8 Hours**
Classification, Selection of site, Steam power plants – Fire tube and Water tube boilers, Feed water treatment, Cooling Tower, Pulverized coal firing systems, Electrostatic precipitator, Nuclear power plants – working principle and basic components, pressurized water reactor, Hydro power plants – basic components, function and details of Reservoirs, Dam, Trash Rack, Forebay, Surge Tank, Penstock, Spillway, Prime Mover and Generator, Draft Tube.
Unit V: Non Conventional Power Plants **6 Hours**
Introduction to Non Conventional energy resources, Basic Components of Solar power plant, principle and working, Basic Components of Wind power plant, principle and working
Unit VI: 3 Hours
Overview of tri-generation system and its analysis, kalina system of combined cooling and power generation, solar integrated power generation and refrigeration system. study of energy efficient heat recovery energy materials

Suggested Reading

1. S. S. Rattan (2011), Fluid Mechanics and Hydraulic Machines, Khanna Publishers, ISBN: 978-8-187-52246-1.
2. R. K. Rajput, (2008), A Text Book of Power Plant Engineering, 4th Edition Laxmi Publications (P) Ltd. ISBN: 978-81-318-0255-7.
3. S.M. Yahya, (2010), Turbine, Fans and Compressors, TMH, 2010
4. P.K. Nag, Power Plant Engineering, Tata McGraw-Hill Publishing Company Ltd., ISBN: 9789339204044.

Name of The Course	**Optimization Techniques and Applications**			
Course Code	**BTME4005**			
Prerequisite				
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	2	**0**	**0**	**2**

Course Objectives

1. **To provide students the knowledge of optimization techniques and approaches.**
2. **To enable the students to apply mathematical, computational and communication skills needed for the practical utility of Optimization techniques.**

Course Outcomes

CO1	**apply graphical and Simplex method for optimization of problems which can be formulated as linear programming**
CO2	**calculate initial solution of transportation and assignment problems using various methods and optimize it**
CO3	**determine the sequencing of jobs through different machines and evaluate project using PERT and CPM techniques**
CO4	**demonstrate various inventory models used in industries and determine associated economic order quantity**
CO5	**illustrate the use of queuing models in practical applications and estimate the solution of a problem involving conflict between two using knowledge of game theory**
CO6	**explain briefly the different modern methods of optimization**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	30	50	100

Course Content:

Unit I: Introduction to optimization and linear programming problems 8 lecture hours
Introduction to Optimization: Optimization,Engineering application of Optimization – Statement of an Optimization problem - Optimal Problem formulation - Classification of Optimization problem. Optimum design concepts: Concept of Global and Local optima Linear Programming: Mathematical Formulation – Graphical method – Simp-lex method – Two Phase Simplex method – Big M Method – Duality
Unit II: Transportation and Assignment problems 8 lecture hours
Transportation problems – Least cost method – Northwest Corner method – Vogel's Approximation method – MODI method – Transhipment problems, Assignment problems.
Unit III:Sequencing and Network Models 8 lecture hours
Sequencing –Problem with N jobs and 2 machines using Johnson's method, Problems with N jobs - 3 machines and 'M' machines.using modified Johnson's method Network Models – Basic Concepts – Construction of Networks – CPM and PERT – Crashing of Network.
Unit IV: Inventory Models 8 lecture hours
Deterministic Inventory Models – Various Costs and Concepts–EOQ–Deterministic inventory models with instenteneous production and finite rate of production.
Unit V: Queuing Models and Game Theory 8 lecture hours
Queuing models – Characteristics of Queuing Model, M/M/1 & M/M/S system, cost consideration Game theory – Two person zero sum game – Graphic solution - Property of dominance – Algebraic solution

Unit VI: Modern methods optimization
Modern methods of optimization:Introduction to modern methods of optimization of Genetic algorithms, Simulated annealing, Particle swarm optimization, Ant colony optimization, Neural network-based optimization and Fuzzy optimization.

Suggested Reading

1. Rao S. S. - 'Engineering Optimization, Theory and Practice' - New Age International Publishers, ISBN- 978-0470183526
2. Kanti Swarup, P.K. Gupta and Manmohan Lal (2010), Operations Research, 15th Edition, S.Chand & Sons, ISBN: 978-8-180-54771-3.
3. H. M. Wagner (2009), Principles of Operation Research, 2nd Edition, Prentice Hall of India Ltd ISBN: 978-8-120-30162-7.
4. Hamdy Taha, (2008), Operations Research-An Introduction, 8th Edition, Pearson Education, ISBN: 978-8-131-71104-0.
5. R. Panneerselvan (2006), Operations Research, 2nd Edition, Prentice Hall of India Pvt Ltd ISBN: 978-8-120-31743-7.
6. J. K. Sharma (2013), Operations Research, 5th Edition, Macmillan Publications, ISBN: 978-9-350-59336-3.

Name of The Course	**Quality and Reliability Engineering**			
Course Code	**BTME4006**			
Prerequisite				
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	2	**0**	**0**	**2**

Course Objectives

1. **To impart knowledge about the significance of quality and the various tools/ concepts of building quality into products.**
2. **To impart knowledge about plans for acceptance sampling and quality systems.**
3. **To address the underlying concepts, methods and application of Quality and Reliability Engineering.**

Course Outcomes

CO1	**Apply the tools and techniques of quality to resolve industrial engineering issues.**
CO2	**Estimate the obvious and hidden quality costs for a given production system.**
CO3	**Prepare and analyze various charts/ methods for quality control and improvement**
CO4	**Use plans for sampling and concepts of quality system management.**
CO5	**Model various systems applying reliability networks.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
30	**20**	**50**	**100**

Course Content:

Unit I:Introduction to Quality 8 lecture hours
Quality - meaning and significance, Essential components of quality, Phases or elements for building quality, Evolution of the concepts of quality, Spiral of progress of quality, Changing scope of quality activities, Ishikawa's seven quality tools, Quality Circles, Quality system economics, Hidden quality costs, Economic models of quality costs.
Unit II: Taguchi's Quality Loss Function 8 lecture hours
System approach for quality management, Juran's quality trilogy, Quality planning activities, Sporadic and chronic quality problems, Causes of variation, General quality control methodology.
Unit III: Statistical Quality Control 8 lecture hours
Control charts for variables: X bar-R, X bar-S, median, XMR charts, Control charts for attributes: p, np, c charts, Product reliability, Process capability analysis.
Unit IV:Acceptance Sampling 8 lecture hours
Plans and tables for attributes and variables, Sampling methods, Type of plans, Operating characteristic curves, Quality improvement methodology, Justin-time philosophy.ISO 9000 Philosophy: Documentation, Implementation and certification process
Unit V: Reliability Concepts 8 lecture hours
Reliability engineering fundamentals; Failure data analysis; Failure rate; mortality curve; Concept of burn in period; Useful life and wear out phase of a system; Mean time to failure (MTTF); Mean time between failure, (MTBF) and mean time to repair (MTTR); Reliability in terms of Hazard rate and failure density, Conditional probability and multiplication rules.

Suggested Reading

1. Dale H. Besterfield, Carol Besterfield (2018), Total Quality Management (TQM),5th Edition, Pearson Education, ISBN: 978-9353066314.

2. Juran, J.M. and Gryna, F.M, Quality Planning & Analysis, McGraw Hill (2001).

3. Grant, E.L., Statistical Quality Control, McGraw Hill (2008).

4. Feignbaum, A.V., Total Quality Control, McGraw Hill (1991).

5. Juran, J.M., Juran's Quality Control Handbook, McGraw Hill (1988).

6.E. Balagurusamy, Reliability Engineering by Tata McGraw-Hill Publishing Company Limited, 2002.

Name of The Course	**Project Management**			
Course Code	**BTME4010**			
Prerequisite				
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	1	**0**	**0**	**1**

Course Objectives

1. **To acquaint students with basic concepts of the Project Management and its uses in real life situation, the formulation of the problems and basic insight of Capital Budgeting decision.**

2. **To be able to recognize and analyse the Market – Demand & Supply factors affecting the Project Execution and study risk factors associated with Project Management.**
3. **To know how to plan, organize and control the resources to achieve specific goals.**

Course Outcomes

CO1	**Explain basic concepts of the Project Management and its uses in real life situation.**
CO2	**Take decisions about Capital Budgeting.**
CO3	**Analyze the Market – Demand & Supply factors affecting the Project Execution.**
CO4	**Select the risk factors associated with Project Management.**
CO5	**Plan, organize and control the resources to achieve specific goals.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	**30**	**50**	**100**

Course Content:

Unit I: Introduction to Project Management 8 Hours
Introduction to Project Management, Uses, scope and applications of Project Management in managerial decision-making, Characteristics of Projects, Classification of Projects: National & International, Project Management: Tools and Techniques, Roles and Responsibilities of Project Manager, Project Life cycle, Project Selection Process.
Unit II: Capital Expenditure Decisions 8 Hours
Meaning and features of capital budgeting decisions, Importance of capital budgeting decisions, Kinds of capital expenditure decisions, Capital expenditure budgeting process, Criteria of capital budgeting, Resource allocation framework and budgeting difficulties.
Unit III: Market Demand Analysis 8 Hours
Information required for marketing and demand analysis, Information required for marketing and demand analysis, Secondary sources of information, Market survey, Demand forecasting, Uncertainties in demand forecasting, Coping with uncertainties: Technical and Financial Analysis.
Unit IV: Determination of Risk factors 8 Hours
Analyses of Project Risk, Market Risk and Firm Risk, Social-Cost, benefit analysis: Need for social cost benefit analysis, Main feature of social cost benefit analysis: UNIDO approach, Little-Mirrless approach.
Unit V: Network Analysis 8 Hours
Rules for drawing the network diagram, Application of CPM and PERT techniques in project planning and control, Illustration by taking numerical examples on CPM and PERT, Case Study: China Telecom Corporation uses PMI standards to develop communications network for Nanshan District.

Suggested Reading

1. Project Management, Prasanna Chandra, Mc. Graw Hill
2. Project Management, S Chaudhry, Tata Mc. Graw Hill.

3. Total Quality Management, P.K. Joy, Macmillan Indian Ltd.
4. Project Finance, H.R. Machiraju, Vikas Publishing House
5. Project Management in Practice, Meredith, Jack R., Sutton, Margaret M., Shafer, Scott M., Wiley.

Name of The Course	**Energy systems Laboratory**			
Course Code	**BTME4003**			
Prerequisite				
Co-requisite	**BTME4001 Energy system and Technologies**			
Anti-requisite				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course Objectives

1. To impart the practical knowledge about the performance characteristics of pumps and turbines.
2. To impart knowledge of boilers.

Course Outcomes

CO1	**Carryout the performance analysis of reciprocating pump.**
CO2	**Carryout the performance analysis of centrifugal pump.**
CO3	**Predict the efficiency of hydraulic turbines.**
CO4	**Explain the working of water and fire tube boilers.**
CO5	**Prepare a heat balance sheet by conducting the morse test**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
70	**-**	**30**	**100**

Course Content:

LIST OF EXPERIMENTS

1. To study the performance characteristics of Centrifugal pump
2. **To study the performance characteristics of reciprocating pump.**
3. To study the performance characteristics of Pelton wheel turbine
4. **To study the performance characteristics of Francis turbine**
5. **To study the performance characteristics Kaplan turbine.**
6. To study construction and working of water tube boiler.
7. To study construction and working of fire tube boiler.
8. To prepare heat balance sheet.

Suggested Reading

1. NPTEL study material

Name of The Course	**Capstone Project- Phase I**				
Course Code	**BTME9991**				
Prerequisite					
Co-requisite					
Anti-requisite					
	L	**T**	**P**	**C**	
				2	

Course Objectives

1. To develop the capacity of students in correlating theoretical knowledge into practical systems either to perform creative works or to perform analysis and hence to suggest solutions to problems, pertaining to mechanical engineering domain.
2. Foster collaborative learning skills.
3. Develop self-directed inquiry and life-long skills.
4. To enhance the communication skills of the students by providing opportunities to discuss in groups and to present their observations, findings and report in formal reviews both in oral and written format.

Course Outcomes

CO1	Explore as a team, the fundamentals, domain knowledge and skills in engineering to identify / conceive a problem.
CO2	Analyze and outline the various aspects of complex engineering systems to formulate the problem.
CO3	Select appropriate methodology using critical and creative thinking and design subsystems / systems.
CO4	Develop a functional product prototype highlighting its utility to society, environment, safety and address ethical concerns.
CO5	**Present and demonstrate the product to peers, academicians, general and industry community.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
50	**-**	**50**	**100**

Course Content:

CATALOGUE DESCRIPTION **The project work can be an investigative analysis of a technical problem in the relevant area, planning and/or design project, experimental project or computer application based project on any of the topics. Each project group will submit abstract of the project within three weeks from start of seventh semester. Project evaluation committee consisting of three or four faculty members specialized in the various fields of department, shall study the feasibility of each project work before giving consent.**
COURSE CONTENT **The project group consisting of not more than four members is expected to fix any topic of mechanical engineering domain and complete preliminary studies like literature review, recent developments, description of a problem etc. in this semester. This work will be continued as a Project Work II during eighth semester.**
Mode of Evaluation **The evaluation committee shall consist of faculty members constituted by the Dean of School which will comprise of at least three members comprising of the Division Chair/Program Chair a nominee of the Dean. The students**

guide would be a special invitee to the presentation. The seminar session shall be an open house session. The internal marks would be the average of the marks given by each member of the committee separately in a sealed envelope to the Dean. There will not be more than three students for a group for such project submission.
The assessment of all the projects should be done at the end of the seventh semester by the project evaluation committee formed. The students will present their project details and progress of their project to the committee. The complete project report is not expected at the end of the seventh semester. However, a three-four page typed report based on the work done should be submitted by each student to the assessing committee.

Name of The Course	**Capstone Project- Phase II**			
Course Code	**BTME9992**			
Prerequisite				
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	0	**0**	**0**	**9**

Course Objectives

1. To develop the capacity of students in correlating theoretical knowledge into practical systems either to perform creative works or to perform analysis and hence to suggest solutions to problems, pertaining to civil engineering domain.
2. Foster collaborative learning skills.
3. Develop self-directed inquiry and life-long skills.
4. To enhance the communication skills of the students by providing opportunities to discuss in groups and to present their observations, findings and report in formal reviews both in oral and written format.

Course Outcomes

CO1	Implement the design using advanced engineering tools
CO2	Test and validate the proposed solution
CO3	Collect and interpret results ensuring that the concerns of utility to society, environment, safety and ethical issues are addressed
CO4	Compare performance with existing similar systems
CO5	**Present and demonstrate the product to peers, academicians, general and industry community**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
50	**-**	**50**	**100**

Course Content:

CATALOGUE DESCRIPTION

The project work can be an investigative analysis of a technical problem in the relevant area, planning and/or design project, experimental project or computer application based project on any of the topics. The problem description done on the seventh semester shall be continued in this semester and solved with various tools or techniques needed for the project work.

COURSE CONTENT
Project work II is expected to be completed in the eighth semester with each student group consisting of not more than five members is expected to design and develop a complete system or make an investigative analysis of a technical problem in the relevant area. The project groups are expected to solve the problem chosen on Project Work I with various tools or techniques required for the project work.
Mode of Evaluation **The evaluation committee shall consist of faculty members constituted by the Dean of School which will comprise of at least three members comprising of the Division Chair/Program Chair a nominee of the Dean. The students guide would be a special invitee to the presentation. The seminar session shall be an open house session. The internal marks would be the average of the marks given by each member of the committee separately in a sealed envelope to the Dean. There will not be more than three students for a group for such project submission.** **The assessment of all the projects should be done at the end of the eighth semester by the project evaluation committee formed. The students will present their project details and progress of their project to the committee. The complete project report based on the work done should be submitted by each student to the assessing committee.**

Name of The Course	**Computer Aided Design**			
Course Code	**BTME3060**			
Prerequisite				
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives

1. **To introduce the CAD concepts both theoretically and application wise.**
2. **To provide students the necessary foundation to advance understanding of both design and manufacturing**
3. **To enable the students to model geometry of objects using curves and surfaces, so that the models can be used further for downstream applications.**

Course Outcomes

CO1	**Understand the computer hardware and graphics.**
CO2	**Develop an analytical ability to represent transformations of rigid bodies using CAD.**
CO3	**Employ the mathematical techniques for geometric modeling.**
CO4	**Interpolate or fit curves through given points, and design curves to achieve the required shape using CAD methods.**
CO5	**Design surfaces to model shapes of objects in the nature mathematically.**
CO6	**Perform mathematical modeling for simulation of basic CAD design.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	30	50	100

Course Content:

Unit I: Introduction to CAD and Computer Graphics 9 lecture hours
Product Development Cycle – Introduction to CAD, Hardware and software requirement of CAD; Graphics input devices- cursor control devices, Digitizers, Scanners, speech oriented devices and touch panels, Graphics display devices- Refresh cathode ray tubes, Raster-scan displays, Random-scan displays, CRT Monitors; Input devices- keyboard, joy-stick, mouse, scanner; DVST, Flat- panel display, Hard copy devices - Printers and Plotters, dot matrix, inkjet, laser printers, Graphics Standards – Neutral File formats –IGES, STEP, Graphics software, Graphics functions, output primitives- Bresenham's Algorithm and DDA.
Unit II: Transformation 9 lecture hours
Geometric Transformation - Basic transformation, translation, rotation, scaling, reflection, homogeneous coordinates; Composite Transformation- Introduction, translation, rotation, scaling, 3-D transformation- translation, rotation, scaling, reflection; 3-D composite transformation- generalized rotation, generalized reflection.
Unit III: Projection and Geometric Modeling 8 lecture hours
3 D projections- orthographic projection, axonometric projection, oblique projection, perspective projection, Geometric Modeling – Wireframe, Surface and Solid – CSG and B-Rep- World/device co-ordinate representations.
Unit IV: Curves 8 lecture hours
Introduction to curves, parametric continuity condition, geometric continuity condition, spline representation, spline specification, geometric and algebra forms, cubic spline interpolation method, natural cubic spline, Bezier curves, B-spline curves, curve animation.
Unit V: Surfaces 6 lecture hours
Quadric surfaces- sphere, ellipsoid, torus; Bezier surfaces; B-spline surfaces, design surface using software.
Unit VI:
Mathematical modeling and simulation of mechanical objects

Suggested Reading

1. Newman & Sprawl (1978), Principles of interactive Computer Graphics, Mcgraw hill college, ISBN- 978-0-074-63293-2
2. Michel E. Mortenson (2006), Geometric modeling, Industrial press, ISBN-978-0-201-84840-3
3. Van Dam, Hughes Jhon, James Foley (2002), Computer graphics, principles and practices Pearson, ISBN-978-0-201-84840-3
4. Foley & van dam (1982), Fundamental of Interactive computer graphics, Addison Wesley longman publishing co, ISBN- 978-1-852-33818-3

5. David Rogers (2001), Procedural elements of Computer graphics, TMH, ISBN- 978-0-070-53529-9
6. Rogers and Adams (2002), Mathematical elements of Computer Graphics, TMH,ISBN- 978-0-070-53529-9
7. Hearn & baker (2011), Computer Graphics, Pearson,ISBN- 978-8-177-58765-4.

Name of The Course	**Product Design**			
Course Code	**BTME3056**			
Prerequisite				
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives

1.To acquire skills to design and develop products in a structured way.
2.To get aware with general design principles for manufacturability.
3.To understand the incorporation of ergonomics in product design.

Course Outcomes

CO1	**Explain product development process and review design of existing product considering reliability.**
CO2	**Design a product according to requirement of market.**
CO3	**Evaluate the existing design on the basis of strategies.**
CO4	**Use DFMA software for product development.**
CO5	**Incorporate the ergonomics into the product design.**
CO6	**Explain the value engineering concepts in product design and development**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	**30**	**50**	**100**

Course Content:

Unit I: New Product development **8 lecture hours**
Product development – Trends– Best practices– Product development process and organizations – Collaborative product development – Time compression Technologies – risk management – Stages of Product development. Conceptual / Industrial / Engineering design. Design analysis and validation.
Unit II: Conceptual design **8 lecture hours**
Early design – Customer needs – Requirement Definition and Conceptual design – Optimization using cost and utility metrics – Trade-off analysis- models and parameters- design to cost – Design to Life cycle cost – Design for warranties- problem solving – Benchmarking.

Unit III: Evaluation 8 lecture hours
Detailed design – Analysis and modeling – Best practices for detailed design – Design analyses – Prototypes in detailed design – Test and Evaluation – Design review, prototyping – simulation and testing – Manufacturing – Strategies – planning and methodologies.
Unit IV: Design for Manufacture and assembly 8 lecture hours
General design principles for manufacturability – strength and mechanical factors, mechanism selection-process capability – Feature tolerances – Geometric tolerances – Assembly limits – Datum features – Tolerance stacks – Problems on tolerancing – Exposure on DFMA software.
Unit V: Design for X 8 lecture hours
Simplification – commonality and preferred methods – Modularity and scalability – part reduction – functional analysis and value engineering – Reliability – Strategies and practices – Testability – Design for test and inspection.Design for people – Ergonomics, Reparability, Maintainability, safety and product liability.
Unit VI:
Rapid prototyping concept ,process, product life cycle management, product design for manual assembly, the application of Value Engineering principles in product design, hands on experience on various product design tools such as CAD, DFM, DFA and DFMA

Suggested Reading

1.Karl T. Ulrich and Steven D. Eppinger (2009), Product Design and Development, 4th Edition, Tata McGraw-Hill Publishing Company Limited, ISBN: 978-0-070-14679-2.

2.Stephen C. Armstrong (2005), Engineering and Product development Management– The Holostic Approach, Cambridge University Press, ISBN: 978-0-521-01774-9.

3.IbrahimZeid (2006), Mastering CAD/CAM, 2nd Edition, Tata McGraw-Hill, ISBN: 978-0-070-63434-3.

4.Anoop Desai, Anil Mital and Anand Subramanian (2007), Product Development: A Structured Approach to Consumer Product Development, Design, and Manufacture, 1st Edition, Butterworth-Heinemann, ISBN: 978-0-750-68309-8.

Name of The Course	**Robotics and Automation**			
Course Code	**BTME3072**			
Prerequisite				
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives

1. **To get acquainted with constructional features and other basic information on robotics.**
2. **To know about the sensors used in robotics.**
3. **To learn robot programming of a typical robot and also the concepts of path planning and applications.**

Course Outcomes

CO1	**Explain the basics of robotics.**
CO2	**Explain the control system of robot.**
CO3	**Evaluate the importance of sensing system in robot.**
CO4	**Write code for robot program.**
CO5	**Apply economic measures to justify the advantages of robots in industry.**
CO6	**Simulating in Real Time: Hybrid Electric Vehicle**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	30	50	100

Course Content:

Unit I: Introduction 8 lecture hours
Definition of a Robot – Basic Concepts –Robot configurations – Types of Robot drives – Basic robot motions – Point to point control – Continuous path control.
Unit II: Components and Operation 8 lecture hours
Basic control system concepts – Control system analysis – Robot actuation and feed back - Manipulators – direct and inverse kinematics - Coordinate transformation – Brief Robot dynamics. Types of Robot and Effectors – Robot/ End – Effector interface.
Unit III: Sensing and Machine Vision 6 lecture hours
Range sensing – Proximity sensing –Touch sensing – Force and Torque sensing. Introduction to Machine vision – Sensing and Digitizing – Image processing and analysis.
Unit IV: Robot Programming 6 lecture hours
Methods – Languages – Capabilities and limitation – Artificial intelligence – Knowledge representation –Search techniques in A I and Robotics.
Unit V: Industrial Applications 6 lecture hours
Application of robots in machining – Welding – Assembly – Material handling –Loading and Unloading – CIM – Hostile and Remote environments.
Unit VI:
Model, simulate, and deploy a hybrid electric vehicle in the MATLAB & Simulink environment

Suggested Reading

1.Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, (2010), Robotic Engineering An Integrated Approach, 1st Edition, Prentice-hall of India. ISBN: 978-8-120-30842-8
2.John J. Craig (2008), Introduction to Robotics: Mechanics and Control, 3rd Edition, Pearson Education. ISBN: 978-8-131-71836-0.

3.S. R. Deb and Sankha Deb (2009), Robotics Technology and Flexible Automation, 2nd Edition, Tata McGraw-Hill Education. ISBN: 978-0-070-07791-1.
4.Robert Joseph Schilling (2007), Fundamentals of Robotics: Analysis and Control, Prentice Hall India. ISBN: 978-8-120-31047-6.

Name of The Course	**Finite Element Analysis**			
Course Code	**BTME3061**			
Prerequisite				
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives

1. **To enable the students understand the mathematical and physical principles underlying the Finite Element Method (FEM) as applied to solid mechanics and thermal analysis**
2. **To understand the characteristics of various finite elements.**
3. **To develop finite element equations for simple and complex domains.**

Course Outcomes

CO1	**Understand concepts of variational principle and elasticity.**
CO2	**Discretize simple and complex bodies.**
CO3	**Populate stiffness matrix for a given discretized body.**
CO4	**Solve advanced field problems.**
CO5	**Use advanced special elements for solving complex engineering problems.**
CO6	**Formulate higher order finite element**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	**30**	**50**	**100**

Course Content:

Unit I: Introduction to Theory of Elasticity 8 lecture hours
Introduction to Theory of Elasticity: Definition of stress and strain – plane stress – plane strain – stress strain relations in three dimensional elasticity. Introduction to Variational Calculus: Introduction –General field problems, discrete and continuous models, Variational formulation in finite elements – Ritz method - Weighted residual methods – Galerkin – sub domain – method of least squares and collocation method - numerical problems.
Unit II: Discretization of the problem 8 lecture hours
Discretization of the Problem: Introduction – Geometrical approximations – Simplification through symmetry – Element shapes and behaviour – Choice of element types – size and number of elements – Element shape and distortion – Location of nodes – Node and Element numbering. Interpolation Function: Simplex - complex and multiplex elements – Linear interpolation polynomials for various simplex elements – Convergence requirements – derivation of shape function equations.

Unit III: Stiffness matrix formulation 8 lecture hours
One dimensional elasticity – Bar with constant and varying cross section - and Pin jointed truss member – Two dimensional elasticity – Plane stress - plane strain and axisymmetric simplex elements only - simple numerical problems.
Unit IV: Field problems **8 lecture hours**
General field equation – Formulation of 1D and 2D – steady state heat transfer problems involving conduction and convection and torsion of prismatic members – simple numerical problems.
Unit V: Higher order problems **8 lecture hours**
Natural coordinate system and numerical integration – Higher order 1D and 2D elements – Derivation of shape function equations for Four node quadrilateral - six node triangle and eight node quadrilateral elements – formulation of element equation.
Unit VI: 3 lecture hours
Formulating the basic equations for brick element, developing the equations for 14 node brick element starting from Papcovitch-Neuber (PN) solutions.

Suggested Reading

1. Tirupathi R. Chandrupatla (2009), Finite Element Analysis for Engineering and Technology, 1st Edition, University Press. ISBN: 978-8-173-71427-6.
2. P. Seshu (2010), Text book of Finite Element Analysis, Prentice Hall of India. ISBN: 978-8-120-32315-5
3. J.N. Reddy (2005), An Introduction to the Finite Element Method, McGraw-Hill, Third Edition. ISBN: 978-0-070-60741-5.
4. S. S. Rao (2012), The Finite Element Method in Engineering, 5th Edition, Elsevier. ISBN: 978-9-380-93155-5.
5. O.C. Zienkiewicz, R.L. Taylor and J. Z. Zhu (2005), The Finite Element Method: Its Basis and Fundamentals, 6th Edition, Butterworth-Heinemann. ISBN: 978-0-750-66320-5.

Name of The Course	**Electric and Hybrid Vehicles**			
Course Code	**BTME3071**			
Prerequisite				
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives

1. **To study the properties of alternative fuels for automobiles.**
2. **To identify the appropriate alternative fuel system for automobile application**

Course Outcomes

CO1	Describe the pros and cons of different types of EVs and HEVs
CO2	Perform basic designs of EV and HEV systems using series, parallel and series-parallel architectures.
CO3	Define the testing procedures for EVs and HEVs
CO4	Discuss the emerging technologies, engineering challenges, and development trends in EVs and HEVs.
CO5	Demonstrate the knowledge of electric, hybrid and solar powered vehicle.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	30	50	100

Course Content:

Unit-1 Need for alternative system **8 hours**
Need of electric vehicles hybrid vehicles – comparative study of diesel, petrol, pure electric and hybrid vehicles. Limitations of electric vehicles. Specification of some electric and hybrid vehicles
Unit-2 Energy sources: Batteries and fuel cells
Battery Parameters-Power requirement of electric vehicles- Different types of batteries – Lead acid-Nickel based-Sodium based-Lithium based- Metal Air based. Battery charging- Charger design- Quick charging devices- Battery Modeling. Fuel Cell- Fuel cell characteristics- Fuel cell types-Hydrogen fuel cell- Connecting cell in series water management in the PEM fuel cell- Thermal Management of the PEM fuel cell
Unit-3 Alcohol Based Fuels
A characteristic of permanent magnet and separately exited DC motors. AC single phase and 3-phase motor – inverters – DC and AC motor speed controllers.
Unit-4 Vehicle design considerations for electric vehicles
Aerodynamic-Rolling resistance- Transmission efficiency- Vehicle mass- Electric vehicle chassis and Body design considerations- Heating and cooling systems- Controllers- Power steering- Tyre choice-Wing Mirror, Aerials and Luggage racks
Unit-5 Hybrid Vehicles
Types of Hybrid- Series, parallel, split – parallel, series - parallel - Advantages and Disadvantages. Power split device – Energy Management System - Design consideration - Economy of hybrid vehicles

Suggested Reading

1. Modern Electric,Hybrid Electric, andFuel Cell Vehicles, Fundamentals, Theory, and Design by Mehrdad Ehsani, Texas A&M University,Yimin Gao, Texas A&M University
2.Sebastien E. Gay, Texas A&M University,Ali Emadi, Illinois Institute of Technology.
3. Ron HodKinson, " light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication,2005
4. Lino Guzzella, " Vehicle Propulsion System" Springer Publications,2005.

GALGOTIAS UNIVERSITY

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

School of Mechanical Engineering

Program: B. Tech., Automobile Engineering

Scheme: 2019 – 2020

Curriculum

Semester 1							Assessment Pattern		
Sl. No.	**Course Code**	**Name of the Course**	**L**	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	BCSE1002	Computer Programming and Problem Solving	0	0	4	2	50	-	50
2	BEEE1002	Basic Electrical and Electronics Engineering	3	0	0	3	20	50	100
3	BEEE1003	Basic Electrical and Electronics Engineering Lab	0	0	2	1	50	-	50
4	BTME1003	Product Manufacturing	0	0	2	1	50	-	50
5	BTME1001	Introduction to Mechanical Engineering	0	0	2	1	50	-	50
6	ENVS1001	Environmental Science	3	0	0	3	20	50	100
7	MATH1001	Multivariable Calculus	3	0	0	3	20	50	100
8	MATH1002	Exploration with CAS-I	0	0	2	1	50	-	50
9	SLBT1001	Basic English	0	0	4	2	50	-	50
10	JAPA1001	JAPANESE -I	0	0	2	1	50	-	50
	FREN1001	FRENCH -I							
	GERN1001	GERMAN –I							
11	PHYS1001	Engineering Physics	3	0	0	3	20	50	100
12	PHYS1002	Engineering Physics lab	0	0	2	1	50	-	50
13	PSSO1001	Psychology and Sociology	2	0	0	2	20	50	100
		Total	14	0	20	24			

Semester 2							Assessment Pattern		
Sl. No.	**Course Code**	**Name of the Course**	**L**	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	BCSE1003	Application Oriented Programming using Python	0	0	4	2	50	-	50
2	BTME1002	Product Design using Graphics	0	0	4	2	50	-	50
3	MATH1003	Matrices and Differential equations	3	0	0	3	20	50	100
4	MATH1004	Exploration with CAS-II	0	0	2	1	50	-	50
5	SLBT1002	English Proficiency and Aptitude Building - 1	0	0	4	2	50	-	50
6	JAPA1002	JAPANESE -II	0	0	2	1	50	-	50
	FREN1002	FRENCH -II							
	GERN1002	GERMAN -II							
7	CHEM1001	General Chemistry	3	0	0	3	20	50	100
8	CHEM1002	General Chemistry Lab	0	0	2	1	50	-	50
9	PHYS1003	Physics of Materials	3	0	0	3	20	50	100
10	PHYS1005	Advance Physics Lab	0	0	2	1	50	-	50
11	UHVE1001	Universal Human Values and Ethics	0	0	4	2	50	-	50

		Total	**9**	**0**	**24**	**21**			

Semester 3							**Assessment Pattern**		
Sl. No.	**Course Code**	**Name of the Course**	**L**	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	**BTME2001**	**Engineering Mechanics**	**3**	**0**	**0**	**3**	**20**	**50**	**100**
2	**BTME2002**	**Engineering Thermodynamics**	**3**	**0**	**0**	**3**	**20**	**50**	**100**
3	**BTME2003**	**Manufacturing Processes I**	**3**	**0**	**0**	**3**	**20**	**50**	**100**
4	**BTME2024**	**Material Science (PBL)**	**2**	**0**	**2**	**3**	**20**	**50**	**100**
5	**MATH2001**	**Functions of complex variables and Transforms**	**3**	**0**	**0**	**3**	**20**	**50**	**100**
6	**SLBT2021**	**English Proficiency and Aptitude Building – 3**	**0**	**0**	**4**	**2**	**50**	**-**	**50**
7	**BTME2004**	**Manufacturing Processes I Laboratory**	**0**	**0**	**2**	**1**	**50**	**-**	**50**
8	**BTME2005**	**Machine Drawing Laboratory (PBL)**	**0**	**0**	**4**	**2**	**50**	**-**	**50**
9	**BTME2022**	**SKILL Lab (Solid Works)**	**0**	**0**	**2**	**1**	**50**	**-**	**50**
10	**BTME2023**	**Excel, PPT Training and Hobby class**	**0**	**0**	**2**	**1**	**50**	**-**	**50**
		Total	**14**	**0**	**16**	**22**			
Semester 4							**Assessment Pattern**		
Sl. No.	**Course Code**	**Name of the Course**	**L**	**T**	**P**	**C**	**IA**	**MTE**	**ETE**
1	**BTME2008**	**Mechanics of Material**	**3**	**0**	**0**	**3**	**20**	**50**	**100**
2	**BTME2009**	**Fluid Mechanics (PBL)**	**2**	**0**	**2**	**3**	**20**	**50**	**100**
3	**BTME2010**	**Manufacturing Processes II and Metrology**	**3**	**0**	**0**	**3**	**20**	**50**	**100**
4	**MATH2003**	**Probability and Statistics**	**3**	**0**	**0**	**3**	**20**	**50**	**100**
5	**BTME2020**	**Microeconomics**	**3**	**0**	**0**	**3**	**20**	**50**	**100**
6	**BTME2017**	**AI & Machine Learning using Python**	**0**	**0**	**4**	**2**	**50**	**-**	**50**
7	**SLBT2002**	**Spoken English, Empower (Cambridge university program)**	**0**	**0**	**4**	**2**	**50**	**-**	**50**
8	**BTME2012**	**Mechanics of Material Laboratory**	**0**	**0**	**2**	**1**	**50**	**-**	**50**
9	**BTME2013**	**Manufacturing Processes II and Metrology Laboratory**	**0**	**0**	**2**	**1**	**50**	**-**	**50**
10	**BTME3023**	**Additive Manufacturing**	**0**	**0**	**4**	**2**	**50**	**-**	**50**
11	**BTME3022**	**Sensors & Transducers**	**1**	**0**	**0**	**1**	**20**	**50**	**100**
		Total	**15**	**0**	**18**	**24**			
Semester 5							**Assessment Pattern**		
Sl. No.	**Course Code**	**Name of the Course**	**L**	**T**	**P**	**C**	**IA**	**MTE**	**ETE**

1	BAUT3001	Automotive Engines	3	0	0	3	20	50	100
2	BAUT3002	Heat Engineering	3	0	0	3	20	50	100
3	BTME3002	Kinematics of Machines	3	0	0	3	20	50	100
4	PE01	Program Elective - 1	3	0	0	3	20	50	100
5	PE02	Program Elective - 2	3	0	0	3	20	50	100
6	PE03	Program Elective - 3	3	0	0	3	20	50	100
7	SLBT3031	English Proficiency and Aptitude Building - 5	0	0	4	2	50	-	50
8	BTME3017	AI & Machine Learning using Python	0	0	4	2	50	-	50
9	BAUT3003	Heat Engineering Lab	0	0	2	1	50	-	50
		Total	18	0	12	23			

Semester 6	Assessment Pattern

Sl. No.	Course Code	Name of the Course	L	T	P	C	IA	MTE	ETE
1	BTME3007	Machine Design(PBL)	4	0	0	4	20	50	100
2	BAUT3004	Automotive Chassis and Body Engineering	3	0	0	3	20	50	100
3	BTME3008	Dynamics of Machines	3	0	0	3	20	50	100
4	BAUT3005	Automotive Transmission Systems	3	0	0	3	20	50	100
5	PE04	Program Elective - 4	3	0	0	3	20	50	100
6	PE05	Program Elective - 5	3	0	0	3	20	50	100
7	SLBT3002	Soft Skill - 6 (Campus to Corporate)	0	0	4	2	50	-	50
8	BTME3010	Dynamics of Machines Laboratory	0	0	2	1	50	-	50
		Total	23	0	4	22			

Semester 7	Assessment Pattern

Sl. No.	Course Code	Name of the Course	L	T	P	C	IA	MTE	ETE
1	BAUT4001	CAD/CAM	3	0	0	3	20	50	100
2	BAUT4006	Pollution control and Lubrication Engineering	3	0	0	3	20	50	100
3	BTME4005	Optimization Techniques and Applications	2	0	0	2	20	50	100
4	BTME4006	Quality and Reliability Engineering	1	0	0	1	20	50	100
5	BTME4010	Project Management	2	0	0	2	20	50	100
6	BTME4004	Comprehensive Examination	0	0	2	1	50	-	50
7	BAUT4004	CAD/CAM Laboratory	1	0	0	1	20	50	100
8	BTAUT4008	Industrial Internship	0	0	0	2	50	-	50
9	BAUT9991	Capstone Project- Phase I	-	-	-	2	50	-	50
		Total	8	0	4	17			

Semester 8	Assessment Pattern

Sl. No.	Course Code	Name of the Course	L	T	P	C	IA	MTE	ETE
1	BAUT9992	Capstone Project- Phase II	-	-	-	9	50	-	50
		Total				9			

List of Electives

Elective 1

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	BAUT3055	Two And Three Wheeled Vehicles	3	0	0	3	20	50	100

Elective 2

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	BAUT3051	Vehicles Dynamics	3	0	0	3	20	50	100

Elective 3

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	BAUT3054	Alternative Fuels & Energy Systems	3	0	0	3	20	50	100

Elective 4

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	BAUT3058	Electric and Hybrid Vehicles	3	0	0	3	20	50	100

Elective 5

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	BAUT3063	Aerodynamic Design of Vehicles	3	0	0	3	20	50	100

Detailed Syllabus

Name of The Course	**Introduction to Mechanical Engineering**				
Course Code	**BTME1001**				
Prerequisite					
Corequisite					
Antirequisite					
	L	**T**	**P**	**C**	
	0	**0**	**2**	**1**	

Course Objectives:

1. To introduce the discipline of Mechanical Engineering, its fundamentals, its sub disciplines and their interaction.
2. To introduce the key mechanical engineering components such as an internal combustion engine, refrigerators, power plant machinery and machine elements.

Course Outcomes

CO1	**Relate various manufacturing techniques and joining process.**
CO2	**Illustrate the power transmitting elements.**
CO3	**Describe the working of internal combustion engine.**
CO4	**Compare the principles of various power plants.**
CO5	**Illustrate the working principle of thermal power cycles and refrigeration.**

Text Book (s)

1. Kumar, Pravin, Basic Mechanical Engineering, 1st Edition, Pearson India, 2013,ISBN: 978-9-332-50575-9

Reference Book (s)

1. Manglik, V. K., Elements of Mechanical Engineering, 1st Edition, PHI, 2013, ISBN: 978-8-120-34629-1

Course Content:

Unit I: Manufacturing Techniques and Machine Elements 7 Hours
Introduction to Lathe and its operations, Drilling; metal joining processes – shielded metal arc & gas welding, Brazing and soldering; Sheet metal working, Smithy.
Unit II: Machine Elements 7 Hours
Helical and leaf springs; Cams - types of cams and followers; Gears - Spur, helical and bevel gears, gear trains; Belt drives – types; chain drives; Introduction to clutch.
Unit III: Internal combustion engine 8 Hours
Introduction to Otto cycle, diesel cycle, Principle of internal and external combustion engines; two strokes and four strokes engines; emission control.
Unit IV: Power Plant Engineering 9 Hours
Introduction and classification of power plants – thermal, hydroelectric, diesel, nuclear power plants, Tidal power plants, Geo-thermal power plant; introduction to steam and gas turbines.
Unit V: Refrigeration cycles 9 Hours

Introduction to Refrigeration – Principle of vapour compression refrigeration system – Principle of vapour absorption refrigeration system, Air-conditioning – Layout of typical domestic refrigerator – window and split, centralized type air conditioner.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Product Design using Graphics**				
Course Code	**BTME1002**				
Prerequisite					
Corequisite					
Antirequisite					
	L	**T**	**P**	**C**	
	0	**0**	**4**	**2**	

Course Objectives:

4. **To introduce the concept of product design.**
5. **To establish the usage of basics of engineering graphics in product design.**
6. **To introduce graphics software and apply graphics software for devloping product model.**

Course Outcomes

CO1	**Understand the concept and principles of engineering graphics in product design.**
CO2	**Make isometric and orthographic projection of solids along with free hand sketching.**
CO3	**Develop a solid model using AutoCAD**
CO4	**Make a solid model for a given assembly using AutoCAD.**
CO5	**Apply the concepts and techniques learnt in the course to make hands-on project.**

Text Book (s)

4. Asimow, M. (1962). Introduction to design. Englewood Cliffs: Prentice-Hall.
5. K C John (2009), Engineering Graphics for Degree, Prentice Hall of India. ISBN: 978-8-120-33788-3.
6. P N Rao (2010), CAD/CAM Principles and Applications, 3rd Edition, Tata McGraw-Hill Education, ISBN: 978-0-070-68193-4.

Course Content:

Unit I: Introduction – Understanding the Concept of Product Design 10 Hours
Fundamentals of Design : Design by Evolution and Design by Innovation, Principles that govern any design, Morphology and Process of Design, Application of Graphics in Design, Engineering Graphics: An Overview, Introduction to Computer Aided Drafting, Lettering, Numerals and Dimensioning.
Unit II: Projection of Solids 13 Hours
Concept of Projection, Object in four quadrant, 2-D description of quadrants, Orthographic Projection of Solids, Isometric Projection of Solids, Free-hand sketching.
Unit III: Solid Modeling 12 Hours
Division of Engineering Solids- Polyhedra, Regular and Irregular polyhedral, solids of revolution, Geometric Modeling – Wireframe, B-Rep and Solid Modeling, Solid Modelling using AutoCAD.

Unit IV: Introduction to Assembly11 Hours
Types of assembly drawings, Accepted Norms for Assembly Drawings, Sequences of Preparing the Assembly Drawing, Solid Modeling of assembly.
Unit V: Application of Design Concepts for Product Design 10 Hours
Hands-on Project in Groups: Choose a specific objective for Product Design, Design the Product and Model it using AutoCAD, presentation.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	--	50	100

Name of The Course	**Product Manufacturing Lab**			
Course Code	**BTME1003**			
Prerequisite				
Corequisite				
Antirequisite				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course Objectives:

1. **To learn to make a product using different basic processes.**
2. **To get acquainted with assembling of two or more components to obtain a product.**
3. **To be trained to make a product out of wood.**

Course Outcomes

CO1	**Develop a product using Welding Process.**
CO2	**Develop a product out of a given sheet.**
CO3	**Assemble a product of wood in carpentry shop.**
CO4	**Create a product using casting and then machining.**
CO5	**Assemble different components to get final product with the help of welding**

Text Book (s)

1. Product Manufacturing Manualprepared by faculties of School of Mechanical Engineering.

Reference Book (s)

3. A.K. Hajra Choudhury, S.K. Hajra Choudhury and Nirjhar Roy (2009), Elements of Workshop Technology, Vol. – I, Media Promoters, ISBN: 978-8-185-09914-9.
4. A.K. Hajra Choudhury, S.K. Hajra Choudhury and Nirjhar Roy (2010), Elements of Workshop Technology, Vol. – II, Media Promoters, ISBN: 978-8-185-09915-6.

List of Exercises
2. To prepare a given product using the knowledge gained in Product Manufacturing Lab while working in the lab. (To be submitted at the end of the session and evaluated in the external examination)

2. Welding Shop
Any two of the following i. Prepare a Lap joint as per drawing using Oxy-Acetylene Gas welding j. Prepare a T-joint as per drawing using Oxy-Acetylene Gas welding k. Prepare a Butt-joint as per drawing using Oxy-Acetylene Gas welding l. Prepare L- joint as per drawing using Oxy-Acetylene Gas welding m. Prepare a Lap joint as per drawing using Electric Arc welding n. Prepare a T-joint as per drawing using Electric Arc welding o. Prepare a Butt-joint as per drawing using Electric Arc welding p. Prepare L- joint as per drawing using Electric Arc welding
3. Fitting Shop
b. Prepare a Male/Female Parts as per drawing
4. Lathe Machine Shop
b. Preparation of Job as per drawing.
5. Sheet metal Shop
b. Preparation of funnel of given dimension. Use soldering to join lower part with upper and use riveting to join cylinder
6. Foundry Shop
b. Preparation of Job of aluminium as per drawing through casting.
7. Carpentry Shop
Any one of the following e) Preparation of T-Joint of given dimension. f) Preparation of Lap Joint of given dimension. g) Preparation of Cross Joint of given dimension. h) Preparation of Dove Tail Joint of given dimension.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	**--**	**50**	**100**

Name of The Course	**Engineering Mechanics**			
Course Code	**BTME2001**			
Prerequisite				
Corequisite				
Antirequisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives:

4. To calculate the reactive forces and analyse the structures.
5. To know the geometric properties of the different shapes.
6. To learn energy and momentum methods.

Course Outcomes

CO1	**Solve the engineering problems involving equilibrium of paritcles and rigid bodies.**
CO2	**Solve the problems involving dry friction and virtual work.**
CO3	**Determine the centroid, centre of gravity and moment of inertia of various surfaces and solids.**
CO4	**Solve problems related to kinematics and kinetics of rigid body.**
CO5	**Solve problems using energy-momentum priniciple for a particle and rigid bodies in plane motion.**
CO6	**The student will be able to static force analysis of simple machines**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	30	50	100

Course Content:

Unit I: Equilibrium of Particle, Rigid body and Trusses 9 Hours
Introduction to Mechanics – Fundamental Principles – Coplanar forces – Equilibrium of particles – Free body diagram – Equilibrium of particle in space – Single equivalent force - - Equilibrium of rigid bodies in two dimensions. Analysis of plane trusses – Method of joints – Method of sections – Zero-force member.
Unit II:Friction and Virtual work 7 Hours
Characteristics of dry friction – Problems involving dry friction – Ladder – Wedges – Square threaded screws. Definition of virtual work – Principle of virtual work – System of connected rigid bodies – Degrees of freedom – Conservative forces – Potential energy – Potential energy criteria for equilibrium.
Unit III: Properties of Surfaces and Solids 6 Hours
Centroid – First moment of area – Theorems of Pappus and Guldinus – Second moment of area – Moment and Product of inertia of plane areas – Transfer Theorems – Polar moment of inertia – Principal axes – Mass moment of inertia.
Unit IV: Kinematic and Kinetics 9 Hours
Position, Velocity and Acceleration – Rectilinear motion – Curvilinear motion of a particle – Tangential and Normal components – Radial and Transverse components – Rotation of rigid bodies about a fixed axis – General plane motion – Absolute and relative motion method – Instantaneous centre of rotation in plane motion.

Linear momentum – Equation of motion – Angular momentum of a particle and rigid body in plane motion – D'Alembert's principle.
Unit V: Energy and Momentum Methods **9 Hours**
Principle of work and energy for a particle and a rigid body in plane motion – Conservation of energy - Principle of impulse and momentum for a particle and a rigid bodies in plane motion – Conservation of momentum – System of rigid bodies – Impact - direct and central impact – coefficient of restitution.
Unit VI
Term Projects will be given to groups to analyze lifting machines for real life applications like material lifting cranes, mechanical screw jack etc.

Suggested Reading

1. J. V. Rao, D. H. Young, S. Timoshenko, Sukumar Pati (2013), Engineering Mechanics, Tata McGraw Hill Education. ISBN: 978-1-259-06266-7.
2. P. Ferdinand, E. Beer and J. Russell (2010), Vector Mechanics for Engineers, 9th Edition, McGraw-Hill International Edition. ISBN: 978-0-079-12637-5
3. Irving H. Shames (2012), Engineering Mechanics – Statics and Dynamics, 4th Edition, Prentice-Hall of India Private limited. ISBN: 978-8-131-72883-3

Name of The Course	**Engineering Thermodynamics**			
Course Code	**BTME2002**			
Prerequisite				
Corequisite				
Antirequisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives:

4. To learn the basic principles of classical thermodynamics.
5. To study the laws of thermodynamics to various systems and analyze the significance of the results.
6. To analyze the performance of thermodynamic gas and vapour power cycles.

Course Outcomes

CO1	**Outline the thermodynamic properties for different types of system.**
CO2	**Apply the first law of thermodynamics for a system undergoing a cycle.**
CO3	**Demonstrate basic understanding of the second law of thermodynamics and its application to open and closed systems.**
CO4	**Demonstrate basic understanding of entropy and its application to engineering systems.**
CO5	**Practice the basic thermal analysis of thermodynamic cycles.**
CO6	**Apply thermodynamics relations to practical cases**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	30	50	100

Course Content:

Unit I: Basic Concepts of Thermodynamics	**6 Hours**
Thermodynamics and Energy, Macroscopic and microscopic viewpoint, Closed and open systems, Thermodynamic properties of a system, State and equilibrium, Processes and cycles, Forms of energy , Temperature and its measurement, Zeroth law of thermodynamics.	
Unit II: First Law of Thermodynamics	**9 Hours**
Work transfer, pdV work, Types of work transfer, Net work done by a system, heat transfer, path function, Specific heat and latent heat, First law of thermodynamics for a closed system undergoing a cycle and change of state, Energy – a property of the system, enthalpy, specific heat at constant pressure and volume, PMM-I, Control volume, First law applied to steady flow process, Mass and energy balance.	
Unit III: Second Law of Thermodynamics	**9 Hours**
Limitations of the first law of Thermodynamics, Kelvin-Planck statement of the second law of thermodynamics, Clausius statement, Equivalence of Kelvin- Planck and Clausius statements, Heat engine, Refrigerators, Heat Pump, COP, Carnot's theorem, Corollary of Carnot's theorem, Reversible and Irreversible process, Efficiency of Reversible Heat engine, PMM-II, Carnot cycle.	
Unit IV: Entropy and properties of pure sustances	**8 Hours**
Introduction, Clausius theorem, Entropy – property of the system, Clausius inequality, Entropy change in irreversible process, Entropy principle, Reversible adiabatic work in steady flow system, Availability and irreversibility, Second law efficiency, p-v, p-T and T-s diagrams for a pure substance, Quality, Introduction to steam tables.	
Unit V: Thermodynamic Cycles	**8 Hours**
Carnot cycle, Otto cycle, Diesel and Dual cycles, Brayton and reversed Brayton Cycle, Rankine cycle.	
Unit VI:	
Equation of State , Gibbs – Duhem relation , Maxwel relation , legendre transform , Thermodynamics potential , Clapeyron Equation	

Suggested Reading

5. P. K. Nag (2010), Basic and Applied Thermodynamics, Tata McGraw-Hill Publishing Company Ltd., ISBN 978-0-070-15131-4
6. R. K. Rajput, A Textbook of Engineering Thermodynamics, Laxmi Publications; Fifth edition, ISBN-13**:** 978-8131800584

7. Yunus A. Cengel and Michael A. Boles, Thermodynamics, An Engineering Approach, 8th Ed., McGraw Hill, 20015, ISBN: 978-9-339-22165-2.
8. Jean-Philippe Ansermet, Sylvain D. Brechet, Principles of Thermodynamics, Ist Ed., Cambridge University Press; ISBN-13: 978-1108426091

Name of The Course	**Manufacturing Processes I**				
Course Code	**BTME2003**				
Prerequisite					
Corequisite					
Antirequisite					
	L	**T**	**P**	**C**	
	3	**0**	**0**	**3**	

Course Objectives:

4. To acquire basic knowledge about the behaviour and manufacturing properties of engineering materials and concepts of foundry and casting processes.
5. To acquire knowledge about various methods of welding, cold and hot working, and forming process.
6. To understand forging, moulding and powder metallurgy processes in detail and application of these in manufacture of a product.

Course Outcomes

CO1	**Develop a simple shape of castings by using different casting methods.**
CO2	**Prepare the weld joints by using different welding methods.**
CO3	**Develop a product by using metal forming processes.**
CO4	**Demonstrate the powder metallurgy process for making a component.**
CO5	**Apply the knowledge in manufacturing a product from plastic or composite materials.**
CO6	**Know the research scope of manufacturing technology and understand the new trends in the manufacturing sector.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	**30**	**50**	**100**

Course Content:

Unit I: Metal Casting Processes	**12 Hours**
Manufacturing- selecting manufacturing process –Fundamentals of metal casting – Fluidity of molten metal – Solidification time – Sand casting – Shell mold casting - Investment casting - Plaster mold casting – Ceramic mold casting – Die casting - Centrifugal casting – Melting practice and furnaces - Defects in sand casting – Testing and inspection of casting.	
Unit II: Joining Processes	**10 Hours**

Metal fusion welding processes – Oxyfuel gas welding – Arc welding processes – Consumable electrode: SMAW- SAW – GMAW – FCAW – Non-consumable Electrode: GTAW- AHW- PAW – EBM – LBM – Solid state welding processes: Ultrasonic welding – Friction welding – Friction stir welding -Resistance welding – Weld quality – Testing welded joints.
Unit III: Metal Forming Processes 8 Hours
Cold and Hot working: Rolling – Forging – Extrusion – Drawing – Sheet metal forming processes – High Energy Rate Forming Processes: Explosive Forming – Electro Hydraulic Forming – Electro Magnetic Forming.
Unit IV: Processing of Metal Powders, Ceramics and Glass 5 Hours
Production of metal powders: Compaction – Sintering and Finishing – Design considerations for powder metallurgy and Process capability **Shaping of ceramics – Forming and shaping of glass – Design considerations for ceramics and glass – Processing of superconductors.**
Unit V: Processing of Plastics and Composite Materials 5 Hours
Types of Plastics – Types of Molding: Injection molding – Blow molding – Compression molding – Transfer molding – Thermoforming – Reinforced plastics – Metal Matrix Composites – Ceramic Matrix Composites.
Unit VI:
To study of research framework and industrial needs modernization of conventional machines and its scope in manufacturing sector.

Suggested Reading

1. Manufacturing Technology – Foundry, Forging and Welding (Vol-1), P.N.Rao. (2008), 3rd Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi,ISBN: 978-0-070-08798-9.
2. A.K. Hajra Choudhury, S.K. Hajra Choudhury and Nirjhar Roy (2009), Elements of Workshop Technology, Vol. – I, Media Promoters, ISBN: 978-8-185-09914-9.
3. W.A.J.Chapman (2001), Workshop Technology, Vol 1, 5th Edition, CBS Publishers, ISBN: 978-8-123-90401-6.

Name of The Course	**Materials Science**			
Course Code	**BTME2024**			
Prerequisite				
Corequisite				
Antirequisite				
	L	**T**	**P**	**C**
	2	**0**	**1**	**3**

Course Objectives:

1. The main objective of this course is to provide the basic knowledge needed to explore the discipline of materials science and engineering.
2. To develop the knowledge of how the structure of materials is described technically, including crystallography, microstructure, defects, and phase diagrams
3. To develop the knowledge of how the properties of materials are described technically and how material failure is analyzed
4. To introduce the concepts of structure-property relationships
5. To develop knowledge in various class of materials and their applications

Course Outcomes

CO1	**Explain how materials are formed and their classification based on atomic arrangement.**
CO2	**Draw the phase diagrams for different combination of metals.**
CO3	**Choose the heat treatment process for material based on the application.**
CO4	**Describe the mechanical behaviour of metallic systems and its importance.**
CO5	**Illustrate the different class of materials and their applications.**
CO6	**Analyze the micro-structural features of different materials.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	30	50	100

Course Content:

Unit I: Crystal Structure	**7 Hours**
Introduction to materials science – Primary and Secondary bonding in materials- Crystalline and amorphous materials –Single crystal and polycrystalline materials – Space Lattice-Module cell – Crystal systems – Bravais Lattice- Miller indices – Closed packed structures- Principal Metallic crystal structures stacking sequence and stacking faults and crystal defects- Point, Line, Planar and volume; Volume, planar and Linear density calculations- Polymorphism and allotropy.	
Unit II: Phase Diagrams	**8 Hours**
Basics of Solidification mechanism – Cooling curve of pure metal and alloy – Phase –Phase Diagram– Gibbs's Phase rule – Interpretation of mass fractions using Lever's rule – Hume Rothery rules-Binary Iso-morphous system- Binary Eutectic alloy system (Lead-Tin System) –Binary Peritectic alloy system (Iron-Nickel System) – Invariant reactions – Iron-Iron carbide phase diagram- Slow cooling of Hypo and hyper eutectoid steels – Temperature-Time-Transformation (TTT) and Continuous Cooling Transformation (CCT) Diagrams – Effect of alloying elements in steel – types of stainless steel and cast iron.	
Unit III: Heat Treatment	**7 Hours**
Heat Treatment – Annealing and its types, Normalizing, Hardening tempering, Aus-tempering and Mar-tempering – Microstructure observation – Surface Heat treatment processes – Carburizing, Nitriding, cyaniding, carbonitriding, flame and induction hardening.	

Unit IV: Mechanical Properties of Materials and Testing 10 Hours
Mechanical properties of materials – Strengthening mechanism –- Plastic deformation of single and poly-crystalline materials – Effect of Slip and twinning – Stress-strain curves of various ferrous and non-ferrous metals –Engineering stress strain – true stress strain relations –problems - Tensile test of ductile material – properties evaluation- Hardness measurement tests – Fracture of metals – Ductile and Brittle fracture; Fatigue – Endurance limit of ferrous and non-ferrous metals – Fatigue test ; Creep and stress rupture– mechanism of creep – stages of creep and creep test – SEM, XRD.
Unit V: Advanced materials and Applications 8 Hours
Composites – Fiber reinforced, Metal Matrix, Ceramic Matrix – properties and applications; Ceramics – Alumina, Zirconia, Silicon Carbide, Sialons, Reaction Bonded Silicon Nitride(RBSN), Glasses– properties and applications- Magnetic materials – Hard and soft magnets – Ferromagnetic Hysteresis – properties of magnetic materials – Intermetallic compounds-Polymers – thermosetting and thermoplastics – mechanical properties of polymers-Material selection procedure (two case studies)
Unit VI: List of Experiments
1. To study crystal structures of materials. 2. To study crystal imperfections in given specimens. 3. To study Bravais lattices with the help of models. 4. Specimen preparation and micro-structural examination. 5. Comparative study of microstructures of given specimens (mild steel, gray C.I., brass, copper etc.) 6. Heat treatment experiments such as annealing, normalizing, quenching, case hardening and comparison of hardness before and after. 7. To study microstructure of heat-treated steel. 8. To study thermo-setting of plastics. 9. To study the creep behavior of a given specimen 10. To study the properties of various types of plastics

Suggested Reading

1. V. Raghavan. Materials science and Engineering: A First Course 5E, ISBN 9788120324558.
2. William D. Callister , David G. Rethwisch, Fundamentals of materials science and Engineering: An integrated approach 3e : An Integrated Approach 3E ISBN 0470125373 (0-470-12537-
3. William F. Smith and Javad Hashemi (2004), Foundations of materials science and Engineering 4th ed., Mc Graw Hill. Isbn: 978-0-073-52924-0

Name of The Course	**Functions of complex variables and transforms**			
Course Code	**MATH 2001**			
Prerequisite				
Corequisite				
Antirequisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives:

In modern world, Functions of complex variables and transform Calculus has become an important tool extensively used in many fields such as science, engineering, business, industry.The objective of the course is familiarizing the prospective engineers with techniques in Transform Calculus and differentiation and integration of Complex variable. It aims to equip the students with standard concepts and tools to advance level that will serve them well towards tackling more advanced level of Mathematics and application that they would find useful in their discipline.

Course Outcomes

CO1	**To understand the behavior of complex valued functions such as continuity/differentiability and analyticity.**
CO2	**To evaluate complex integral, singularities, residue of an analytic function, contour integral and an integral over the real line.**
CO3	**To apply Laplace transforms for solving initial value problems**
CO4	**To applyFourier transforms for solving one dimensional heat and wave equations.**
CO5	**To apply inverse Z-transforms for solving difference equations.**
CO6	**To apply Z - transform for difference equations.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	30	50	100

Course Content:

Unit I: Complex Differentiation **12 Hours**
Complex number system(A review), Limit, Continuity, Differentiability of function, Cauchy-Riemann Equations in Cartesian and Polar coordinates, Analytic function, elementary analytic functions (exponential, trigonometric, logarithm),Harmonic functions, harmonic conjugate, Conformal mappings and mobius transformations with their properties.
Unit II: Complex Integration **10 Hours**
Contour integral, Cauchy theorem (without proof), Cauchy Integral formula (withoutproof), Maximum-Modulus theorem (without proof), Taylor's and Laurent's series: radius and circle of convergence, Zeroes and singularities of analytic functions, Residues, Residue theorem (without proof), Evaluation of definite integrals involving sine and cosine, and real definite integrals around unit and semi circles.
Unit III: **Laplace Transform** **10 Hours**
Definition, existence condition, Properties, Laplace transform of Periodic, Unit step and Dirac Delta functions, Laplace transforms of derivatives and integrals, Evaluation of integrals using Laplace transforms, Convolution theorem, Inverse Laplace transform, Application of Laplace Transform in solving initial value problems.
Unit IV: Fourier Transform **7 Hours**

Fourier integrals, Complex Fourier transforms, Fourier sine and cosine transforms, Properties of Fourier transforms, Convolution theorem, Fourier transforms of derivatives, Applications of Fourier transform in solving one dimensional Heat and Wave equations.
Unit V: Z Transform **6 Hours**
Definition and Elementary properties of Z-transform (Unilateral, Bilateral), Inverse Z–transform.
Unit VI: **3 Hours**
Convolution theorem, Solution of difference equations using Z - transform.

Suggested Reading

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley &Sons.
2. J W Brown and R V Churchill, Complex Variables and Applications ,7th Ed., Mc-GrawHill,2004
3. Michael D. Greenberg, Advanced Engineering Mathematics, 2nd Edition, PearsonEducation
4. Peter V. O'Neil,Advanced Engineering Mathematics, 6th Edition, CengageLearning.
5. R. K. Jain and S. R. K. IyengarAdvanced Engineering Mathematics, 4th Edition, NarosaPublishers

Name of The Course	**Artificial Intelligence and Applications**				
Course Code	**BTME2021**				
Prerequisite					
Co-requisite					
Anti-requisite					
	L	**T**	**P**	**C**	
	1	**0**	**0**	**1**	

Course Objectives

1. To present a problem oriented in depth knowledge of Artificial Intelligence and Applications.
2. To address the underlying concepts, methods and application of different Artificial Intelligence and Applications

Course Outcomes

CO1	**Understand the scope of AI**
CO2	**Explain problem solving state space search**
CO3	**Apply knowledge representation predicate logic**
CO4	**Describe handling uncertainty and learning**
CO5	**Apply for practical cases.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	30	50	100

Course Content:

Unit I: Scope of AI	**8 Hours**
Introduction to AI- application domains - natural language processing, vision and speech processing, robotics, expert systems, AI techniques- search knowledge, abstraction.	
Unit II: Problem solving State space search	**8 Hours**
Production systems, search space control: depth first, breadth-first search, heuristic search - hill climbing, best-first search, branch and bound. Problem Reduction, Constraint Satisfaction End, Means-End Analysis.	
Unit III: Knowledge Representation Predicate Logic	**8 Hours**
Unification, modus pones, resolution, dependency directed backtracking. Rule based Systems: forward reasoning, conflict resolution, backward reasoning, use of no backtracks. Structured Knowledge Representation: semantic net slots, exceptions and default frames, conceptual dependency, scripts.	
Unit IV: Handling uncertainty and learning	**8 Hours**
Non-monotonic reasoning, probabilistic reasoning, use of certainty factors, fuzzy logic, Concept of learning, learning automation, genetic algorithm, learning by inductions, neural network.	
Unit V: Applications using AI	**8 Hours**
Various Applications - Robot Classification, Robot Specification, notation Direct and Inverse Kinematics: Co-ordinates Frames, Rotations, Homogeneous Coordinates.	

Suggested Reading

1. S. E. Rich and K. Knight, "Artificial intelligence", MH, 2nd ed., 1992.
2. N.J. Nilsson, "Principles of AI", Narosa Publ. House, 2000.
3. Robin R Murphy, Introduction to AI Robotics PHI Publication, 2000
4. D. W. Patterson, "Introduction to AI and Expert Systems", PHI, 1992.
5. R. J. Schalkoff, "Artificial Intelligence - an Engineering Approach", McGraw Hill Int. Ed., Singapore, 1992.
6. George Lugar,. Al-Structures and Strategies for and Strategies for Complex Problem solving, 4/e, 2002, Pearson Education

Name of The Course	**Manufacturing Processes I Laboratory**				
Course Code	**BTME2004**				
Prerequisite					
Corequisite					
Antirequisite					
	L	**T**	**P**	**C**	
	0	**0**	**2**	**1**	

Course Objectives:

1. To learn to give initial shapes to a metal in foundry shop and to be processed further to make a product.

2. To train to join metal pieces using different welding techniques.

Course Outcomes

CO1	**Prepare sand mould and it further used to produce casting.**
CO2	**Determine the characteristics of sand permeability number and fine grainness number.**
CO3	**Produce simple casting components using sand mould casting technique.**
CO4	**Prepare a weld joint by using different welding techniques.**
CO5	**Illustrate the relationship between cutting parameters of cutting speed, feed rate and depth of cut on forces generated in oblique cutting.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
50	**-**	**50**	**100**

Course Content:

List of Experiments
1. Preparation of green sand mould using wooden pattern. **2. Determination of grain fineness number.** **3. Determination of permeability number.** **4. Determination of compressive and shear strength of moulding sand.** **5. Preparation of casting using non-ferrous metals with the help of tilting furnace.** **6. Preparation of butt joint using gas oxy acetylene gas welding.** **7. Welding of stainless steel specimen using TIG welding.** **8. Preparation of butt joint with V-groove using MIG welding.** **9. To establish the relationship between cutting parameters of cutting speed, feed rate and depth of cut on forces generated in oblique cutting.** **10. Study and identification of various types of flames generated in oxy-acetylene gas welding.**

Suggested Reading

5. Manufacturing Processes I Lab manual prepared by faculties of School of Mechanical Engineering

- A.K. Hajra Choudhury, S.K. Hajra Choudhury and Nirjhar Roy (2009), Elements of Workshop Technology, Vol. – I, Media Promoters, ISBN: 978-8-185-09914-9.
- W.A.J.Chapman (2001), Workshop Technology, Vol 1, 5th Edition, CBS Publishers, ISBN: 978-8-123-90401-6.
- P.N.Rao. (2008), Manufacturing Technology – Foundry, Forging and Welding (Vol-1), 3rd Edition, McGraw Hill Publishing Company Ltd., New Delhi, ISBN: 978-0-070-08798-9.

Name of The Course	**Machine Drawing Laboratory**

Course Code	**BTME2005**				
Prerequisite					
Corequisite					
Antirequisite					
	L	**T**	**P**	**C**	
	0	**0**	**2**	**1**	

Course Objectives:

1. To introduce the students to the basics and standards of engineering drawing related to machine elements.

2. To enable the students to draw sectioned views, development of surfaces and orthographic views of machine elements.

3. To train the students technical skills regarding part drawings, production and assembly drawings.

Course Outcomes

CO1	**Draw and interpret sectioned solids and development of surfaces.**
CO2	**Explain various standards and specifications related to standard machine components.**
CO3	**Apply the knowledge of fits and tolerances for various applications.**
CO4	**Draw orthographic views of machine elements.**
CO5	**Select, configure and synthesize mechanical components into assemblies.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
50	**-**	**50**	**100**

Course Content:

Unit I: Sectioning of Solids and Development of Surfaces **6 Hours**
Selection of Views-Parts not usually sectioned- Development of Surfaces and application in sheet metal industry.
Unit II: Machine Drawing Conventions **4 Hours**
Need for drawing conventions- introduction to BIS conventions-Reference to hand book for the selection of standards-Conventional representation of material, common machine elements and parts -Methods and general rules of dimensioning of holes, centers, curved and tapered features.
Unit III: Limits, Fits and Tolerances **4 Hours**
Limits, Fits and tolerances – Allocation of fits for various mating parts – Tolerance data sheet – Tolerance table preparation –Geometric tolerance.
Unit IV: Drawing of Machine Elements **10 Hours**
Drawing of the following machine elements: threaded fasteners and joints, keys, cotters and pin joints, welded and riveted joints, pipe joints, shaft coupling and pulleys, journals and bearings.
Unit V: Assembly Drawings **4 Hours**

Drawings of assembled views for the part drawings of the Engine parts and and other machine parts- Screw jack, Machine Vice, single tool post. Valves: Steam stop valve, feed check valve.

Suggested Reading

7. N.D. Bhatt (2011), Machine Drawing, Published by R.C.Patel, 46th Edition, Charotar PublishingHouse Book Stall, ISBN: 978-9-380-35846-8.
8. K C John (2009), Engineering Graphics for Degree, Prentice Hall of India. ISBN: 978-8-120-33788-3.
9. Warren Luzadder and Jon M. Duff (2009), Fundamentals of Engineering Drawing with an Introduction to Interactive Computer Graphics for Design and Production, 11th Edition, PHI Learning, ISBN: 978-8-120-30885-5.
10. P.S. Gill (2012), Machine Drawing, S. K. Kataria& Sons, ISBN: 978-8-185-74979-2.
11. Ajeet Singh (2012), Machine Drawing (with AutoCAD), 2nd Edition, Tata Mcgraw Hill Education, ISBN: 978-0-071-07294-6.
12. Barclay James and Griffiths Brian (2002), Engineering Drawing for Manufature, Butterworth-Heinemann, ISBN: 978-1-857-18033-6.

Name of The Course	**Skill (Solid Works)**			
Course Code	**BTME2022**			
Prerequisite				
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course Objectives:

- To enable students to use a modern CAD software package for solid modeling.
- To draw 3D views of various machine elements.
- To apply the knowledge of software package to model any chosen prototype.

Course Outcomes

CO1	**Use SolidWorks software package for solid modeling.**
CO2	**Draw solid models of various machine elements in SolidWorks.**
CO3	**Apply the knowledge of SolidWorks to model any chosen prototype.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
50	-	50	100

Course Content:

	Unit	Unit Topics

Week 1(2Hours)	**1.Introduction to SOLIDWORKS**	• Introduction to SOLIDWORKS 2016 • Getting Started with SOLIDWORKS • Menu Bar and SOLIDWORKS Menus • Command Manager • Toolbar • Dimensioning Standard and Units • Important Terms and Their Definitions • Hot Keys • Color Scheme
Week 1 (2Hours)	**2. Drawing Sketches for Solid Models**	• The Sketching Environment • Starting a New Session of SOLIDWORKS 2016 • Task Panes • Starting a New Document in SOLIDWORKS 2016 • Understanding the Sketching Environment • Setting the Document Options • Learning Sketcher Terms • Drawing Sketch Entities • Drawing Display Tools • Deleting Sketched Entities
Week2(2Hours)	**3. Editing and Modifying Sketches**	• Editing Sketched Entities • Creating Patterns • Editing Patterns • Writing Text in the Sketching Environment • Modifying Sketched Entities
Week2(2Hours)	**4. Adding Relations and Dimensions to Sketches**	• Applying Geometric Relations to Sketches • Design Intent • Dimension a Sketch • Concept of a Fully Defined Sketch • Deleting Overdefined Dimensions • Opening an Existing File
Week3(2Hours)	**5. Advanced Dimensioning Techniques and Base Feature Options**	• Advanced Dimensioning Techniques • Measuring Distances and Viewing Section Properties • Creating Base Features by Extruding Sketches • Creating Base Features by Revolving Sketches • Determining the Mass Properties of Parts • Dynamically Rotating the View of a Model • Modifying the View Orientation • Restoring the Previous View • Displaying the Drawing Area in Viewports • Display Modes of a Model • Additional Display Modes • Assigning Materials and Textures to Models

Week3(2Hours)	**6. Creating Reference Geometries**	• Importance of Sketching Planes • Reference Geometry • Advanced Boss/Base Options • Modeling Using the Contour Selection Method • Creating Cut Features • Concept of Feature Scope
Week 4 (2Hours)	**7. Advanced Modeling Tools-I**	• Creating Simple Holes • Creating Standard Holes Using the Hole Wizard • Adding External Cosmetic Threads • Creating Fillets • Selection Options • Creating Fillets Using the FilletXpert • Creating Chamfers • Creating Shell Features • Creating Wrap Features
Week 4 (2Hours)	**8. Advanced Modeling Tools-II**	• Creating Mirror Features • Creating Linear Pattern Features • Creating Circular Pattern Features • Creating Sketch Driven Patterns • Creating Curve Driven Patterns
Week 5 (2Hours)		• Creating Table Driven Patterns. • Creating Fill Patterns • Creating Variable Patterns • Creating Rib Features • Displaying the Section View of a Model • Changing the Display States

Week 5 (2Hours)	**9. Editing Features**	• Editing Using the Edit Feature Tool • Editing Sketches of the Sketch-based Features • Editing the Sketch Plane Using the Edit Sketch Plane Tool • Editing Using the Instant3D Tool • Editing Features and Sketches byUsing the Cut, Copy, and Paste Options • Cutting, Copying, and Pasting Features and Sketches fromOne Document to the Other • Copying Features Using Drag and Drop • Deleting Features • Deleting Bodies • Suppressing Features • Unsuppressing the Suppressed Features • Unsuppressing Features with Dependents • Hiding Bodies • Moving and Copying Bodies • Reordering the Features • Rolling Back the Feature • Renaming Features • Creating Folders in the FeatureManager Design Tree • What's Wrong Functionality
Week 6 (2Hours)	**10. Advanced Modeling Tools-III**	• Creating Sweep Features • Creating Cut-Sweep Features • Creating Loft Features • Adding a Section to a Loft Feature • Creating Lofted Cuts
Week 6 (2Hours)		• Creating 3D Sketches • Creating Grid Systems • Editing 3D Sketches • Creating Curves • Extruding a 3D Sketch • Creating Draft Features
Week 7 (2Hours)	**11. Advanced Modeling Tools-IV**	• Advanced Modeling Tools • Creating Fastening Features • Creating Freeform Features • Dimensioning a Part Using DimXpert
Week 7 (2Hou	**3D Modelling Project**	• Use the concept of Reverse Engineering and Redesign the parts by measuring them using the Measuring Instrument
Week 8 (2Hou	**3D Modelling Project**	• Use the concept of Reverse Engineering and Redesign the parts by measuring them using the Measuring Instrument

Week 8 (2Hours)	**12. Assembly Modeling-I**	• Assembly Modeling • Creating Bottom-up Assemblies • Creating Top-down Assemblies • Moving Individual Components • Rotating Individual Components • Moving and Rotating Individual Components Using the Triad • Assembly Visualization
Week 9 (2Hours)	**13. Assembly Modeling-II**	• Advanced Assembly Mates • Mechanical Mates • Creating Sub-assemblies • Deleting Components and Sub-assemblies • Editing Assembly Mates • Editing Components • Editing Sub-assemblies • Dissolving Sub-assemblies • Replacing Components
Week 9 (2Hours)		• Creating Patterns of Components in an Assembly • Copying and Mirroring Components • Copying a Component along with Mates • Simplifying Assemblies using the Visibility Options • Checking Interferences in an Assembly • Checking the Hole Alignment • Creating Assemblies for Mechanism • Creating the Exploded State of an Assembly
Week 10 (2Hours)	**14. Working with Drawing Views-I**	• The Drawing Mode • Starting a Drawing Document • Types of Views • Generating Standard Drawing Views • Generating Derived Views • Working with Interactive Drafting in SOLIDWORKS • Editing and Modifying Drawing Views • Modifying the Hatch Pattern in Section Views
Week 10 (2Hours)	**15. Working with Drawing Views-II**	• Adding Annotations to Drawing Views • Adding the Bill of Materials (BOM) to a Drawing • Linking Bill of Materials • Adding Balloons to the Drawing Views • Adding Balloons Using the AutoBalloon Tool • Creating Magnetic Lines • Adding New Sheets to the Drawing Views • Editing the Sheet Format • Creating User-Defined Sheet Formats

Week 11 (2Hours)	**16. Surface Modeling**	• Creating an Extruded Surface • Creating a Revolved Surface • Creating a Swept Surface • Creating a Lofted Surface • Creating a Boundary Surface • Creating a Planar Surface • Creating a Fill Surface • Creating a Radiated Surface • Offsetting Surfaces, Trimming Surfaces • Untrimming Surfaces
Week 11 (2Hours)		• Extending Surfaces, Knitting Surfaces ,Filleting Surfaces • Creating a Mid-Surface, Deleting Holes from Surfaces • Replacing Faces, Deleting Faces • Moving and Copying Surfaces • Mirroring Surface Bodies • Adding Thickness to Surface Bodies • Creating a Thicken Surface Cut, Creating a Surface Cut
Week 12 (4Hours) + Week 13 (2Hours)	**3D Modeling, Assembly and Drafting Project (Minimum 10 parts)** **Project Display**	• Use the concept of Reverse Engineering and Redesign the parts by measuring them using the Measuring Instrument • Creating Assemblies of parts created earlier • Drafting of the assembly model created • Student needs to demonstrate his project

Suggested Reading

3. 1. Matt Lombard, :Solidworks 2013 Bible", 2013, ISBN: 978-1-118-50840-4
4. Greg Jankowski, Richard Doyle, "SolidWorks For Dummies", 2nd Edition, 2011 ISBN: 978-1-118-05147-4

Name of The Course	**Mechanics of Materials**				
Course Code	**BTME2008**				
Prerequisite	**BTME2001-Engineering Mechanics**				
Co-requisite					
Anti-requisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

1. To develop the relationship between the loads applied to a non-rigid body, the internal stresses and deformations induced in the body.
2. To study the general state of stresses and strains in a given loaded member and the magnitude and direction of the principal stresses
3. To understand the different approaches to calculate slope and deflection for various types of beams.
4. To analyze the columns with different edge conditions by using different theories.

Course Outcomes

CO1	**Understand the basics of simple stress and strain**
CO2	**Draw Mohr's circle and solve problems involving biaxial state of stress.**
CO3	**Apply theory of simple bending for analysing problems.**
CO4	**Calculate deflection of various beams of different shapes.**
CO5	**Calculate torsion in shafts and buckling load of column.**
CO6	**Able to model the system and find out deflection**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	30	50	100

Course Content:

Unit I: Stresses and Strains **8 Hours**
Definition/derivation of normal stress, shear stress, and normal strain and shear strain – Stress-strain diagram- Elastic constants – Poisson's ratio – relationship between elastic constants and Poisson's ratio – Generalized Hook's law – Strain energy – Deformation of simple and compound bars – thermal stresses.
Unit II: Bi-axial Stress system **8 Hours**
Biaxial state of stress – Stress at a point – stresses on inclined planes – Principal stresses and Principal strains and Mohr's circle of stress, Theories of failure **Thin cylinders and shells – deformation of thin cylinders and shells; Thick Cylinders, Shrink fits, Compounding. Fundamentals of theory of elasticity.**
Unit III: Simple Bending **8 Hours**
Types of beams: Cantilever, Simply supported, Overhanging: Shear Force and Bending Moment Diagrams. Theory of simple bending – bending stress and shear stress in beams.
Unit IV: Deflection of Beams **8 Hours**

Deflection of beams by Double integration method – Macaulay's method – Area moment theorems for computation of slopes and deflections in beams – Conjugate beam method.
Unit V: Torsion and columns 8 Hours
Introduction to Torsion – derivation of shear strain – Torsion formula – stresses and deformations in circular and hollow shafts – Stepped shafts – shafts fixed at the both ends Theory of columns – Long column and short column - Euler's formula – Rankine's formula - Secant formula - beam column.
Unit VI:
Modeling of the system and find out deflection at various points

Suggested Reading

1. S. S. Rattan (2011) Strength of material Tata McGraw Hill Education. ISBN: 978-0-071-07256-4.

2. S.P. Timoshenko and D.H. Young (2011), Strength of Materials, 5th edition, East West Press Ltd, ISBN: 978-8-176-71019-0.

3. R.K. Bansal (2010), Strength of Materials, 5th Edition, Laxmi Publications, ISBN: 978-8-131-80814-6.

Name of The Course	**Fluid Mechanics**				
Course Code	**BTME2009**				
Prerequisite					
Co-requisite					
Anti-requisite					
		L	**T**	**P**	**C**
		2	**0**	**2**	**3**

Course Objectives

1. **Understand fluid behaviour for engineering design and control of fluid systems.**
2. **Develop competence with mass, energy and momentum balances.**
3. **Study the development of boundary layers.**

Course Outcomes

CO1	**Explain the properties of fluid and its kinematics.**
CO2	**Categorize the types of flow and applications of governing equations in a fluid flow system.**
CO3	**Examine the losses of fluid flow through pipes and study about pipe network design.**
CO4	**Calculate the dependent and independent parameters of fluid flow.**
CO5	**Examine the boundary layer and no-slip boundary condition in the fluid flow.**
CO6	**Apply the basic laws of fluid mechanics in flow measurement.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	30	50	100

Course Content:

Unit I: Fluid Properties and Hydrostatics **6 Hours**
Density, Viscosity, Surface tension, compressibility, capillarity, Hydrostatic forces on plane, inclined and curved surfaces, buoyancy, centre of buoyancy, metacentre.
Unit II: Fluid Dynamics **6 Hours**
Control volume, Fluid Kinematics, Types of flows; Steady flow, Unsteady flow, Uniform and Non Uniform flow, Rotational flow, Irrotational flow, 1-D, 2-D, 3-D flows– Streamline and Velocity potential lines, Euler and Bernoulli's equations and their applications, moment of momentum, Momentum and Energy correction factors, Impulse, Momentum equation- Navier-Stokes Equations, Applications.
Unit III: Open & Closed Channel Flow **12 Hours**
Open Channels Flow, Laminar & turbulent flow through pipes, Darcy's law, Minor losses, Multi reservoir problems, Moody's diagram, Hagen Poiseuille equation, Turbulent flow, Specific Energy, Critical flow concept, Hydraulic jump, uniform flow and gradually varying flow concepts, Pipe network design, Measurement of pressure and flow, Measurement of pipe flow, velocity through pipes and open channels.
Unit IV: Dimensional Analysis **10 Hours**
Dimensional homogeneity, Raleigh and Buckingham π theorems, Non-dimensional numbers, Model laws and distorted models, Module quantities, Specific quantities
Unit V: Boundary layers **6 Hours**
Boundary layers, Laminar flow and Turbulent flow, Boundary layer thickness, momentum- Integral equation, Drag and lift, Separation of boundary layer, Methods of separation of boundary layer.
Unit VI:
1. Conducting experiments to verify Bernoulli's theorem. **2. Determination of the Coefficient of discharge and coefficient of velocity for the given Orifice meter.** **3. Determination of the Coefficient of discharge of given Venturi-meter.** **4. Determination of the Coefficient of discharge of given Rectangular notch.** **5. Determination of the Coefficient of discharge of given 'V' notch.** **6. Comparative study of head loss in pipes connected series and parallel.** **7. Study of fluid flow types using Reynolds apparatus.** **8. Determination of drag force at different incidence angle in wind tunnel.** **9. Determination of metacentric height.** **10. Determination of the Reynolds no. in fluid flows.**

Suggested Reading

1. R. K. Bansal (2010), A Textbook of Fluid Mechanics and Hydraulic Machines, 9th Edition, Laxmi Publication (P) Ltd., New Delhi. ISBN- 978-8-131-80815-3
2. G.K. Batchelor, An Introduction to Fluid Dynamics, Cambridge Mathematical Library, ISBN: 9780521663960
3. Yunus A. Çengel (2010), Fluid Mechanics, Tata McGraw Hill, ISBN: 978-0-070-70034-5.
4. Frank M. White (2011), Fluid Mechanics, 7th edition, Tata McGraw-Hill Education, ISBN- 978-0-071-33312-2.

Name of The Course	**Manufacturing Processes II and Metrology**			
Course Code	**BTME2010**			
Prerequisite	**BTME2003- Manufacturing Processes I**			
Co-requisite				
Anti-requisite				
L	**T**	**P**	**C**	
3	**0**	**0**	**3**	

Course Objectives

1. To get acquainted with the theory of metal cutting, mechanism of machining and the parameters that influences the machining processes.
2. To get basic idea about different conventional and non conventional machining processes.
3. To gain knowledge of various instruments for linear measurement, angular measurement and surface finish etc

Course Outcomes

CO1	**Explain the mechanism of chip formation in machining.**
CO2	**Describe the various machining processes such as turning, drilling, boring, shaping, slotting, milling and grinding.**
CO3	**Illustrate the principle of gear generation process.**
CO4	**Illustrate the working principle of Non-traditional machining processes.**
CO5	**Explain the principle of different metrology instruments.**
CO6	**Able to explain the working of CNC machines and micromachining.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	**30**	**50**	**100**

Course Content:

Unit I: Theory of Metal Cutting	**10 Hours**
Mechanism of chip formation – Tool Specification System- Tool signature for single point & Multi-point cutting Tools- Orthogonal and Oblique cutting – Single Point and Multipoint Cutting Tools-Machining	

forces - Merchant's Circle Diagram - Thermal aspects of metal machining - Cutting fluids - Machinability - Cutting tool materials - Tool wear and Tool life calculations.
Unit II: Lathe and Basic Machine Tools 08 Hours
Lathe - Types - Operating Parameters - lathe operations – Tool nomenclature - Work holding devices. Shaping - Planing - Slotting – Drilling - Boring – Reaming – Tapping – Broaching.
Unit III: Milling, Grinding Machines and Gear Generation 08 Hours
Milling machines - Cutters - Milling operations - Indexing. Grinding – Types of grinding machines - Grinding wheel designation and selection - Bond and Bonding processes. **Gear generating principles - Gear Hobber - Gear finishing methods - Bevel gear generator**
Unit IV: Non-traditional Machining Processes 07 Hours
Classification of Nontraditional Machining process – Principle of AJM, WJM, USM, EDM, ECM, LBM - Process characteristics – Applications
Unit V: Metrology and Instrumentation 07 Hours
Measurement standards - Linear, angular and form measuring instruments – Comparators – Gauge blocks – Gauges - Optical instruments – Profilometer – Coordinate measuring machine
Unit VI:
CNC machining: Machining on CNC lathe, drilling and milling machines, Micromaching: Abrasive jet micromachining (AJMM), Abrasive water jet micromachining (AWJMM), Water jet micromachining (WJMM), Ultrasonic micromachining (USMM).

Suggested Reading

1. P.C. Sharma, (2008), Text book of Production Technology, 7th Edition, S. Chand & Company Ltd, New Delhi, ISBN: 978-8-121-91114-6.
2. O.P. Khanna & M. Lal (2010), A Text book of Production Technology, Dhanpat Rai Publications, New Delhi, ISBN: 978-8-189-92832-2.
3. S. KapakjianandS.R.Schmid (2005), Manufacturing Engineering and Technology, 4th Edition, Pearson Education (Singapore) Pvt. Ltd. ISBN: 978-8-177-58170-6.

Name of The Course	**Probability and Statistics**				
Course Code	**MATH2003**				
Prerequisite					
Co-requisite					
Anti-requisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

The aim of this course is to introduce students to the basic concepts of probability distributions and their applications. The course also serves as a foundation to analyze problems in Science and Engineering applications through statistical testing methods.

Course Outcomes

CO1	**Define the basic concepts of Probability theory and Random variables.**
CO2	**Identify the type of distribution and Apply it in problem solving.**
CO3	**Apply the concept of correlation and Regression.**
CO4	**Explain the concepts of sampling distributions and estimation theory and apply it to estimate the confidence intervals.**
CO5	**Apply statistical tests to solve the hypothesis testing problems.**
CO6	**Apply statistical tests to solve Large and Small samples.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	30	50	100

Course Content:

Unit I: Variables and probability Distributions **12 Hours**
Review of Probability, Probability density function, Cumulative distribution function, Expectation and Variance. Binomial, Poisson and Geometric distributions, Probability density function, Cumulative distribution function, Expectation and Variance, Uniform, Normal, Exponential distributions, Joint distribution and joint density functions, Conditional distribution.
Unit II: Correlation and Regression **8 Hours**
Curve fitting by method of least squares, Fitting of straight lines, Polynomials, Exponential curves, Correlation, Rank correlation, Regression analysis, Linear and non-linear regression, Multiple regression.
Unit III:Sampling Theory **5 Hours**
Population and sample, Statistical inference, Sampling with and without replacement, Random samples, Population parameters, Sample statistics, Sampling distributions, Sample mean, Sampling distribution of means, Sample variances, Sampling distribution of variances, Case where population variances is unknown,
Unit IV: Estimation Theory **5 Hours**
Estimators, Point and Interval Estimation, Confidence Interval estimates of population parameters, Confidence intervals for variance of a Normal distribution, Maximum likelihood estimates.

Unit IV: Tests of Hypothesis and Significance	**7 Hours**
Statistical hypothesis, Null and Alternate hypothesis, test of hypothesis and significance, Type I and Type II errors, Level of Significance, Tests involving the Normal distribution, One-Tailed and Two-Tailed tests, P value,	
Unit VI:	**3 Hours**
Review Special tests of significance for Large and Small samples (F, chi- square, z, t- test), one way ANOVA.	

Suggested Reading

1. R. E. Walpole, R. H. Mayers, S. L. Mayers and K. Ye (2007), Probability and Statistics for Engineers and Scientists, 9th Edition, Pearson Education, ISBN:978-0-321-62911-1.
2. Sheldon M. Ross (2011), Introduction to Probability and Statistics for Engineers and Scientists, 4th Edition, Academic Foundation, ISBN:978-8-190-93568-5.
3. Douglas C. Montgomery (2012), Applied Statistics and Probability for Engineers, 5th Edition, Wiley India, ISBN: 978-8-126-53719-8.
4. M. R. Spiegel, J. Schiller and R. A. Srinivasan(2010), Probability & Statistics, 3rd Edition, Tata-McGraw Hill, ISBN:978-0-070-15154-3.

Name of The Course	**Mechanics of Materials Laboratory**			
Course Code	**BTME2012**			
Prerequisite				
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course Objectives

To supplement the theoretical knowledge gained in Strength of Materials with practical testing under applied loads. This would enable the student to have a clear understanding of the design for strength and stiffness.

Course Outcomes

CO1	**Conduct tension and compression tests on standard specimens.**
CO2	**Calculate impact strength of standard specimen.**
CO3	**Determine spring constant of closed and open coil helical spring.**
CO4	**Calculate the fatigue strength of given specimens.**
CO5	**Calculate hardness of specimens, and determine the young's modulus of material by deflection test.**

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Exam (MTE)**	**End Term Exam (ETE)**	**Total Marks**

50	**-**	**50**	**100**

Course Content:

1. To determine Brinell Hardness Number (BHN) for the given material of the specimen.
2. To determine Rockwell Hardness Number (RHN) for the given material of the specimen.
3. To determine the stiffness and modulus of rigidity of open coil helical spring.
4. To determine the stiffness and modulus of rigidity of closed coil helical spring.
5. To determine the impact strength for the given specimen using Charpy test.
6. To determine the impact strength for the given specimen using Izod test.
7. To determine the Young's modulus of the given material by conducting the deflection test.
8. To study the fatigue strength for the given specimen using Fatigue test.
9. To determine the Young's modulus by conducting tension test on a given mild steel specimen.
10. To determine the Maximum compressive strength by conducting compression test on a given specimen on UTM.
11. To study the strain aging behavior of steel (associated with the yield-point phenomena) using load-elongation curve obtained from tensile test.

Suggested Reading

1. S. S. Rattan (2011), Strength of Material, Tata McGraw Hill Education.

2. S.P. Timoshenko and D.H. Young (2011), Strength of Materials, 5th edition, East West Press Ltd.

3. R.K. Bansal (2010), Strength of Materials, 5th Edition, Laxmi Publications.

Name of The Course	**Manufacturing Processes II and Metrology Laboratory**				
Course Code	**BTME2013**				
Prerequisite					
Co-requisite					
Anti-requisite					
	L	**T**	**P**	**C**	
	0	**0**	**2**	**1**	

Course Objectives

4. To learn and identify parts of a Lathe Machine and different operations on a Lathe.
5. To become skilled to handle and use drilling, lathe, milling and surface grinding machines.
6. To gain hands on practices in measurements and measuring instruments

Course Outcomes

CO1	**Develop a component using basic operations of lathe and drilling machine.**
CO2	**Produce a component using milling and shaper machine.**
CO3	**Create a single point cutting tool with various angles using tool and cutter grinder**
CO4	**Measure the different measurements using measuring instruments and analyse the errors.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks

50	**-**	**50**	**100**

Course Content:

1.Lathe Exercise – Facing, Straight turning, knurling, chamfering, Thread cutting operations using Lathe Machine
2. Drilling - Countersinking and Tapping using Drilling Machine.
3. End milling and Gear cutting using Milling Machine.
4. Surface finishing using Surface Grinding Machine.
5. Grinding of single point cutting tool using Tool and Cutter Grinder.
6. Machining a block on shaper machine.
7. Study & working of simple measuring instruments like Vernier calipers and micrometer.
8. Measurement of effective diameter of a screw thread.
9. Measurement of angle using sine bar & slip gauges.
10. Study & angular measurement using bevel protector.
11. Measurement of various angles of SPCT (Single Point Cutting Tool-HSS) using Tool maker's Microscope.
12. Measurement of various dimensions of spur gear using Optical Profile Projector.

Suggested Reading

6. Manufacturing Processes II and Metrology Lab manual prepared by faculties of School of Mechanical Engineering.
7. Manufacturing Practices Lab Manual, SOME, Galgotias University, Dr. P. Tamilchelvan, 2016.
8. Metrology Lab Manual, SOME, Galgotias University, Dr. P. Tamilchelvan, 2016.
9. A.K. Hajra Choudhury, S.K. Hajra Choudhury and Nirjhar Roy (2010), Elements of Workshop Technology, Vol. – II, Media Promoters, ISBN: 978-8-185-09915-6.
10. Manufacturing Engineering and Technology, S. Kapakjian and S.R. Schmid, 4th Edition, Pearson Education (Singapore) Pvt. Ltd. (2005) ISBN: 978-8-177-58170-6.

Name of The Course	**Additive Manufacturing Laboratory**				
Course Code	**BTME3023**				
Prerequisite					
Co-requisite					
Anti-requisite					
	L	**T**	**P**	**C**	
	0	**0**	**4**	**2**	

Course Objectives

1. To augment the theoretical knowldege of design to print the physical 3D mechanical components and prosthetics.
2. To get the hands on skill of designing to printing any mechanical or bomedical product.

Course Outcomes

CO1	**Understand the concept of Parametric design.**

CO2	**Develop a solid model using Tinker CAD and Fusion 360 software.**
CO3	**Print different Mechanical Component**
CO4	**Print Biomedical based prothetics**
CO5	**Understand and design the basic working 3D printer**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
50	**-**	**50**	**100**

Course Content:

COURSE CONTENT
1. To Learn and make simple parametric design on TinkerCAD software. 2. To Learn and make simple parametric design on AutoDesk Fusion 360 software. 3. To study different types of 3D printer in the lab, make sketch of the printer. 4. To Learn the circuit and microcontroller of the common FDM based 3D printer available in the lab. 5. To design and print the fuel injector of the IC engine. 6. To design and print the fuel injector of the IC engine. 7. To design and print the dental implant and crown. 8. To design and print the hearing aid. 9. To make Arduino or Raspberry based simple prototype of 3D printer. 10. To learn the programming of G-Code.

Suggested Reading

1. Chee Kai Chua, Kah Fai Leong(2016), 3D Printing And Additive Manufacturing: Principles And Applications, WSPC
2. Ben Redwood, FilemonSchöffer& Brian Garret(2017), The 3D Printing Handbook:Technologies, design and applications, 3D Hubs B.V
3. Hod Lipson, M.Kurman(2013)Fabricated:The New World of 3D Printing, Wiley.

Name of The Course	**Automotive Engines**				
Course Code	**BAUT3001**				
Prerequisite					
Co-requisite					
Anti-requisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

1. To study the working of engines

2. To study Engine parts and their functions
3. To study the Different Engine technologies

Course Outcomes

CO1	**Understand the Construction and operation of IC Engine**
CO2	**Perform a thermodynamic analysis of Otto, Diesel, andDual cycle models**
CO3	**Demonstrate knowledge of the characteristics of common liquid and gaseous fuels**
CO4	**Demonstrate an understanding the role of lubrication in reducing friction and wear**
CO5	**Demonstrate an understanding of technological, environmental, and social impacts of alternative fuels**
CO6	**Demonstrate an understanding MPFI and CRDI engines**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	30	50	100

Course Content:

Unit I: Introduction **8 Hours**
Classification of Automobiles, type of automobile engines, Constructional details and working principles of spark ignition (SI) and compression ignition (CI) engines, Two stroke SI and CI engines – construction and working, Comparison of SI and CI engines and fourstroke and two stroke engines, Engine classification, firing order, Otto, diesel and dual cycles, fuels for modern automobile engines like LPG, CNG, bio-diesel, national and international pollution norms.
Unit II: Engine parts and their functions **8 Hours**
Types of cylinder head, piston, special features in pistons, piston rings, types of piston rings, piston pin, connecting rod, special features of connecting rods, crank shaft, flywheel, cam and follower, camshaft, valve and valve mechanism, crank case
Unit III: Fuel Supply Systems **8 Hours**
Fuel system in petrol engine, carburetion principle and carburetors, petrol injection system, MPFI fuel system, diesel engine- diesel fuel pump principle, types of fuel pumps, types of fuel injector nozzles, simple and multiple unit pumps, C. A. V. Bosch pump, types of fuel systems for diesel engines, modern distributers; Air cleaners
Unit IV: Cooling and Safety **8 Hours**
Cooling system in Automobiles; air and water cooled engines; Lubricants system; lubrication Vehicle safety, safety features in modern automobiles like air bags, anti-lock braking system, crumple zones, introduction to power steering and power brakes
Unit V: Engine Types **8 Hours**
Single Fuel & Multi Fuel Engine: Combustion in dual fuel engines, factors affecting combustion in duel fuel engines performance of dual fuel engines, advantages of dual fuel engines; multi-fuel engines,

characteristics of Multi fuel engines, modification of fuel system, performance of multi-fuel engines, brief introduction to working of stratified charged engine, Sterling engine, Wankel engine, variable compression engine, Air cleaners &Silencers .
Unit VI:
MPFI engine, CRDI engine, performance parameter analysis

Suggested Reading

1. William.H.Crouse (2006), Automotive Mechanics, 10th Edition, McGraw-Hill, ISBN: 978-0-07-063435-0.
2. Kirpal Singh (2011), Automobile Engineering, 12th edition, Standard Publications, ISBN: 978-8-180-14177-5
3. Bosch Automotive Hand Book (2007), 8th Edition, SAE Publications,ISBN:978- 0-7680-4851-3.
4. K. Newton and W. Steeds (2001), the motor vehicle, 13th Edition, Butterworth-Heinemann Publishing Ltd, ISBN: 978-0-080-53701-6.

Name of The Course	**Kinematics of Machines**				
Course Code	**BTME3002**				
Prerequisite	**BTME2001 Engineering Mechanics**				
Co-requisite					
Anti-requisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

1. To familiarize students with basic types of mechanisms, joints and degrees of freedom to perform position, velocity and acceleration analysis using graphical and analytical methods.
2. To provide students an understanding of different types of mechanisms.
3. To teach the basics of synthesis of simple mechanisms.
4. To teach students the kinematic analysis of cam-follower motion and gear train configurations.

Course Outcomes

CO1	**Understand the concepts of various mechanisms and pairs.**
CO2	**Analyze the displacement, velocity and acceleration of different links in a simple mechanism.**
CO3	**Synthesize simple mechanisms based on the given input conditions.**
CO4	**Draw the profile of cam for different types of follower motions.**
CO5	**Apply kinematics principle to gears operation.**
CO6	**Model and analysis of mechanism**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	30	50	100

Course Content:

Unit I: Basics of Mechanisms	**8 Hours**
Introduction to mechanisms and its terminologies - Degree of freedom – Mobility - Kutzbach criterion - Grubler's criterion for planar mechanisms - Grashoff's law - Kinematic InVersion 2.2s of 4-bar chain - Single slider and double slider crank chains - Quick return mechanism - Limiting positions - Mechanical advantage - Transmission angle - Ratchets and escapements – Indexing Mechanisms – Rocking Mechanisms – Straight line generators.	
Unit II: Kinematic Analysis of Simple Mechanisms	**8 Hours**
Displacement, velocity and acceleration analysis in simple mechanisms having turning, sliding and rolling pair - Coriolis acceleration using graphical relative motion method - Instantaneous center method - Four bar and slider crank mechanisms - Analytical method for four bar and slider crank mechanisms.	
Unit III: Synthesis of Simple Mechanisms	**8 Hours**
Classification of kinematic synthesis problems - Two position synthesis of slider crank and crank rocker mechanisms - Three position synthesis of double rocker mechanism - Chebychev spacing - Freudenstein analytical method - synthesis of function generator using three precision positions, Graphical and analytical design of a four bar linkage for body guidance, path generation by graphical method.	
Unit IV: Kinematics of CAMS	**8 Hours**
Types of cams and followers - Definitions related cam profile - Derivatives of follower motion – High speed cams – Undercutting - Graphical disk cam profile design - Simple harmonic motion, Constant acceleration and deceleration, constant velocity, Cycloidal motion for knife edge and roller (in-line and offset), flat faced and oscillating followers - Tangent cam with roller follower - circular arc cam with flatfaced follower.	
Unit V: Kinematics of Gears and Gear Train	**8 Hours**
Spur gear terminology and definitions - Law of toothed and involute gearing - Interchangeable gears - Gear tooth action - Interference and undercutting - Basics of nonstandard gear teeth -Helical – Bevel – Worm - Rack and pinion gears, cycloidal tooth properties - Comparison of involute and cycloidal tooth forms.	
Unit VI:	
Model and analysis of mechanisms for different applications.	

Suggested Reading

1. S.S. Rattan (2009), "Theory of Machines", 3rd Edition, Tata McGraw-Hill. ISBN: 978-0-070-14477-4.

2. J. Uicker John, Gordon R. Pennock Jr. and Joseph E. Shigly (2011), Theory of Machines and Mechanisms, 4th Edition, Oxford University Press, ISBN: 978-0-199-77781-5.

3. Thomas Bevan (2009), Theory of Machines, 3rd Edition, Pearson Education, ISBN: 978-8-131-72965-6.

4. A. Ghosh (2009), Theory of Mechanisms and Machines, 3rd Edition, East-West Press Pvt. Ltd., New Delhi, ISBN: 978-8-185-93893-6.

5. Kenneth J Waldron and Gary L. Kinzel (2007), Kinematics, Dynamics, and Design of Machinery, 2nd Edition, John-Wiley and Sons Inc., New York, ISBN: 978-8-126-51255-3.

Name of The Course	**Heat Engineering**				
Course Code	**BAUT3002**				
Prerequisite	**BTME2002 Engineering Thermodynamics,**				
Co-requisite					
Anti-requisite					
	L	**T**	**P**	**C**	
	3	**0**	**0**	**3**	

Course Objectives

1.To enable the students understand the principles and performance of IC engines

2To introduce students to the working of compressors, and various refrigeration and air-conditioning systems.

3.To teach students the principles of heat transfer

Course Outcomes

CO1	**Solve problems on internal combustion engines and prepare heat balance sheet**
CO2	**Identify and analyse the different modes of heat transfer in engineering applications**
CO3	**Demonstrate the knowledge of refrigeration and air-conditioning**
CO4	**Get an insight of various components of thermal systems viz., compressors, evaporators, condensers etc**
CO5	**To compute heat exchanger effectiveness and plot temperature distribution.**
CO6	**VAS system, single-effect, double-effect system, staggered grid arrangement**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	**30**	**50**	**100**

Course Content:

Unit I: Internal Combustion Engines	**8 Hours**

Review of Otto, Diesel and Dual thermodynamic cycles, Normal and abnormal combustion in SI engines, Factors affecting knocking. Normal and abnormal combustion in CI engines, Detonation factors and remedies. Performance parameters in IC engines, Measurement of brake power, indicated power, fuel consumption, air consumption, Morse test and Heat balance, effect of various parameters on the performance of the engines.
Unit II: Heat Transfer –I 8 hours
Basic concepts: conduction, convection and radiation, General equation of heat conduction, One dimensional steady state heat conduction in simple geometries: plane wall, cylinder and sphere, Heat transfer in composite walls, composite cylinders and composite spheres, Critical thickness of insulation,Heat generation, Extended surfaces: general equations, types and applications of fins,fin efficiency and effectiveness, Fin performance.Transient heat flow: Lumped parameter system,significance of Biot and Fourier numbers.
Unit-3 Heat Transfer –II 8 hours
Boundary layer theory, Conservation equations of mass, momentum and energy for laminar flow over a flat plate, Turbulent flow over a flat plate, Flow over cylinders, spheres, tube bank, Internal flow through pipes, annular spaces, Analogy between momentum and heat transfer, Natural convection in vertical, inclined and horizontal surfaces, Mixed convection, Dimensional analysis.
Unit IV: Condensation, Boiling and Radiation 8 Hours
Unit of refrigeration, vapour compression cycle,componentsandworking,p-h and T-s diagrams, Calculation of COP, Effect of sub-cooling, super-heating,evaporator pressure and condenser pressure. Actual vapour compression cycle, methods for improving COP. Refrigerants: classification, nomenclature, desirable properties.Psychrometry: properties, relations, chart and processes.Cooling load calculations: SHF, RSHF, GSHF, ESHF.
Unit V: Compressors and Heat exchangers 8 Hours
Reciprocating compressors:construction,working,effect of clearance volume,multi staging, volumetric efficiency,isothermalefficiency.Centrifugal compressors, velocity triangle, Axial flow compressors, surging, choking and stalling. Heat Exchangers – Types and practical applications, Use of LMTD, Effectiveness – NTU method, Compact heat exchangers, Plate heat exchangers, Fouling factor
Unit VI:
Numerical radiation phenomena. Specific intensity of radiation. General formulation of the fundamental equation of radiation (RTE or Radiative Transfer Equation). Review of methods of analysis of radiation in non-participating media. Extension of the formulation to participating media. Introduction to numerical resolution techniques of intensity of spectral and directional radiation according to the DOM (Discrete Ordinate Methods) and FVM (Finite Volume Method) methods.

Suggested Reading

1. Onkar Singh, (2009), Applied Thermodynamics, New Age International.
2. C.P. Arora, (2009), Refrigeration and Air Conditioning, Tata McGraw-Hill Publishing Company Ltd.
3. V. Ganesan, (2008), Internal Combustion Engines, Tata McGraw-Hill Publishing Company Ltd.
4. J. P. Holman, (2005), Heat Transfer, 9th Edition, McGraw-Hill Publishing Company Limited

Name of The Course	**Machine Design**			
Course Code	**BTME3025**			
Prerequisite	**BTME2008**			
Co-requisite	**BTME3002**			
Anti-requisite				
	L	**T**	**P**	**C**
	2	**0**	**2**	**3**

Course Objectives

4. **To understand the design methodologies for various machine elements.**
5. **To understand the various standards and methods of standardization**
6. **To produce working drawings of the system involving shafts, couplings, joints and bearings.**

Course Outcomes

CO1	**Understand and implement the design process in machine elements.**
CO2	**Apply fatigue failure criteria in the analysis and design of mechanical components.**
CO3	**Design and analyze the power transmission in shafts and couplings carrying different elements under various loading conditions.**
CO4	**Design and analyze the permanent and detachable structural joints under various loading conditions.**
CO5	**Design and analyze the sliding and rolling contact bearings.**
CO6	**Model and analyse gear**

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Exam (MTE)**	**End Term Exam (ETE)**	**Total Marks**
30	**20**	**50**	**100**

Course Content:

Unit I: Introduction to Design Process **9 Hours**
Introduction to Design process – Factors – Materials selection direct – Bending and Torsional stress equation – Impact and Shock loading - - Factor of safety – Design stress – Theories of failures — Design of Levers, Problems.
Unit II: Fatigue strength and design of springs **9 Hours**

Stress concentration factor – Size factor –Surface limits factor ,Variable and cyclic loads – Fatigue strength – S- N curve – Continued cyclic stress – Soderberg and Goodman equations – Design of Helical – Leaf – Disc springs under Constant loads.
Unit III:Design of Shafts and Coupling 7 Hours
Design of Shafts carrying various elements with geometrical featuresunder various loading conditions,Design and drawings of couplings – Rigid – Flexible
Unit IV:Design of Joints 9 Hours
Design and Drawings of Cotter joints – Knuckle joints, Riveted joints, Welded joints and Screwed fasteners
Unit V: Design of bearings 6 Hours
Design of sliding contact bearing using Sommerfield number – Design using Mckee'sequation – Selection of rolling contact bearings.
Unit VI:
Gear geometry – Kinematics – Forces on gear tooth – Stresses in Gear tooth Selection of gear material based on bending stress

Suggested Reading

4. **V.B. Bhandari (2010), Design of Machine elements, 3rd Edition, Tata McGraw Hill.ISBN: 978-0-070-68179-8.**
5. **V.B. Bhandari (2014), Machine Design Data Book, 1stEdition, Tata McGraw Hill. ISBN: 978-9-351-34284-7.**
6. **Joseph Edward Shigley and Charles, R. Mischke (2011), Mechanical Engineering Design, 9th Edition,McGraw –Hill International Editions, ISBN: 978-0-071-07783**

Name of The Course	**Heat Engineering Lab**			
Course Code	**BAUT3003**			
Prerequisite	**BTME2002 Engineering Thermodynamics**			
Co-requisite	**BTME3001 Applied Thermodynamics**			
Anti-requisite				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course Objectives

1. Identify the various parts of IC engines and explain its functions for running the engines.
2. Evaluate the performance characteristics of air compressor.

3. Study of the effect of forward, backward, curved and radial vanes of the centrifugal blower.

Course Outcomes

CO1	**Examine the performance of compressors and blower.**
CO2	**Analyze the performance of vapour compression refrigeration system at different operating conditions.**
CO3	**Demonstrate the working of air-conditioner and its psychrometric test.**
CO4	**Calcualte the heat transfer co-efficient for free and forced convection.**
CO5	**Calculate the heat transfer coefficient for parallel flow, counter flow heat exchangers, and study the radiation heat transfer phenomenon.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
50	-	50	100

Course Content:

LIST OF EXPERIMENTS

1. To find out the volumetric efficiency, isothermal power and isothermal efficiency of air Compressor.
2. To study the effect of forward, backward, curved and radial vanes and find out the discharge, head and overall efficiency of the centrifugal blower.
3. To study the different components of vapour compression refrigeration system.
4. To calculate the actual Coefficient of Performance of Vapour compression refrigeration cycle on VCR test Rig and compare with theoretical COP using p-h diagram.
5. To determine various psychrometric properties on Air conditioning test Rig.
6. To calculate total thermal resistance and thermal conductivity of composite wall.
7. To calculate the average heat transfer co-efficient of vertical cylinder under natural convection.
8. To calculate the heat transfer coefficient experimentally and theoretically for free and forced convection and compare the theoretical temperature distribution with experimentally obtained distribution.
9. To determine the value of Stefan-Boltzman constant for radiation heat transfer.
10. To study and compare temperature distribution, heat transfer rate, overall heat transfer coefficient in parallel flow and counter flow heat exchanger.

Suggested Reading

1.Lab manuals prepared by faculty.
2. NPTEL study materials

Name of The Course	**Dynamics of Machines**				
Course Code	**BTME3008**				
Prerequisite	**BTME3002 Kinematics of Machines**				
Co-requisite					
Anti-requisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

1. To understand the concepts of turning moment diagrams, flywheel design and the dynamics of reciprocating engines.
2. To understand the balancing procedures for rotating and reciprocating masses, rotors and engines.
3. To understand the fundamentals of free and forced vibrations.
4. To understand the mechanisms for control.

Course Outcomes

CO1	**Conduct dynamic force analysis of various systems.**
CO2	**Describe static and dynamic balancing of high speed rotary and reciprocating machines.**
CO3	**Analyze free and forced vibrations of machines, engines and structures.**
CO4	**Calculate the frequency of transverse and torsional vibration systems.**
CO5	**Calculate gyroscopic couple and its effect on various vehicles, and apply the concept of governors for speed control.**
CO6	**Able to perform modeling and simulation of dynamic system.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	**30**	**50**	**100**

Course Content:

Unit I: Dynamic Force Analysis **8 Hours**
D'Alembert's principle – Equivalent offset inertia force – Dynamic analysis of four bar mechanism – Dynamic Analysis of reciprocating engines – Piston effort, Crank effort, Turning moment on crankshaft, Inertia of connecting rod – Inertia force in reciprocating engines (Graphical method). Turning moment diagrams – Single and multi cylinder engines – Fluctuation of energy – Fly Wheels – Applications in engines and punching presses.
Unit II:Balancing **8 Hours**
Static and Dynamic balancing of rotating masses – Balancing of reciprocating masses – Balancing of locomotives – Partial balancing of reciprocating masses – Multi cylinder Inline and radial engines.
Unit III: Vibration – Singh Degree of Freedom Systems **8 Hours**

Introduction to vibration – Terminology – Classification of vibrations –Undamped and Damped free vibration of single degree of freedom systems – Viscous damping – Introduction to coulomb damping. Forced vibration – harmonic excitation – Magnification factor – Vibration isolation and Transmissibility.
Unit IV: Transverse and Torsional Vibration Systems 8 Hours
Transverse vibrations of shafts and beams – Rayleigh's and Dunkerley's method – Whirling of shafts. Torsional vibrations – Single rotor, two rotors and three rotors systems – Free vibration of geared systems.
Unit V: Mechanism for Control 8 Hours
Functions of Governors – Gravity controlled and Spring controlled governor characteristics. Stability – Hunting and Isochronisms. Effect of friction – Calculation of equilibrium speeds and ranges of speed of governors. Gyroscopic couple – Gyroscopic effects on the movement of air planes and ships – Stability of two wheel drive and four wheel drive – Gyroscope stabilization.
Unit VI
Simulation of dynamic system, Balancing techniques, Modeling and Control of Vibration in Mechanical Structures, Damping mechanism, vibration isolation technologies.

Suggested Reading

1. S.S. Rattan (2009), "Theory of Machines", 3rd Edition, Tata McGraw-Hill Publishing Company Ltd, ISBN: 978-0-070-14477-4.
2. J. Uicker John, Gordon R. Pennock Jr., and Joseph E. Shigly (2009), Theory of Machines and Mechanisms, 3rd Edition, Oxford University Press, ISBN: 978-0-198-06232-5.
3. J. Peter Sadler and Charles E. Wilson (2008), Kinematics and Dynamics of Machinery, 3rdPearson Education, ISBN: 978-8-131-72022-6.
4. Ghosh (2009), Theory of Mechanisms and Machines, 3rd Edition, East-West Press Pvt. Ltd., New Delhi, ISBN: 978-8-185-93893-6.
5. T Thomson William, Dillon Dahleh Marie and PadmanabhanChandramouli (2008), Theory of Vibration with applications, 5th Edition, Pearson Education Publishers, ISBN: 978-8-131-70482-0.

Name of The Course	**Dynamics of Machines Laboratory**				
Course Code	**BTME3010**				
Prerequisite					
Co-requisite	**BTME3008 Dynamics of Machines**				
Anti-requisite					
	L	**T**	**P**	**C**	
	0	**0**	**2**	**1**	

Course Objectives

1. To supplement the principles learnt in Kinematics and Dynamics of Machinery.
2. To understand how certain measuring devices are used for dynamic testing.

Course Outcomes

CO1	**Calculate natural frequency of longitudinal vibration.**
CO2	**Determine torsional frequency of a single rotor system.**
CO3	**Measure the magnitude of gyroscopic couple in a motorized gyroscope.**
CO4	**Compare Tri–Filar / Bi-Filar system for determining moment of inertia of an object.**
CO5	**Calculate thecritical speed of a shaft and determine the performance characteristics of governors.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
50	-	50	100

Course Content:

LIST OF EXPERIMENTS
1. To determine natural frequency of longitudinal vibration in spring mass system. 2. Determination of torsional frequency of a single rotor system. 3. To study nomenclature of cam and plotting the cam profile. 4. To determine gyroscopic couple on motorized gyroscope. 5. Comparative study of different types of clutches 6. To determine the frequency of un-damped free vibration of an equivalent spring mass system. 7. To perform experiment on Watt and Porter governors to determine performance 8. Comparative study of static and dynamic balancing inrotors. 9. To find out critical speed and to compare the whirling speed of a shaft. 10. To study TRI –FILAR / BI-FILAR System 11. Comparative study of different types of clutches

Suggested Reading

1. S.S. Rattan (2009), "Theory of Machines", 3rd Edition, Tata McGraw-Hill Publishing Company Ltd, ISBN: 978-0-070-14477-4.
J. Uicker John, Gordon R. Pennock Jr., and Joseph E. Shigly (2009), Theory of Machines and Mechanisms, 3rd Edition, Oxford University Press, ISBN: 978-0-198-06232-5.

Name of The Course	**Project Management**				
Course Code	**BTME4010**				
Prerequisite					
Co-requisite					
Anti-requisite					
		L	**T**	**P**	**C**
		1	**0**	**0**	**1**

Course Objectives

1. To acquaint students with basic concepts of the Project Management and its uses in real life situation, the formulation of the problems and basic insight of Capital Budgeting decision.

2. To be able to recognize and analyse the Market – Demand & Supply factors affecting the Project Execution and study risk factors associated with Project Management.
3. To know how to plan, organize and control the resources to achieve specific goals.

Course Outcomes

CO1	**Explain basic concepts of the Project Management and its uses in real life situation.**
CO2	**Take decisions about Capital Budgeting.**
CO3	**Analyze the Market – Demand & Supply factors affecting the Project Execution.**
CO4	**Select the risk factors associated with Project Management.**
CO5	**Plan, organize and control the resources to achieve specific goals.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	30	50	100

Course Content:

Unit I: Introduction to Project Management **8 Hours**
Introduction to Project Management, Uses, scope and applications of Project Management in managerial decision-making, Characteristics of Projects, Classification of Projects: National & International, Project Management: Tools and Techniques, Roles and Responsibilities of Project Manager, Project Life cycle, Project Selection Process.
Unit II: Capital Expenditure Decisions **8 Hours**
Meaning and features of capital budgeting decisions, Importance of capital budgeting decisions, Kinds of capital expenditure decisions, Capital expenditure budgeting process, Criteria of capital budgeting, Resource allocation framework and budgeting difficulties.
Unit III: Market Demand Analysis **8 Hours**
Information required for marketing and demand analysis, Information required for marketing and demand analysis, Secondary sources of information, Market survey, Demand forecasting, Uncertainties in demand forecasting, Coping with uncertainties: Technical and Financial Analysis.
Unit IV: Determination of Risk factors **8 Hours**
Analyses of Project Risk, Market Risk and Firm Risk, Social-Cost, benefit analysis: Need for social cost benefit analysis, Main feature of social cost benefit analysis: UNIDO approach, Little-Mirrless approach.
Unit V: Network Analysis **8 Hours**
Rules for drawing the network diagram, Application of CPM and PERT techniques in project planning and control, Illustration by taking numerical examples on CPM and PERT, Case Study: China Telecom Corporation uses PMI standards to develop communications network for Nanshan District.

Suggested Reading

1. Project Management, Prasanna Chandra, Mc. Graw Hill
2. Project Management, S Chaudhry, Tata Mc. Graw Hill.
3. Total Quality Management, P.K. Joy, Macmillan Indian Ltd.
4. Project Finance, H.R. Machiraju, Vikas Publishing House
5. Project Management in Practice, Meredith, Jack R., Sutton, Margaret M., Shafer, Scott M., Wiley.

Name of The Course	**Optimization Techniques and Applications**				
Course Code	**BTME4005**				
Prerequisite					
Co-requisite					
Anti-requisite					
		L	**T**	**P**	**C**
		2	**0**	**0**	**2**

Course Objectives

1. To understand the role of optimization in Engineering design and its importance
2. To introduce the different optimization techniques for constrained and unconstrained problems

Course Outcomes

CO1	**Study and analyze different techniques of optimization and its applications**
CO2	**Formulate the design problem in mathematical form which can be solved by suitable optimization algorithm**
CO3	**Optimize the constrained and unconstrained design problem**
CO4	**Compare the efficiency of different algorithms.**
CO5	**Formulate and solve constrained optimization problems of linear and non-linear programming**

Continuous Assessment Pattern

Internal Assessment (IA)	**Mid Term Exam (MTE)**	**End Term Exam (ETE)**	**Total Marks**
20	**30**	**50**	**100**

Course Content:

Unit I: Introduction to Optimization Methods	**4 lecture hours**
Introduction, Optimization methods in Engineering, Characteristics of Optimization Models, Application in Engineering Areas, General Method of Optimization, Limitation of Optimization Models.	

Unit II: Unconstrained Single-variable Optimization 8 lecture hours
Unconstrained Optimization: Optimizing Single-Variable Functions using Analytical Method, Maxima-Minima Method of Optimization, Local and Global Maxima and Minima, Inflection Point, Single –variable Optimization using Bisection (Newton-Raphson) Numerical method
Unit III: UnConstrained Multi-variable Optimization 8 lecture hours
Unconstrained Optimization: Optimizing Multi-Variable Functions using Analytical Method, Multi-variable Optimization using Numerical Method: Univariate Method, Hooke-Jeeves Pattern Search Method
Unit IV: Constrained Optimization for Linear Programming 10 lecture hours
Constrained Optimization, Optimizing Multivariable Functions with Equality Constraint: Direct Substitution Method, Constraint Variations Method, Optimizing Multivariable Functions with Inequality Constraint, Branch and Bound Method.
Unit V: Constrained Optimization for Nonlinear Programming 10 lecture hours
Kuhn-Tucker Method with Necessary Conditions and Sufficient Conditions, Constrained Optimization techniques for Nonlinear Programming Problems, Factors Affecting a Constrained Problem, Normalization of Constraints, Exterior Penalty Function Method, Interior Penalty Function Method, Introduction to AI in optimization.

Suggested Reading

1. **Raju, N.V.S. (2014) Optimization methods for Engineers, PHI Publications, ISBN-978-81-203-4744-1.**
2. **Bhavikatti S.S. (2010), Fundamental of Optimum Design IN Engineering, New Age International Publishers, ISBN-978-81-224-2591-8**
3. **Deb Kalyanmoy (2012) Optimization for Engineering Design, PHI Publications, ISBN-978-81-203-4678-9.**
4. **Rao S. S. (2013) Engineering Optimization Theory and Practice, ISBN: 978-81-265-4044-0**

Name of The Course	**Quality and Reliability Engineering**				
Course Code	**BTME40006**				
Prerequisite					
Co-requisite					
Anti-requisite					
		L	**T**	**P**	**C**
		2	**0**	**0**	**2**

Course Objectives

- To impart knowledge about the significance of quality and the various tools/ concepts of building quality into products.

- To impart knowledge about plans for acceptance sampling and quality systems.
- To address the underlying concepts, methods and application of Quality and Reliability Engineering.

Course Outcomes

CO1	**Apply the tools and techniques of quality to resolve industrial engineering issues.**
CO2	**Estimate the obvious and hidden quality costs for a given production system.**
CO3	**Prepare and analyze various charts/ methods for quality control and improvement**
CO4	**Use plans for sampling and concepts of quality system management.**
CO5	**Model various systems applying reliability networks.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
30	20	50	100

Course Content:

Unit I:Introduction to Quality	**8 lecture hours**
Quality - meaning and significance, Essential components of quality, Phases or elements for building quality, Evolution of the concepts of quality, Spiral of progress of quality, Changing scope of quality activities, Ishikawa's seven quality tools, Quality Circles, Quality system economics, Hidden quality costs, Economic models of quality costs.	
Unit II: Taguchi's Quality Loss Function	**8 lecture hours**
System approach for quality management, Juran's quality trilogy, Quality planning activities, Sporadic and chronic quality problems, Causes of variation, General quality control methodology.	
Unit III: Statistical Quality Control	**8 lecture hours**
Control charts for variables: X bar-R, X bar-S, median, XMR charts, Control charts for attributes: p, np, c charts, Product reliability, Process capability analysis.	
Unit IV:Acceptance Sampling	**8 lecture hours**
Plans and tables for attributes and variables, Sampling methods, Type of plans, Operating characteristic curves, Quality improvement methodology, Justin-time philosophy.ISO 9000 Philosophy: Documentation, Implementation and certification process	
Unit V: Reliability Concepts	**8 lecture hours**
Reliability engineering fundamentals; Failure data analysis; Failure rate; mortality curve; Concept of burn in period; Useful life and wear out phase of a system; Mean time to failure (MTTF); Mean time between failure, (MTBF) and mean time to repair (MTTR); Reliability in terms of Hazard rate and failure density, Conditional probability and multiplication rules.	

Suggested Reading

1. Dale H. Besterfield, Carol Besterfield (2018), Total Quality Management (TQM),5th Edition, Pearson Education, ISBN: 978-9353066314.

2. Juran, J.M. and Gryna, F.M, Quality Planning & Analysis, McGraw Hill (2001).

3. Grant, E.L., Statistical Quality Control, McGraw Hill (2008).

4. Feignbaum, A.V., Total Quality Control, McGraw Hill (1991).

5. Juran, J.M., Juran's Quality Control Handbook, McGraw Hill (1988).

6.E. Balagurusamy, Reliability Engineering by Tata McGraw-Hill Publishing Company Limited, 2002.

Name of The Course	**Alternative Fuels & Energy Systems**			
Course Code	**BAUT3054**			
Prerequisite				
Co-requisite				
Anti-requisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives

1. To study the properties of alternative fuels for automobiles.

2. To identify the appropriate alternative fuel system for automobile application

Course Outcomes

CO1	**Understand the fuel economy, the fuel conservation and the air fuel ratio, carburettors and various types of fuel injection system.**
CO2	**Know the properties, performance and emission characteristics of liquid fuels like gasoline , alcohol , vegetable oils in both SI and CI engines.**
CO3	**Know the properties, performance and emission characteristics of gaseous fuels like LPG, CNG, and Hydrogen.**
CO4	**Know the modification of SI and CI engines for various alternative fuels**
CO5	**Demonstrate the knowledge of electric, hybrid and solar powered vehicle.**
CO6	**Able to understand the electric and Hybrid Vehicles**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	**30**	**50**	**100**

Course Content:

Unit I:Introduction	**8 lecture hours**
Important properties(Calorific value , Flash point, fire point, pour point, cloud point, viscosity, Cetane and Octane number etc) of a fuel. General characteristics of SI & CI Engines fuels, estimation of petroleum reserve, need for alternate fuel, availability of various alternative fuels, general use of Alcohols,LPG,Hydrogen,CNG, LNG, Vegetable oils and Biogas.	
Unit II: Vegetable Oils & Bio-diesel	**8 lecture hours**

Composition & Properties of various vegetable oils for engines; Transesterification reaction and bio-diesel production , Performance and emission characteristics of Bio-diesel.
Unit III: Alcohol Based Fuels 8 lecture hours
Properties as engine fuels, merits and demerits, alcohol as SI and CI engine fuel, alcohols with gasoline& diesel blends, Combustion characteristics and emission characteristics in engines.
Unit IV:Natural Gas and Hydrogen 8 lecture hours
Source and composition of CNG, Properties, advantages &disadvantages, performance and emission characteristics of CNG, Introduction to Hydrogen as fuel, Safety and Performance of Hydrogen.
Unit V: Solar Energy and Fuel Cells 5 lecture hours
Semiconductor and Photovoltaic effect, Solar Cell, advantages & disadvantages of Solar Energy, application of solar energy. Fuel Cells: Types of fuel cell, advantages & disadvantages and applications.
Unit VI: 3 Lecture hours
Analysis of electrical drive trains, Topology of electric/hybrid systems, Sizing of components, Electric motors for automobile applications, Electric Propulsion system, Battery Storage

Suggested Reading

1.Richard L. Bechtold (1997), Alternative Fuels Guidebook: Properties, Storage, Dispensing, and Vehicle Facility Modifications, SAE International.

2. V. Ganesan (2004) , Internal Combustion Engines, Tata McGraw Hill Co.

3. SAE paper Nos.840367, 841156,841333,841334.

4. Mark L. Poulton, (1994) Alternative fuels for road vehicles, Computational Mechanics

Name of The Course	**Electric and Hybrid Vehicles**				
Course Code	**BAUT3058**				
Prerequisite					
Co-requisite					
Anti-requisite					
	L	**T**	**P**	**C**	
	3	**0**	**0**	**3**	

Course Objectives

1. To study the properties of alternative fuels for automobiles.

2. To identify the appropriate alternative fuel system for automobile application

Course Outcomes

CO1	**Describe the pros and cons of different types of EVs and HEVs**
CO2	**Perform basic designs of EV and HEV systems using series, parallel and series-parallel architectures.**
CO3	**Define the testing procedures for EVs and HEVs**

CO4	**Discuss the emerging technologies, engineering challenges, and development trends in EVs and HEVs.**
CO5	**Demonstrate the knowledge of electric, hybrid and solar powered vehicle.**
CO6	**Perform initial modelling and simulation of basic layout of hybrid-electric vehicle**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	30	50	100

Course Content:

Unit I: Need for alternative system 8 lecture hours
Need of electric vehicles hybrid vehicles – comparative study of diesel, petrol, pure electric and hybrid vehicles. Limitations of electric vehicles. Specification of some electric and hybrid vehicles
Unit II: Energy sources: Batteries and fuel cells 8 lecture hours
Battery Parameters-Power requirement of electric vehicles- Different types of batteries – Lead acid-Nickel based-Sodium based-Lithium based- Metal Air based. Battery charging- Charger design- Quick charging devices- Battery Modeling. Fuel Cell- Fuel cell characteristics- Fuel cell types-Hydrogen fuel cell- Connecting cell in series water management in the PEM fuel cell- Thermal Management of the PEM fuel cell
Unit III:Alcohol Based Fuels 8 lecture hours
A characteristic of permanent magnet and separately exited DC motors. AC single phase and 3-phase motor – inverters – DC and AC motor speed controllers.
Unit IV:Vehicle design considerations for electric vehicles 8 lecture hours
Aerodynamic-Rolling resistance- Transmission efficiency- Vehicle mass- Electric vehicle chassis and Body design considerations- Heating and cooling systems- Controllers- Power steering- Tyre choice-Wing Mirror, Aerials and Luggage racks
Unit V: Hybrid Vehicles 5 lecture hours
Types of Hybrid- Series, parallel, split – parallel, series - parallel - Advantages and Disadvantages. Power split device – Energy Management System - Design consideration - Economy of hybrid vehicles
Unit VI: 3 lecture hours
Simulating In Real Time: Hybrid Electric Vehicle Model, simulate, and deploy a hybrid electric vehicle in the MATLAB & Simulink environment

Suggested Reading

1. Modern Electric,Hybrid Electric, andFuel Cell Vehicles, Fundamentals, Theory, and Design by Mehrdad Ehsani, Texas A&M University,Yimin Gao, Texas A&M University

2. Sebastien E. Gay, Texas A&M University,AliEmadi, Illinois Institute of Technology

3. Ron HodKinson, " light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication,2005

4. Lino Guzzella, " Vehicle Propulsion System" Springer Publications,2005.

Name of The Course	**Vehicle dynamics**				
Course Code	**BAUT3051**				
Prerequisite					
Co-requisite					
Anti-requisite					
	L	**T**	**P**	**C**	
	3	**0**	**0**	**3**	

Course Objectives

1. To broaden the understanding of vehicle dynamics.
2. To understand tyre mechanics.
3. To understand performance characteristics of road vehicle and vehicle ride characteristics.
4. To broaden the understanding of stability

Course Outcomes

CO1	**Understand mathematical Modeling methods in vehicle dynamics**
CO2	**Understand tyre dynamics**
CO3	**Design and analyze passive, semi-active and active suspension systems**
CO4	**Predict vehicle performance**
CO5	**Understand directional control of vehicles**
CO6	**perform initial modelling and simulation of basic layout of hybrid-electric vehicle**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	**30**	**50**	**100**

Course Content:

Unit I: Introduction to Vehicle Dynamics **8 lecture hours`**
Definition by SAE, vehicle control loop, mathematical Modeling methods, multi-body system approach, Newtonian and Legrangian formulation, method of Investigation, stability concepts.
Unit II: Mechanics of Pneumatic Tyres **8 lecture hours**
Tyre forces and moments, Tyre structure, Longitudinal and Lateral force at various slip angles, rolling resistance, Tractive and cornering property of tyre, Performance of tyre on wet surface, Ride property of tyres, Tyre model, Estimation of tyre road friction, Test on Various road surfaces, Tyre vibration, SAE recommended practice.
Unit III:Vertical Dynamics **8 lecture hours**
Human response to vibration, Sources of Vibration. Design and analysis of Passive, Semi-active and active suspension using Quarter car, half car and full car model. Influence of suspension stiffness,suspension damping,

and tire stiffness, Control law for LQR, H-Infinite, Skyhook damping, Airsuspension system and their properties
Unit IV:Longitudinal Dynamics And Control 8 lecture hours
Aerodynamic forces and moments, Equation of motion, Tire forces, rolling resistance, Load distribution for three wheeler and four wheeler, Calculation of Maximum acceleration, Reaction forces for Different drives. Braking and Driving torque, Prediction of Vehicle performance, ABS, stability control, Traction control
Unit V: Lateral Dynamics 5 lecture hours
Steady state handling characteristics, Steady state response to steering input,Testing of handling characteristics, Transient response characteristics, Direction control of vehicles, Roll center, Rollaxis,Vehicle under side forces, Stability of vehicle on banked road,during turn, Effect of suspension oncornering.
Unit VI: 3 Lecture hours
The modelling and simulation of vehicle

Suggested Reading

1. Ellis J.E.R; Vehicle Dynamics; Business Book London

2. Ramalingam KK; Automobile engineering; Scitech pub

3. Giri N.K.; Automotive Mechanics

4. Wong; Theory of Ground Vehicle; John Wiley & Sons

5. Jazar, Reza N. Vehicle dynamics: theory and application. Springer, 2008

Name of The Course	**Two and Three Wheeled Vehicles**				
Course Code	**BAUT3055**				
Prerequisite					
Co-requisite					
Anti-requisite					
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives

1. To discuss about various systems of different two and three wheeled vehicles.

2. To discuss about the recent trends in two wheeled and three wheeled vehicles

Course Outcomes

CO1	**Understand the construction and working of two stroke engines**
CO2	**Understand the two wheeled vehicle chassis and chassis sub-systems**
CO3	**Understand the construction and working of brakes, tyres of two wheeled vehicles**
CO4	**Understand the maintenance and servicing of common two wheeled vehicles**

CO5	Understand the construction and working of common three wheeled vehicles
CO6	Understand the performance parameters of Two and Three Wheelers

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
30	20	50	100

Course Content:

Unit I:The Power Unit **8 lecture hours**
Two stroke SI engine, merits and demerits, symmetrical and unsymmetrical port timing diagrams, types of scavenging processes, merits and demerits, scavenging efficiency, scavenging pumps. Rotary valve engine, fuel system, lubrication system, magneto coil and battery coil spark ignition system, electronic ignition system, variable timing ignition system (VTI), starting system, kick starter system
Unit II: Chassis and Sub-Systems **8 lecture hours**
Main frame, its types, chassis, shaft drive and chain drive, single, multiple and centrifugal clutches, gear box and gear controls, front and rear suspension systems, shock absorbers. Panel meters and controls on handle bar
Unit III:Brakes and Wheels **8 lecture hours**
Drum brakes & Disc brakes Construction and Working and its Types, Front and Rear brake links layouts.Brake actuation mechanism, Spoked wheel, cast wheel, Disc wheel & its merits and demerits, Tyres and tubes Construction & its Types, Steering geometry.
Unit IV:Two Wheelers **8 lecture hours**
Case study of popular Indian motor cycle models, scooters, scooterettes and mopeds, and their Servicing and maintenance
Unit V: Three Wheelers **5 lecture hours**
Case study of Indian Three wheeler models, Front mounted engine and rear mounted engine types, Auto rickshaws, Pick up vans, Delivery vans and Trailers, E- Rickshaws,and their Servicing and maintenance.
Unit VI: Two three wheelers characteristics **4 Lecture hours**
Handling characteristics, seating arrangement for driver & pillion rider, ergonomics & comfort, road holding & vehicle stability, riding characteristics, safety arrangements, Racing bikes – special requirements.

Suggested Reading

1. Irving P E (1992), Motor cycle engineering, Temple Press Book, London.

2. Dhruv U. Panchal (2015), Two And Three Wheeler Technology, PHI Learning; 1 edition

3. Newton Steed (2000), "The Motor Vehicle", McGraw Hill Book Co. Ltd., New Delhi

Name of The Course	**Automotive Transmission Systems**				
Course Code	**BAUT3005**				
Prerequisite	**BTME3002**				
Co-requisite					
Anti-requisite					
	L	**T**	**P**	**C**	
	3	**0**	**0**	**3**	

Course Objectives

1. To study the working of engines.

2. To study Engine parts and their functions

3. To study the Different Engine technologies

Course Outcomes

CO1	**Demonstrate the knowledge of different automotive axles**
CO2	**Demonstrate the knowledge of different automotive clutches**
CO3	**Understand the constructional details of gear boxes**
CO4	**Demonstrate the knowledge of wheel drives**
CO5	**Understand the automatic transmission systems**
CO6	**Understand the importance and working of emerging technologies in Automobile Transmission systems.**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	**30**	**50**	**100**

Course Content:

Unit I:Introduction **8 lecture hours**
Transmission requirements: requirements of transmission system, general arrangement of power transmission, general arrangement of rear-engine vehicle with live axles, general arrangement of dead-axle and axles transmission; four-wheel-drive transmission
Unit II: Automotive clutches **8 lecture hours**
Clutches Requirements of clutches, principle of friction clutches, types of clutches and materials used-cone, single-plate, diaphragm-spring, multi-plate, centrifugal, over-running and ferro-electromagnetic clutch
Unit III:Automotive Gear boxes **8 lecture hours**
Need of gear boxes, types- sliding mesh, constant mesh and epicyclic, gear boxes; synchronizers: principle, early and later Warner synchronizer, Vauxhall synchronizer- gear materials lubrication and design of gear box; Hydrodynamic drive: Advantages and limitations, principle of fluid coupling, constructional details, torque-capacity performance characteristics, drag torque, methods of minimizing drag torque; Torque converter: performance characteristics; single, multistage and poly-phase torque converters, converter-coupling-performance characteristics, coupling-blade angle and fluid flow, converter fluid

Unit IV:Transmission systems-Drive line	8 lecture hours
Definition, forces & torques acting; types of drives-Hotchkiss, torque tube & radius rod drives; components- propeller shaft, slip joint, universal joints & constant velocity universal joints; front wheel drive; Final drive: definition; types- worm-wheel, straight-bevel gear, spiral-bevel gear & hypoid-gear drives; double-reduction & twin-speed final drives; Differential: Function, principle, construction and working; non-slip differential; differential lock; rear axle- loads acting & types; multi-axled vehicles	
Unit V: Automatic transmission	**5 lecture hours**
Chevrolet turboglide transmission, power glide transmission, hydraulic control system of automatic transmission; Electric drive: advantages and limitations, principle of early and modified Ward-Leonard system, modern electric drive for buses; performance characteristics.	
Unit 6:	**3 Lecture hours**
Block diagrams of-Chevrolet "Turbo-glide" Transmission, Power-glide Transmission & Clutch Hydraulic Actuation system, Introduction to Toyota "ECT-i" Automatic Transmission with Intelligent Electronic controls system.	

Suggested Reading

1. Heldt P.M.; Torque converters; Chilton Book Co.
2. Giri NK; Automobile Engineering; Khanna Publisher
3. Newton, Steeds & Garret; Motor Vehicles; B.H. Publication.
4. Judge, A.W., Modern Transmission Systems, Chapman & Hall Ltd.
5. Chek Chart; Automotive Transmission; Harper & Row Publication.

Name of The Course	Automotive Chassis and Body Engineering				
Course Code	BAUT3004				
Prerequisite	BTME2008				
Co-requisite					
Anti-requisite					
		L	T	P	C
		3	0	0	3

Course Objectives

1. To broaden the understanding of details of car body aspects.

2. To introduce car body and bus body details used.

3. To broaden the understanding of students in the structure of vehicle chassis.

4. To introduce students to steering, suspension and braking systems.

Course Outcomes

CO1	Understand the construction details of various types of automotive chassis and basic functions of subsystems in the chassis.
CO2	Demonstrate knowledgeof various types of suspension systems.
CO3	Demonstrate knowledgeof various types of brake system
CO4	Demonstrate knowledge of steering system, wheels &tyres in the vehicles
CO5	Understand various safety provisions

CO6	**Perform simulation on chassis system by applying varying loads**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	30	50	100

Course Content:

Unit I:Introduction **8 lecture hours**
General consideration relating to chassis layout, types of automobiles, layout of an automobile, weight distribution, stability, Terms used in body building construction, Angle of approach, Angle of departure, Ground clearance, Cross bearers, Floor longitudes, posts, seat rail, waist rail, cant rail, Roof stick, Roof longitude, Rub rail, skirt rail, truss panel, wheel arch structure.
Unit II: Vehicle Body **8 lecture hours**
Car Body: Types, Regulations, drivers visibility, tests for visibility, methods for improving visibility and space in cars, safety design, safety requirements for car, car body construction. **Bus Body Details: Types, bus body layout, floor height, engine location, entrance and exit locations, seating dimensions, constructional details, frame construction.**
Unit III:Axle And Steering Systems **8 lecture hours**
Axle parts and materials, loads and stresses, centre sections, section near steering head, spring pads, front axle loads, rear axles loads, types of rear axles, multi axles vehicles,steering heads, factors of wheel alignment, wheel balancing, centre point steering, correct steering angle, steering mechanisms, cornering force, self righting torque, under steer and over steer, Steering linkages, steering gears, special steering columns, power steering
Unit IV:Brakes **8 lecture hours**
Necessity, stopping distance and time, brake efficiency, weight transfer, brake shoe theory, determination of braking torque, classification of brakes, types, construction, function, operation, braking systems, bleeding of brakes, brake drums, brake linings, brake fluid, factors influencing operation of brakes such as operating temperature, lining, brake clearance, pedal pressure, linkages etc, Numerical problems. Brake compensation, Parking and emergency brakes
Unit V: Suspension & Wheels and Tyres **5 lecture hours**
Springs: Operation & materials, type leaf springs, air bellows or pneumatic suspension, hydraulic suspension, telescopic shock absorbers, independent suspension, front wheel independent suspension, rear wheel independent suspension, types, stabilizer, trouble shooting, Numerical problems. Types of wheels, construction, structure and function, wheel dimensions, structure and function of tyres, types of tyres, materials, tyre section & designation, factors affecting tyre life.
Unit VI: **3 Lecture hours**
Simulation on chassis system by applying varying loads

Suggested Reading

1. **P.M. Heldt (2010), Automotive Chassis, Chilton & Co.**
2. **S. S. Rattan (2004), Automotive Mechanics, N.K. Giri , Khanna Publications, New Delhi.**

3. **T.R. Banga&Nathu Singh, (1993), Automobile Engineering, Khanna Publications.**

4. **Joseph I Heintner, (1967), automotive mechanics, Affiliated East West press, New Delhi/Madras.**

Name of The Course	**Aerodynamics Design of Vehicle**				
Course Code	**BAUT3063**				
Prerequisite					
Co-requisite					
Anti-requisite					
	L	**T**	**P**	**C**	
	3	**0**	**0**	**3**	

Course Objectives

1. To broaden the understanding of aerodynamics.

2. Understand how to approach various industrial applications using CFD..

3. Hands on experience on many leading commercial

Course Outcomes

CO1	**Understand basic fluid theory**
CO2	**Understand basics of CFD**
CO3	**Develop solutions using various commercial solvers and validate the results using standard solutions**
CO4	**Compare various types of grids for approaching accurate solution.**
CO5	**Analyse the aerodynamic issues related to specified automobile design case**
CO6	**perform full simulation of automotive vehicle**

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	**30**	**50**	**100**

Course Content:

Unit I:Fundamentals of Aerodynamics **8 lecture hours**
Scope – Development trends – Flow phenomena related to vehicles – External and Internal flow problems – Performance of cars and light vans – Resistance to vehicle motion – Drag –Types of drag – Flow field around car – Aerodynamic development of cars – Optimization of car bodies for low drag. Navier Stokes equation
Unit II: Basics Of CFD **8 lecture hours**
Basic aspects of discretization, finite difference method, difference equations, Explicit and Implicit schemes, stability analysis One-dimensional steady state diffusion Steady one-dimensional convection and diffusion, pressure correction technique, SIMPLE algorithm.
Unit III:ANSYS Software **8 lecture hours**

An introduction to several commercial CFD software codes and their applications to the governing differential equations, solution procedures, interpretation of the results, visualization of the results and the built in graphics will be described.
Unit IV:Mesh Generation With Commercial Cfd Codes 8 lecture hours
Introduction of Gambit, ICEMCFD, FLUENT, CFX, Ansys Package to give students a taste of various commercial CFD software applications
Unit V: Aerodynamic Design 5 lecture hours
Simulation and case studies –cars, buses, trucks
Unit VI: 3 Lecture hours
Turbulent flow simulation and analysis of armed body, simulation of auto motive vehicle from scratch

Suggested Reading

1. Vehicle Aerodynamics, SAE, 1996.
2. Schlichting, H (1999), Boundary Layer Theory, McGraw Hill, New York
3. John D Anderson, Jr., Computational Fluid Dynamics -The Basics with Applications, McGraw Hill, 1995

GALGOTIAS UNIVERSITY

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

School of Mechanical Engineering

Program: M.Tech (CAD/CAM)

Scheme: 2019 – 2020

Vision

To be known as a premier department in mechanical engineering by synergizing teaching, learning and research to produce competent Mechanical Engineers with an exposure to interdisciplinary engineering knowledge.

Mission

MD1: Create an effective foundation in the field of production, design, thermal, industrial and automation engineering by imparting quality education.

MD2: Conduct interdisciplinary research leading to the delivery of innovative technologies through Problem and Research Based Learning.

MD3: Provide relevant industrial experience that instills the problem solving approach; integrate the product design to manufacturing life cycle management.

MD4: Prepare students for careers in academia and various industrial organization related to mechanical and allied engineering.

Program Educational Objectives

PEO1: Graduates of Mechanical Engineering shall be engineering professionals and innovators in core engineering, service industries or pursue higher studies.

PEO2: Graduates of Mechanical Engineering shall be competent in latest technologies by exploiting automation and smart manufacturing tools to address various industry 4.0 problems.

PEO3: Graduates of Mechanical Engineering shall leverage their imbibed skill through continuous working on technologies like drone and additive manufacturing knowledge to transform the society.

Program Outcomes

1. Engineering Knowledge : Apply the knowledge of Mathematics, Science, and Engineering fundamentals, and an engineering specialization to solution of complex engineering problems.
2. Problem analysis : Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3. Design/development of solutions : Design of solutions for complex engineering problems and design of system components or processes that meet the specified needs with appropriate considerations of public health and safety, and cultural, societal, and environmental considerations.
4. Conduct investigations of complex problems : Use research based methods including design of experiments, analysis and interpretation of data and synthesis of information leading to logical conclusions.
5. Modern tool usage : Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling complex engineering activities with an understanding of limitations.

6. The engineer and society : Apply reasoning within the contextual knowledge to access societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and sustainability : Understand the impact of the professional engineering solutions in the societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable developments.
8. Ethics : Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
9. Individual and team work : Function effectively as an individual independently and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communication : Communicate effectively on complex engineering activities with the engineering community and with society at large such give and receive clear instructions.
11. Project management and finance : Demonstrate knowledge and understanding of engineering management principles and apply those to one's own work as a member and leader of a team to manage projects in multidisciplinary environments.
12. Life-long Learning : Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Curriculum

Semester 1									
Sl. No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MATH5001	Advanced Numerical and Statistical Methods	3	1	0	4	20	50	100
2	MCDM5001	Advanced Strength of Materials	3	0	0	3	20	50	100
3	MCDM5002	Advanced Materials and Processing	3	0	0	3	20	50	100
4	MCDM5003	Advanced Manufacturing Technology	3	0	0	3	20	50	100
5	MCDM5004	Product Design and Life Cycle Management	3	0	0	3	20	50	100
6	MCDM5005	Advanced Computer Aided Design	3	0	0	3	20	50	100
		Total	18	1	0	19			
Semester II									
Sl No	Course Codee	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	CENG5001	Professional and Communication Skills	0	0	4	2	70	-	30
2	MCDM5006	Finite Element Methods	2	1	0	3	20	50	100
3	MCDM5007	Computer Integrated Manufacturing	3	0	0	3	20	50	100
4	MCDM5008	Advanced Vibration Engg.	3	0	0	3	20	50	100
5	MCDM5009	Computer Aided Process Planning	0	0	2	1	70	-	30
6		Elective 1	3	0	0	3	20	50	100
7		Elective 2	3	0	0	3	20	50	100
8		Data Analysis	0	0	2	1	70	-	30
		Total	14	1	8	19			
Semester III									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MCDM6001	Advanced Computer Aided Design and Manufacturing Lab	0	0	4	2	70	-	30
2	MCDM9998	Dissertation-1	-	-	-	5	50	-	50
3		Elective 3	3	0	0	3	20	50	100
4		Elective 4	3	0	0	3	20	50	100
5		Elective 5	3	0	0	3	20	50	100
		Total	9	0	6	16			
Semester IV									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MCDM9999	Dissertation-2	-	-	-	15	50	-	50

List of Electives

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MCDM5010	Rapid Prototyping	3	0	0	3	20	50	100
2	MCDM5011	Tool Engineering	3	0	0	3	20	50	100
3	MCDM5012	Advanced Computer Aided Manufacturing	3	0	0	3	20	50	100
4	MCDM5013	Performance Modelling and Analysis of Manufacturing Systems	3	0	0	3	20	50	100
5	MCDM5014	Design for Manufacturing	2	1	0	3	20	50	100
6	MCDM5015	Quality Management	2	1	0	3	20	50	100
7	MCDM5016	Reliability Engineering	3	0	0	3	20	50	100
8	MCDM5017	Metrology and Non Destructive Testing	3	0	0	3	20	50	100
9	MCDM5018	Design and Analysis of Experiments	3	0	0	3	20	50	100
10	MCDM5019	Research Methodology	3	0	0	3	20	50	100
11	MCDM5020	Optimization Methods	2	1	0	3	20	50	100

Name of The Course	Professional and Communication Skills
Course Code	CENG 5001
Prerequisite	
Corequisite	
Antirequisite	

Course Objective:

1. To develop the professional and communicational skills of learners in a technical environment.
2. To enable students acquire functional and technical writing skills.
3. To enable students acquire presentation skills to technical and non-technical audience.

Course Outcomes:

CO1	Improve their reading fluency skills through extensive reading
CO2	Use and assess information from academic sources, distinguishing between main ideas and details
CO3	Compare and use a range official support through formal and informal writings
CO4	The students will be able to exhibit language proficiency in comprehending, describing, and investigating.

Text Books

Rajendra Pal and J.S.Korlahalli. Essentials of Business Communication. Sultan Chand & Sons. New Delhi.

Reference Books

1. Kaul. Asha. Effective Business Communication.PHI Learning Pvt. Ltd. New Delhi.2011.
2. Murphy, Essential English Grammar, CUP.
3. J S Nesfield, English Grammar: Composition and Usage
4. Muralikrishna and S. Mishra, Communication Skills for Engineers.

UNIT 1: Aspects of Communication; Sounds of syllables; Past tense and plural endings; Organizational techniques in Technical Writing; Paragraph Writing, Note taking, Techniques of presentation
UNIT 2: Tense, Voice, conditionals, Techno-words; Basic concepts of pronunciation; word stress; Business letters, email, Techniques for Power Point Presentations; Dos and don'ts of Group Discussion
UNIT 3: An introduction to Modal and Phrasal verbs; Expansion; Word formation; Technical Resume; Company Profile Presentation; Interview Skills

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	-	50	100

Name of The Course	Advanced Numerical and Statistical Methods
Course Code	MATH5001
Prerequisite	
Corequisite	
Antirequisite	

Course Objective:

With ever growing demand of computational techniques, scope of numerical methods is penetrating aggressively into major and important fields including Science, Engineering &Technology, Medical, Space Science, Economics, Business and Environment. The objective is to achieve knowledge and understanding of numerical methods and to apply appropriate methods to model and solve problems where ordinary analytical methods fail.

Statistical methods are used in manufacturing, development of food product, computer software, energy sources, pharmaceuticals and many other areas. The objective of statistics and probability is to analyze data to make scientific judgments in the face of uncertainty and variation for the improvement of the desired quality.

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

CO1	Apply various numerical methods to solve system of linear and non-linear equations.
CO2	Apply standard interpolation methods to interpolate required/ missing value.
CO3	Apply appropriate methods of numerical differentiation /integration to solve related problems.
CO4	Solve ordinary differential equations and partial differential equations using appropriate numerical methods.
CO5	Identify the type of distributions and apply a suitable test to draw the conclusion.

Text Books

1. Cormen, Leiserson, Rivest and Stein, "Introduction to Algorithms", 2nd Edition, by, McGraw-Hill, 2000.
2. E. Horowitz, and S. Sahni, "Fundamentals of Computer Algorithms", Computer Science Press (1978).

Reference Books

1. Jon Kleinberg and Eva Tardos. Algorithm Design. Pearson Education, 2007.
2. Sanjoy Das Gupta, Christos Papadimitriou, Umesh Vazirani, Algorithms 1st Edition, Mcgraw Higher Ed, 2006.
3. Alfred V. Aho, John E. Hopcroft, Jeffery D.Ulman, Data Structures and Algorithms, Pearson; 1st edition, 2001.

Unit –I
8 hours
System of Linear Equations: Direct Methods- Gauss elimination – Pivoting, Partial and Total Pivoting, Triangular factorization method using Crout LU decomposition, Cholesky method, Iterative Method- Gauss- Seidel and Jacobi method, ill conditioned matrix System of Non-linear equation- Newton Raphson and Modified Newton Raphson Method. Iterative methods

Unit –II 8 hours Interpolation and Approximation: Lagrange, Spline and Hermite interpolation, Approximations, Error of approximation, Norms for discrete and continuous data, Least square approximation.
Unit –III 8 hours Numerical Integration: Newton Cotes closed Quadrature, Gauss Legendre Quadrature, Multiple Integration An introduction to Modal and Phrasal verbs; Expansion; Word formation; Technical Resume; Company Profile Presentation; Interview Skills
Unit –IV 8 hours Numerical Solution of Differential Equations: Finite Difference Schemes, Numerical solution of Ordinary differential equation using Modified Euler's method, Runge-Kutta method of 2nd, 3rd and 4th orders, Predictor- Corrector method, Solution of Laplace's and Poisson's equations by Liebman's method, Solution of one dimensional time dependent heat flow.
Unit –V 8 hours Probability and statistics: Review of concept of probability, Random Variables, Continuous and discrete distribution function, moments and moments generating functions, Binomial, Poisson, Negative Binomial, Geometric and Hyper-geometric Distributions, Uniform, Normal, Exponential, Gamma and Beta distributions. Point and Interval estimation, Testing of Hypothesis (t-test and chi square test), Analysis of variance and Introduction of Design of experiments

Text Books:

1. Numerical Methods for Scientific and Engineering Computation (6th edition) by Jain, Iyengar & Jain, New Age International publishers.
2. Probability & Statistics for Engineers & Scientists (9th edition) by R.E.Walpole, R,H,Myers & K.Ye.

Reference Books:

1. Numerical Methods by E Balagurusamy, Tata McGraw Hill
2. Curtis F. Gerald and Patrick O Wheatley, Applied Numerical Analysis, Pearson Education Ltd.
3. Introductory Methods of Numerical Analysis by S.S. Sastry, PHI learning Pvt Ltd.
4. Numerical methods for Engineers (6th edition), Steven C. Chapra and Raymond P. Caynale.
5. Numerical Methods in Engineering & Science (9th edition), by B.S.Grewal
6. Statistical Methods by S.P. Gupta, Sultan Chand and Sons
7. Probability and Statistics by Schaum's series (3rd edition)

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	Advanced Strength of Materials
Course Code	MCDM5001
Prerequisite	-
Corequisite	-
Antirequisite	-

Course Objectives:

1. To introduce the students to the behavior of structural and mechanical systems subjected to various types of loading.
2. To evaluate the resulting stresses, strains and deflections as well as failure criteria of these systems.

Course Outcomes

CO1	Develop a physical understanding of how mechanical and structural systems respond to a wide variety of loading (K3)
CO2	Analyze and compute the stresses and deflection in symmetrical and asymmetrical bending for various sections and evaluate failure criteria of a variety of mechanical and structural systems (K4)
CO3	Analyze and compute the stresses in curved flexural members, closed and open geometrical shapes (K4)
CO4	Develop an understanding of torsion of non-circular shafts of different cross-sections (K3)
CO5	Calculate the stresses due to rotation in elements of circular geometry with different thicknesses and at different speeds (K3)

Text Book (s) and Reference Book (s)

1. Boreshi and Sidebottom (1952), Advanced Mechanics of Materials, John Wiley International Edition.
2. Kamal kumar and R C Ghai (1990), Advanced Mechanics of Materials, Khanna publishers. ISBN- 978-8-174-09281-6.
3. Den Hartong (1952), Advanced strength of Materials, Mc Graw – Hill Book Co. New York.
4. Timoshenko and Goodier, Theory of Elasticity, Tata McGraw – Hill publishing company Limited. ISBN- 978-0-070-70122-9.
5. Robert D Cooki, Warren C. Young (1952), Advanced Mechanics of Material, Mac Millian publishing Co. ISBN- 978-0-133-96961-0.
6. L S Srinath (1990), Advanced Mechanics of Solids, Tata McGraw – Hill publishing Company Limited, ISBN- 978-0-070-13988-6.

Unit-1 Introduction 7 hours
Elasticity: Stress-strain relations and general equations of elasticity in Cartesian polar and spherical co-ordinates, differential equations of equilibrium – Compatibility – boundary conditions – representation of 3- dimensional stress of a tensor – Generalized Hook's law St.Venant's principle –plane strain – plane stress – Airy's stress function.
Unit-2 8 hours
Shear centre and Unsymmetrical bending: Location of shear centre for various sections – shear flow. Stresses and deflection in beams subjected to unsymmetrical loading, kern of a section.
Unit-3 9 hours
Curved flexural members : Circumferential and radial stresses – deflections curved beam with restrained ends – closed ring subjected to concentrated load and uniform load – chain links and crane hooks.
Unit-4 9 hours
Torsion of non-circular shafts: Torsion of rectangular cross sections – St Venant's theory – Elastic membrane analogy – Prandtl's stress function – Torsional stresses in hollow thin–walled tubes.
Unit-5 7 hours
Stresses due to Rotation: Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness – allowable speeds.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	Advanced Materials and Processing
Course Code	MCDM5002
Prerequisite	-
Corequisite	-
Antirequisite	-

Course Objectives:

1. To impart the knowledge on mechanical behavior of materials.
2. To acquire knowledge in various class of materials and their applications.
3. To import knowledge on various surface modification techniques.

Course Outcomes

CO1	Analyse the mechanical behaviour of metallic systems and its importance (K4)
CO2	Develop an understanding of engineering alloys and their applications (K3)
CO3	Evaluate the various methods of surface modification of materials (K5)

CO4	apply the knowledge to classify the properties and applications of metallic and non-metallic materials, and learn the selection of them (K3)
CO5	Categorize the modern materials and alloys, and analyse their behaviour and applications (K4)

Text Book (s)

1. Callister W.D, (2006) Material Science and Engineering- An introduction, Wiley –Eastern. ISBN- 978-0-471736967.
2. Raghavan, V, (2003) Physical Metallurgy, Prentice Hall of India. ISBN- 978-8-120-33012-2.

Reference Book (s)

1. Thomas H. Courtney, (2000), Mechanical Behavior of Materials, McGraw Hill. ISBN-978-0-073-22824-2.
2. Flinn R. A. and Trojan P. K., (1999), Engineering Materials and their Applications, Jaico. ISBN-978-0-395-18916-0.
3. Kenneth Budinski (1988), Surface Engineering for wear resistance, Prentice Hall. ISBN- 978-0-138-77937-5.
4. Avner S.H. (2006), Introduction to physical metallurgy, Tata McGraw Hill, ISBN-978-0-074-63006-8.

Unit-1 Review of Mechanical Behaviour of Materials 12 hours
Plastic deformation in poly phase alloys - Strengthening mechanisms - Griffith's theory of failure modes –Brittle and ductile fractures - Damping properties of materials - fracture toughness - Initiation and propagation of fatigue cracks - Creep mechanisms - Hydrogen embitterment of metals, Selection of materials for various applications.
Unit-2 Engineering Alloys 6 hours
Cast iron , steels , alloy steels and stainless steels – an overview of phases and microstructure, types, specifications applications, heat treatment, effect of alloying elements, Aluminum, Magnesium and Ti wrought and cast alloys used in engineering applications –Types, specifications, applications, heat treatment
Unit-3 Surface Modifications of Materials 6 hours
Mechanical surface treatment and coating - Case hardening and hard facing - thermal spraying – vapour deposition-ion implantation - Diffusion coating - Electroplating and Electrolysis - Conversion coating - Ceramic and organic coatings – Diamond coating
Unit-4 Nonmetallic Materials 6 hours
Composite materials, ceramics, plastics - Introduction, an overview of processing, their characteristic features, types and applications.
Unit-5 Modern Materials and Alloys 9 hours
Super alloys- Refractory metals - Shape memory alloys- Dual phase steels, Micro alloyed, High strength low alloy steel, Transformation induced plasticity (TRIP) steel, Maraging steel –SMART materials, Metallic glass – Quasi crystal and Nano crystalline materials., metal foams.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	Advanced Manufacturing Technology
Course Code	MCDM5003
Prerequisite	-
Corequisite	-
Antirequisite	-

Course Objectives:

The course is aimed at understanding of the following

1. To provide a through coverage of traditional and non-traditional machining processes.
2. To develop and understanding of various fundamental mechanics of machining processes.
3. To provide awareness of high speed machining, micro-machining and nano-fabrication techniques.
4. To introduce the semi conductor, IC chips and micro actuator fabrication techniques.

Course Outcomes

CO1	Develop and understanding of metal cutting &analyze the properties of tools, workpieces and cutting fluids (K3)
CO2	Analyze and categorize the special machining processes (K4)
CO3	Investigate the high speed machining processes and their applications (K4)
CO4	Correlate the non-traditional machin processes, their mechanism of metal remo and their applications (K4)
CO5	Evaluate various micro-machining processes and their applications in diverse fields (K6)

Text Book (s) and Reference Book (s)

1. Boothroyd G., and Knight W.A. (1989), Fundamentals of Metal Machining and Machine Tools, Marcel Dekker. ISBN- 978-1-574-44659-3.
2. Serope Kalpakjian and Steven R.Schmid (2001), Manufacturing Engineering and Technology, Pearson Education. ISBN- 978-8-177-58170-6.
3. Battacharya, "Theory of Metal Cutting", NCB Agency, 1984.
4. Benedict G. (1987), Non Traditional Manufacturing Processes, Marcel Dekker, ISBN-978-0-824-77352-6.
5. Mishra.P.K. (1997), Non-conventional Machining, Narosa publishing house, ISBN- 978-8-173-19192-3.
6. Bert T. Erdel (2003), High Speed Machining, Society of Manufacturing Engineers. ISBN- 978-0-872-63649-1.
7. Madou, M.J. (1997), Fundamentals of Micro fabrication, CRC press. ISBN- 978-0-849-30826-0.
8. Rai-Choudhury P. (1997), Handbook of Microlithography, Micromachining, and Micro fabrication, Vol.1 and Vol.2, Editor: IEEE Materials and Devices Series 12, London, ISBN- 978-0-819-42378-8.

Unit-1 Theory of Metal Cutting 8 hours
Mechanism of metal cutting – Orthogonal and Oblique cutting, derivation of equations for forces and shear angles etc., various shear angle theories. Tool materials – Tool life and tool wear – Temperature in metal cutting – Cutting fluids and surface roughness.
Unit-2 Special Machining 8 hours
Deep hole drilling – Gun drills – Gun boring – Trepanning – Honing – Lapping – Super finishing – AFM – MAF – Burnishing – Broaching – Hard machining – Hot machining.
Unit-3 High Speed Machining 8 hours
The high performance machining of components – Application of HSM – Tools for HSM - Design of tools for HSM – High speed and high performance grinding – Ultra precision machining.
Unit-4 Non-traditional Machining 8 hours
USM, WJM, AWJM, EDM, ECM, LBM, EBM, Plasma machining and Hybrid machining processes – Mechanism of metal removal, characteristic features and applications
Unit-5 Micro Machining 8 hours
Importance of micro machining, various micro machining processes, application of micro machining in semi-conductor IC technology, micro actuator and micro sensors – CVD, PVD and Ion Implantation.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	Product Design and Life Cycle Management
Course Code	MCDM5004
Prerequisite	-
Corequisite	-
Antirequisite	-

Course Objectives:

To make the student to be familiar with

1. The new product management process.
2. Product lifecycle management stages.
3. The DFx concepts from the conception to recovery or disposal.

4. Applying analytic methods for all stages of product planning, development, launch, and control.

Course Outcomes

CO1	Illustrate the product development processes and their different stages(K3)
CO2	Analyze the first stage of the product development cycle using various models(K4)
CO3	Appraise and design in detail the product and its prototyping(K4)
CO4	Analyze the producibility and reliability of a product(K4)
CO5	Evaluate the issues in supply chain management, ergonomics, safety and failure mode analysis(K5)

Text Book (s)

1. John W. Priest and Jose M. Sanchez (2001), Product development and design for manufacturing- A collaborative approach to produciability and reliability, Marcel Dekker Publications, ISBN- 978-0-824-79935-9.

Reference Book (s)

1. Stephen C. Armstrong (2001), Engineering and product development management – the holistic approach, Cambridge university press, ISBN- 978-0-521-83253-3.
2. Thomas A. Sabomone, (1995), What every engineer should know about concurrent engineering, Marcel Dekker Publications, ISBN- 978-0-824-79578-8.
3. Karl T. Ulrich, Ateven D. Eppinger (2003), Product Design and Development, Tata McGraw-Hill, ISBN- 978-0-070-58513-3.

Unit-1 Introduction 10 hours
Product development – Trends affecting product development – Best practices for product development – Product development process and organizations – Collaborative product development – concurrent engineering – risk management - Stages of Product development.
Unit-2 Product Development Life cycle – I 8 hours
Early design – Requirement Definition and Conceptual design - Trade-off Analysis – Optimization using cost and utility metrics – Trade-off analysis models and parameters- design to cost – Design to Life cycle cost – Design for warranties.
Unit-2 Product Development Life cycle – II 8 hours
Detailed design – Analysis and modeling – Best practices for detailed design – Design analyses – Prototypes in detailed design – Test and Evaluation – Design review, prototyping – simulation and testing – Manufacturing – Strategies – planning and methodologies
Unit-4 Producibility and Reliability 7 hours
Producibility – strategies in design for manufacturing – requirements for optimizing design and manufacturing decisions – Simplification – commonality and preferred methods – Modularity and scalability – part reduction – functional analysis and value engineering – Reliability – Strategies and practices – Testability – Design for test and inspection.
Unit-5 Product Development Life cycle – III 7 hours
Supply chain – Logistics, packaging, supply chain and the environment – ISO 14000/210 – Design for people – Ergonomics, Repairability, maintainability, safety and product liability – Task analysis and failure mode analysis.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	Advanced Computer Aided Design
Course Code	MCDM5005
Prerequisite	-
Corequisite	-
Antirequisite	-

Course Objectives:

1. To introduce the CAD concepts both theoretically and application wise.
2. To provide students the necessary foundation to advance understanding of both design and manufacturing
3. To enable the students to model geometry of objects using curves and surfaces, so that the models can be used further for downstream applications.

Course Outcomes

CO1	Analyze the hardware and software requirement of CAD with the latest developments
CO2	Develop an analytical ability to represent transformations and projections of rigid bodies using CAD
CO3	Interpolate or fit curves through given points, and design curves to achieve the required shape using CAD method in two and three dimensions
CO4	Design surfaces to model shapes of objects in the nature mathematically.
CO5	Develop programs to employ the mathematical techniques for geometric modeling and transformations

Text Book (s)

1. Newman & Sprawl (1978), Principles of interactive Computer Graphics, Mcgraw hill college, ISBN- 978-0-074-63293-2

2. Michel E. Mortenson (2006), Geometric modeling, Industrial press, ISBN-978-0-201-84840-3

3. Van Dam, Hughes Jhon, James Foley (2002), Computer graphics, principles and practices Pearson, ISBN- 978-0-201-84840-3

Reference Book (s)

1. Foley & van dam (1982), Fundamental of Interactive computer graphics, Addison Wesley longman publishing co, ISBN- 978-1-852-33818-3

2. David Rogers (2001), Procedural elements of Computer graphics, TMH, ISBN- 978-0-070-53529-9

3. Rogers and Adams (2002), Mathematical elements of Computer Graphics, TMH,ISBN-978-0-070-53529-9

4. Hearn & baker (2011), Computer Graphics, Pearson,ISBN- 978-8-177-58765-4

Unit-1 Introduction 8 hours
Hardware and software requirement of CAD; Video display devices- Refresh cathode ray tubes, Raster-scan displays, Random-scan displays, Color CRT Monitors; Input devices- keyboard, joy-stick, mouse, scanner; Hard copy devices- dot matrix, inkjet, laser printers.
Unit-2
Geometric Transformation - Basic transformation, translation, rotation, scaling, reflection, homogeneous coordinates; Composite Transformation- Introduction, translation, rotation, scaling.
Unit-3
3-D transformation- translation, rotation, scaling, reflection; 3-D composite transformation- generalized rotation, generalized reflection; 3 D projections- orthographic projection, axonometric projection, oblique projection, perspective projection.
Unit-4
Introduction to curves, parametric continuity condition, geometric continuity condition, spline representation, spline specification, geometric and algebra forms, cubic spline interpolation method, natural cubic spline, Bezier curves, B-spline curves, curve animation.
Unit-5
Quadric surfaces- sphere, ellipsoid, torus; Super quadrics- superellipse, superellipsoid; Bezier surfaces; B-spline surfaces.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Finite Element Methods**			
Course Code	**MCDM5006**			
Prerequisite				
Corequisite				
Antirequisite				
	L	**T**	**P**	**C**
	2	**1**	**0**	**3**

Course Objectives:

4. To enable the students understand the mathematical and physical principles underlying the Finite Element Method (FEM) as applied to solid mechanics and thermal analysis
5. To understand the characteristics of various finite elements.
6. To develop finite element equations for simple and complex domains.

Course Outcomes

CO1	Apply the knowledge of mathematics and engineering to solve problems in structural and thermal engineering by approximate and numerical methods.
CO2	Design a new component or improve the existing components using FEA.
CO3	Solve the problems in solid mechanics and heat transfer using FEM.
CO4	Analyze the vibration problems and transient state problems dynamically.
CO5	Use commercial FEA packages like ANSYS and modern CAD/CAE tools for solving real life problems.

Text Book (s)

1. Seshu, P.(2010), *Textbook of Finite Element Analysis*, Prentice-Hall of India Pvt. Ltd. ISBN- 978-8-120-32315-5.
2. Tirupathi R. Chandrapatla, Ashok D. Belegundu, *Introduction to Finite Element in Engineering Prentice-Hall of India Private limited*, New Delhi – 110 001. ISBN-978-0-130-61591-6.

Reference Book (s)

1. Bathe, K.J, (1996), *Finite Element Procedures*, Prentice-Hall of India Pvt. Ltd., third Edition. ISBN- 978-0-979-00490-2.
2. Zienkiewicz O.C. (1989), *The Finite Element Method*, McGraw-Hill. ISBN- 978-0-070-84072-0.
3. Reddy J.N. (1993), *The Finite Element Method*, McGraw-Hill, Third Edition, 1993. ISBN- 978-0-072-46685-0.
4. C.S. Krishnamoorthy, (1994), *Finite Element Analysis Theory and Programming*, Tata McGraw-Hill, ISBN- 978-0-074-62210-0.
5. Robert cook, R.D. et. Al., (2004), *Concepts and Applications of Finite Element Analysis*, John Wiley & sons, ISBN- 978-0-471-35605-9.

Unit-1 Fundamental Concepts 6 hours
Matrix Algebra, Gaussian Elimination, Definition of Tensors and indicial notations, Plane strain-Plane stress hypothesis. Physical problems, Mathematical models, and Finite Element Solutions, Finite Element Analysis as Integral part of Computer Aided Design, Stresses and Equilibrium; Boundary Conditions; Strain-Displacement Relations; Stress –strain relations, Temperature Effects.
Unit-2 Finite Element Formulation from Governing Differential Equations and on Stationary of a Functional 6 hours
Weighted Residual Method for Single Continuous Trail Function and General Weighted Residual Statement, Weak Variational Form of Weighted Residual statement, Comparison of Differential Equation, Weighted Residual and Weak forms, Piece-wise Continuous Trail function solution of weak form, One dimensional bar finite element and one dimensional heat transfer element, Functional of a differential equation forms, Rayleigh-Ritz Method, Piece-wise Continuous trail functions, Finite Element Method and Meaning of Finite Element Equations.
Unit-3 One-Dimensional Finite Element Analysis 9 hours
General form for Total Potential for 1-D, Generic form of finite element equations, Linear Bar Finite element, Quadratic Bar Element- Shape function and Element matrices, Beam element- selection of nodal d.o.f., Determination of Shape functions and Element matrices, 1-D Heat transfer problem.
Unit-4 Unit IV: Two-Dimensional Finite Element Analysis 9 hours
Approximation of Geometry and Field variable: Three-noded triangular element, Four-noded rectangular element, six-noded triangular elements, natural coordinates and coordinate transformation, 2-D elements for structural mechanics, Numerical integration, Incorporation of Boundary Conditions and Solution.
Unit-5 Dynamic Analysis using Finite Elements 9 hours

Introduction to vibration problems, Consistent and Lumped mass matrices, Form of finite element equations for vibration problems, Eigenvalue Problems, Transient vibration analysis and unsteady heat transfer problem.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Computer Integrated Manufacturing**			
Course Code	**MCDM5007**			
Prerequisite				
Corequisite				
Antirequisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives:

1. To acquaint the students with the CIM concepts and role of CAD in manufacturing
2. To enable the students learn the analysis tools for manufacturing
3. To help students know the control structures for manufacturing systems in the CAM area

Course Outcomes

CO1	Analyse the components of CIM system and their functions in relation to manufacturing. (K4)
CO2	Apply the concept of group technology to group the parts manufactured by organisation to take advantages of it. (K3)
CO3	Evaluate the production planning and material requirement planning for whole organisation. (K5)
CO4	Prepare process plan using various tools and techniques of computer aided process planning. (K6)
CO5	Apply the knowledge of CIM in automating the material handling systems.(K3)

Text Book (s) and Reference Book (s)

1. U.Rembold (1993), *Computer Integrated Manufacturing and Engineering*, Addison Wesley Publishers, 1993 edition. ISBN- 978-0-201-56541-6.

2. Rajan Suri(1998), *Quick Responsive Manufacturing*, Productivity Press, ISBN- 978-1-563-27201-1.

Unit-1 Fundamentals of Automation in Manufacturing Systems and Functions and Components of CIM System 9 hours
Manufacturing Systems: Concept Objectives, Types and Trends; Concepts of Mechanization, Automation and Integration. Functions and Components of CIM System: Concept of CAD/CAM and CIMS; Software Technology for CIM System:Business Database System: File processing, Data Processing and Database Design, File Organization and Relational Analysis; Decision Support System, Personal/Distributed Computing and Local Area Network.
Unit-2 Group Technology and Cellular Manufacturing 7 hours
Concept of Group Technology and its Application, classification and Coding Techniques; Clustering Techniques and Cellular Manufacturing.
Unit-3 Planning and Scheduling Functions in CIM System 9 hours
Aggregate Production Planning (APP), Master Production Schedule (MPS), Material Requirement Planning (MRP), Capacity Requirement Planning (CRP), Manufacturing Resource Planning (MRPII), Just-In-time Production Systems and Concept of Enterprise Resource Planning (ERP).
Unit-4 Computer-Aided Process Planning 7 hours
Approaches – Variant and Generative, Feature Classification and Recognition; Process Classifications and Selections, Machines and Tool Selection, Setting Process Parameters, Process Sheet Documentation.
Unit-5 Automated Material Handling Systems and Advanced Manufacturing Systems 8 hours
Industrial Robots, Conveyors, AGVs, Automatic Storage and Retrieval Systems; Lean Manufacturing Systems, Agile Manufacturing

Systems, Reconfigurable Manufacturing Systems, Holonic Manufacturing Systems and Agent-Based Manufacturing Systems.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Advanced Vibration Engineering**
Course Code	**MCDM5008**
Prerequisite	-
Corequisite	-
Antirequisite	-

Course Objectives:

1. To introduce classical Vibration theories, relating to discrete and continuous systems with applications.
2. To teach various numerical techniques including FE for analysis of complex structures and modal testing for natural frequencies and mode shapes.
3. To introduce special cases of non-linearity and random phenomena in vibrating systems including their stability.

Course Outcomes

CO1	Demonstrate an understanding of the concepts of Mechanical vibrations starting from single, two, Multi degree freedom systems. (K3)
CO2	Analyse free and forced vibrations in single, two, Multi degree freedom systems. (K4)
CO3	Examine advanced concepts like Continuous, Non-linear and Random Vibrations. (K3)
CO4	Apply FEM to formulate the mechanical vibrations (K3)
CO5	Analyse systems utilizing different modes of vibration (K4)

Text Book (s) and Reference Book (s)

1. W. T. Thomson (1999), *Theory of Vibration*, Kluwer Academic Pub; 4th edition. ISBN- 978-0-748-74380-3.

2. TSE, Morse and Hinkel (1991), *Mechanical Vibrations*, Chapman and Hall, ISBN-978-0-205-05940-9.

3. Den Hartong (1986), Mechanical Vibrations, McGraw Hill. ISBN- 978-0-486-64785-2.

4. V.P.Singh (1988), *Mechanical Vibrations*, Dhanput Rai & Co. ISBN-978-0-000-27184-7.

5. S.Timoshenko, D.H.Young (1991), Vibrations Problems in Engineering, D.Van Hostrand Company, Inc, Afiliated East-West Press Pvt. Ltd. ISBN-978-0-471-63228-3.

Unit-1 Single and Two degrees of freedom system 8 hours
Introduction to free, forced, transient and damped vibrations, terminology and applications. Discrete systems – single degree and two degree systems, response to free forced motions (steady state and transient) applications to vibration isolation and absorption.
Unit-2 Several degrees of freedom 6 hours
Multi degree systems – techniques of analysis such as Dunkerley, Rayleigh, Holzer, Matrix iteration, Transfer matrices and modal analysis.
Unit-3 Continuous and Torsional Vibration 9 hours
Continuous systems Free and forced vibrations of bars for longitudinal, shear, torsional and transverse vibrations, Beams with attached masses rotor dynamics and FEM applications.
Unit-4 Non-linear Vibrations 9 hours
Non-linear vibrations, jump phenomenon and stability. Applications including self excited and parameter excited vibrations.
Unit-5 Random Vibrations 8 hours
Random vibrations – stationary and non-stationary, ergodic systems, response of single degree systems to random excitation.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Computer Aided Process Planning**			
Course Code	**MCDM5009**			
Prerequisite				
Corequisite				
Antirequisite				
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course Objectives:

To provide the student with an understanding of the importance of process planning role in manufacturing and the application of Computer Aided Process Planning tool in the present manufacturing scenario

Course Outcomes

CO1	Distinguish the concepts of process planning applicable to manufacturing in consideration with production planning, concurrent engineering and group technology (K4)
CO2	Execute part design representations for process planning using different coding systems(K3)
CO3	Apply process engineering skills for different process panning methods (K3)
CO4	Implement logical design concepts for computer aided process planning systems (K3)
CO5	Interpret totally integrated process planning systems and generate reports (K3)

Text Book (s) and Reference Book (s)

1. Gideon Halevi and Roland D.Weill (1995), *Principle of Process Planning-A logical Approach*, Chapman & Hall, ISBN- 978-0-412-54360-9.
2. Tien-Chien-Chang, Richard A.Wysk (1985), *An Introduction to automated process planning systems*, Prentice Hall. ISBN- 978-0-134-78140-2.
3. Chang.T.C. (1985), *An Expert Process Planning System*, Prentice Hall.
4. Nanua Singh (1996), *Systems Approach to Computer Integrated Design and Manufacturing*, John Wiley & Sons, ISBN-978-0-471-58517-6.
5. P. N. Rao, N. K. Tewari, T. K. Kundra (2000), *Computer Aided Manufacturing*, Tata McGraw Hill Publishing Co. ISBN- 978-0-074-60205-8.

Unit-1 Introduction 6 hours
The Place of Process Planning in the Manufacturing cycle- Process planning and production planning –Process planning and Concurrent Engineering, CAPP, Group Technology.
Unit-2 Part Design Representation 7 hours
Design Drafting – Dimensioning – Conventional Tolerencing – Geometric Tolerencing- CAD – input/output devices – Topology – Geometric transformation – Perspective transformation – Data Structure– Geometric modeling for process planning –GT coding – The OPITZ system – The MICLASS System.
Unit-3 Process Engineering and Process Planning 6 hours
Experience based planning – Decision table and Decision trees – Process capability analysis – Process planning – Variant process planning – Generative approach – Forward and backward planning, Input format, A1
Unit-4 Computer Aided Process Planning Systems 6 hours
Logical Design of process planning – Implementation considerations- Manufacturing system components, Production Volume, No. of production families- CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP.
Unit-5 An Integrated Process Planning Systems 5 hours
Totally integrated process planning systems – An Overview – Modulus structure – Data structure – Operation – Report Generation, Expert process planning.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	Advanced Computer Aided Design and Manufacturing Lab				
Course Code	MCDM6001				
Prerequisite					
Corequisite					
Antirequisite					
		L	T	P	C
		0	0	2	1

Course Objectives:

To provide students the necessary foundation for advanced understanding of both design and manufacturing problems in a systematic manner.

Course Outcomes

CO1	Gain practical experience in handling 2D drafting and 3D modeling software systems
CO2	Examine and handle design problems in a systematic manner
CO3	Develop the use of the concepts of G and M codes and manual part programming.
CO4	Apply the knowledge of CNC machines for machining simulation
CO5	Apply the knowledge of specialized softwares for modelling as well as analysis of machining operations
CO6	Student will able to understand the new trends of automobile bio fuels, it's engine modification and research on new generation of biofuels

Reference Book (s)

1. CAD/CAM Lab Manual (Prepared by Staff)

2. Bathe K.J, (2007), Finite Element Procedures, Prentice-Hall of India Pvt. Ltd., third edition ISBN: 978-0-979-00490-2

3. Zienkiewicz O.C.(1979), The Finite Element Method, McGraw-Hill, ISBN- 978-0-750-66431-8

4. ANSYS Help manual

5. Hyper mesh Help manual

6. CATIA Help manual

7. Yorem Koren (1983), Computer Integrated Manufacturing Systems, McGraw Hill, ISBN- 978-0-891-16874-4

8. Ranky, Paul G.(1986), Computer Integrated Manufacturing, Prentice Hall International, ISBN-978-0-131-65655-0

9. R.W. Yeomamas, A. Choudry and P.J.W. Ten Hagen (1985.), Design rules for a CIM system, North Holland Amsterdam, ISBN- 978-0-444-87812-0

10. Pro-E Help manual

11. Master CAM Help manual

List of experiments

1. 3-D part modeling, assembling and drafting by using Pro-E/CATIA/Solid Works/ Unigraphics etc. of following components :
   - i. Piston Head
   - iii. Crank shaft
   - ii. Connecting rod
   - iv. Controller arm
2. By using Ansys/Nisa/Hyper-mesh/Solid-Works/CATIA software, perform the analysis of the above components by using 1D, 2D and 3D elements for:
   - i. Static analysis
   - iii. Harmonic analysis
   - ii. Modal analysis
   - iv. Buckling analysis
3. Write the part program for the following and simulate it by using Master-CAM/ Solid CAM/ Cimatron/ EXSL Win/ CNC Pro build/ CMAS simulator:
   - i. Turning operation
     - a. Centre turning
     - b. Taper turning
     - c. Threading
   - ii. Milling operation
     - a. Edge cutting
     - c. Boring Pocketing

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
70	-	30	100

Name of The Course	**Dissertation-1**			
Course Code	**MCDM9998**			
Prerequisite				
Corequisite				
Antirequisite				
	L	**T**	**P**	**C**
	-	**-**	**-**	**5**

Course Objectives:

1. To make literature survey for various recently emerging technologies.
2. To select any topic of interest and to review the related literature in detail.
3. To compare and analysis the various topologies for the selected topic of interest.
4. To give more emphasize to the one of best topology and to obtain a network model for it.
5. To analysis the simulation results of the particular topology obtained from various simulation tools.
6. To get realize the hardware implementation of the above topology for which we obtained simulations.

Course Outcomes

CO1	Analyze the relevance of knowledge obtained from literature for the research work taken up
CO2	Evaluate the recently advanced techniques.
CO3	Extract detailed information about the topic of interest
CO4	Plan an innovative work in the area of interest
CO5	Apply the different simulation tools applicable to the area of research

Text Book (s)

Depending upon the area of interest student may choose any text book of relevant field.

Reference Book (s)

As per the chosen area of research.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	Nil	50	100

Name of The Course	**Dissertation-II**			
Course Code	**MCDM9999**			
Prerequisite				
Corequisite				
Antirequisite				
	L	**T**	**P**	**C**
	-	**-**	**-**	**15**

Course Objectives:

1. To make literature survey for various recently emerging technologies.
2. To select any topic of interest and to review the related literature in detail.
3. To compare and analysis the various topologies for the selected topic of interest.
4. To give more emphasize to the one of best topology and to obtain a network model for it.
5. To analysis the simulation results of the particular topology obtained from various simulation tools.
6. To get realize the hardware implementation of the above topology for which we obtained simulations.

Course Outcomes

CO1	Design a project relevant to the field of study
CO2	Demonstrate expertise in the selected area of research
CO3	Conduct an innovative work in the selected area of research
CO4	Apply the different simulation tools applicable to the area of research
CO5	Demonstrate a thorough understanding of the chosen topic of dissertation

Text Book (s)

Depending upon the area of interest student may choose any text book of relevant field.

Reference Book (s)

As per the chosen area of research.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	Nil	50	100

Name of The Course	**Tool Engineering**			
Course Code	**MCDM5011**			
Prerequisite				
Corequisite				
Antirequisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives:

The main objective of the course is to give students the basic concepts of tool engineering. The student is guided to use these concepts in the design of jigs, fixtures and various types of dies used in production industry through assigned projects and factory visits.

Course Outcomes

CO1	Compare the materials used to make different types of tooling components including tool steels, low carbon steels, cast iron, aluminum, plastics and cutting tool materials.
CO2	Integrate CAD techniques into the design of production tooling to help understand the advantages and disadvantages for productive tool design.
CO3	Develop an understanding of the factors involved in the design of special production inspection gages, cutting tools for production machines and the selection of tool geometries for metal cutting methods
CO4	Develop an understanding of the principles involved in the design of jigs and fixtures concentrating on locating methods, clamping and use of drill bushings. Standard jig and fixture designs will be reviewed.
CO5	Develop an understanding of the principles used in the design and plastic injection mold tooling and Composite tooling. To include cavity layout, sprue and runner design, gate design, venting, cooling, and selection of tooling components

Text Book (s)

1.James A Szumera, The Metal stamping Process, Industrial Press Incorp. Donaldson of al 'Tool Engineering', Tata Mc-Graw Hill.

Reference Book (s)

1. Pollack, H.W. Tool Design, Reston Publishing Company, Inc.
2. Kempster, M.H.A. Principles of Jig and Tool Design, English University Press Ltd.
3. John G. Nee, Fundamentals of Tool Design Author - Society of Manufacturing Engineers
4. Handbook of Fixture Design (SME)", Society of Manufacturing Engineers,McGraw-Hill.
5. D.F. Eary and E.A. Red, "Techniques of Pressworking Sheet Metal", PrenticeHall.
6. "Tool Engineers Handbook, ASTME", McGraw-Hill.
7. R.G.W.Pye, Injection Mould Design, Long man scientific and technical ltd.

Unit-1 10 hours
Introduction and basic tool design principles .Broad Classification of Tools-Cutting tools, Dies, Holding and measuring tools, Tool manufacturing and Introduction to Computer aided die design applications.
Unit-2 8 hours
Design of Cutting Tools: Single Point and multi-pint cutting tools; Single Point Cutting Tools: Classification, Nomenclature, geometry, design of single point tools for lathes, shapers, planers etc. Chip breakers and their design; Multipoint Cutting Tools: Classification and specification, nomenclature, Design of drills, milling cutters, broaches, taps etc.; Design of Form Tools: Flat and circular form tools, their design and application.
Unit-3 6 hours
Design of Dies for Bulk metal Deformation-Wire Drawing, Extrusion, Forging and Rolling; Design of Dies for Sheet metal: Blanking and Piercing,

Bending and Deep-drawing; Design of Dies used for Casting and Moulding.
Unit-4 5 hours
Design of Jigs, Fixtures and Gauges: Classification of Jigs and Fixtures, Fundamental Principles of design of Jigs and Fixtures, Location and Clamping in Jigs and fixtures, Simple design for drilling Jigs, Milling fixtures etc. Indexing Jigs and fixtures.
Unit-5 8 hours
Design of Moulds: Mould making, General Mould Constructions, Intermediate Mould Design-Splits, Side core and side cavities, Moulding Internal undercuts, Runner less moulds, Aspects of practical mould design.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Advanced Computer Aided Manufacturing**				
Course Code	**MCDM5012**				
Prerequisite					
Corequisite					
Antirequisite					
	L	**T**	**P**	**C**	
	3	**0**	**0**	**3**	

Course Objectives:

Introduction to the use of computers in several extended areas of product design and manufacturing, including product data management in a sustaining engineering environment

Course Outcomes

CO1	Demonstrate a basic understanding of machining fundamentals such as tooling systems, and work-holding systems for CNC milling and turning equipment
CO2	Analyze the constructional features of CNC machines
CO3	Apply the numerical controlled (NC) programming strategies for manufacturing
CO4	Generate NC code using G-codes to machine parts to specifications.
CO5	Interpret the design of robot technology and their application in manufacturing

Text Book (s)

1. Mikell P. Groover (1997), CAD-CAM, Prentice hall of India,.ISBN- 978-8-177-58416-5

2. B.S. Pabla (2003), CNC machines, New age international publishers, ISBN- 978-8-122-40669-6

3. Koren Y (1986), Computer Control of Manufacturing systems, McGraw Hill,ISBN-978-0-070-60743-9.

4. Petruzella F D (1989), Programmable Logic Controllers, McGraw Hill,ISBN- 978-0-071-06738-6.

Reference Book (s)

1. John W. (1980) Programmable Controllers - Principles and Applications - Merrill Publ.Co, New York, ISBN- 978-0-130-41672-8

2. Alan Overby (2010), CNC machining Handbook, McGraw Hill Professional, ISBN-978-0-071-62302-5

3. Barry Leatham – Jones (1986), Introductions to Computer Numerical Control, Pitman, London - John willey & Sons,ISBN- 978-0-132-79497-8

4. Reinbold U, Blume C and Dilmann R (1985), Computer Integrated Mfg. Technology & Systems, Marcel Dekker, ISBN- 978-0-824-77403-5.

Unit-1 Introduction Introduction to CAM and automation 9 hours
Current trends in Manufacturing Engineering, the product cycle and CAD/CAM, automation and control, basic elements of an automated system, power to accomplish the automatic process,

program of instructions, control system, advanced automation functions, safety monitoring, maintenance and repair diagnostics, error detection and recovery, levels of automation.
Unit-2 Fundamentals of CNC machines 12 hours
Basic Components of CNC system - Part programming, Machine control unit, Machine tool - Historical developments and their role in control of machine tools, Classification of NC / CNC systems - Based on type of Control (PTP\C\L), method of programming, Direct numerical control (DNC), adaptive control machining system
Unit-3 Constructional Features of CNC Machines 8 hours
Design considerations of CNC machines for improving machining accuracy-Structural members-Slide ways - Sides linear bearings - Ball screws - Spindle drives and feed drives - work holding devices and tool holding devices - Automatic Tool changers. Feedback devices - Principles of Operation-Machining Centres - Tooling for CNC machines.
Unit-4 Programming for CNC Machines 9 hours
Numerical control codes - Standards - Manual Programming - Canned cycles and subroutines - Computer Assisted Programming, CAD / CAM approach to NC part programming - APT language, machining from 3D models
Unit-5 Robot Technology 6 hours
Introduction, robot physical configurations, Basic robot motion, technical features, programming the robot and languages, end effectors, robotic sensors, robot applications.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Performance Modelling and Analysis of Manufacturing Systems**
Course Code	**MCDM5013**
Prerequisite	
Corequisite	
Antirequisite	

	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives:

1. To learn the fundamental aspects of automated manufacturing system, simulation and computer control system.
2. To develop the ability to formulate and analyze problems which are encountered in manufacturing systems.

Course Outcomes

CO1	Value the importance of modelling and simulation in manufacturing
CO2	Apply the understanding of the behaviour of dynamic and stochastic queuing systems and discrete-event simulation concepts in modelling.
CO3	Model automated manufacturing system “intelligently” and come up with high fidelity models.
CO4	Develop the queuing models and Petri net models for solving manufacturing problems.
CO5	Produce codes for modelling and simulation based on the understanding of the course

Text Book (s) and Reference Book (s)

1. N. Viswanadham and Y. Narahari (1994), Performance Modeling of Automated Manufacturing Systems, Prentice hall of India, New Delhi, ISBN-
2. K.S. Trivedi (1982), Probability and Statics with Reliability, Queuing and Computer Science Applications, Prentice Hall, New Jersey, ISBN- 978-1-600-21518-6
3. S.C. Gupta and V.K. Kapoor (1988), Fundamentals Mathematical Statics”, 3 rd Edition, Sulton chand and sons, New Delhi, ISBN- 978-8-170-14791-6

Unit-1 Manufacturing systems and simulation 12 hours
Modeling automated manufacturing systems- role of performance modeling-performance measures- performance modeling tools- Simulation models- Analytical models. Automated

manufacturing systems- introduction product cycle-manufacturing automation- Economics of scale and scope. Manufacturing system- input-output model- plant configurations. Performance measures- manufacturing lead time-work in process-machine utilization throughput- capacity- flexibility- performability-quality. Computer control system- control system architecture- factory communications-local area networks- factory networks-open system interconnection model- net work to network interconnections- manufacturing automation protocol- data base management system.
Unit-2 Manufacturing process 9 hours
Examples of Stochastic processes- Poison process, Discrete time Markov Chain models-Definitions and notation- Sojourn Times in States-Examples of DTMCs in manufacturing-Chapman-Kolmogorov equation- Steady state analysis. Continuous Time Markov chain models-Definition and notation-Sojourn times in states-Examples of CTMCs in manufacturing- Equation for CTMC evolution-Markov model of a transfer line- Birth and Death Process in manufacturing
Unit-3 Queuing models 6 hours
Notation for queues- Examples of queues in manufacturing-Performance measures-the M/M/m queue- queues with general distributions-queues with breakdowns- Analysis of a flexible machining center.
Unit-4 Queuing networks 7 hours
Examples of queuing network models in manufacturing- Little's Law in queuing networks- Open queuing network- closed queuing networks- Product form queuing networks.
Unit-5 PETRI NETS 6 hours
Classical Petri nets- Stochastic Petri net-Generalized stochastic Petri nets modeling of KANBAN system- Manufacturing models.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Design for Manufacturing**			
Course Code	**MCDM5014**			
Prerequisite				
Corequisite				
Antirequisite				
	L	**T**	**P**	**C**
	2	**1**	**0**	**3**

Course Objectives:

The course is aimed at developing students to acquire skills to analyze product design and be able to design products that are easier to manufacture, assemble, service and more friendlier to environment, etc.

Course Outcomes

CO1	Apply the general design principles for manufacturability (K4)
CO2	Produce customer-oriented, manufacturing and life-cycle sensitive approach to product design and development, with product design principles and structured design methodologies (K4)
CO3	Utilize the methods and approaches for developing, implementing, and nurturing an effective DFM process within the firm (K3)
CO4	Develop robust designs using design of experiments (K4)
CO5	Modify existing designs using design principles for specific considerations (K4)

Text Book (s)

1. Harry Peck (1983), Design for Manufacture, Pittman Publication, ISBN- 978-0-273-00008-2.

Reference Book (s)

1. Karl T. Ulrich, Ateven D. Eppinger (2003), Product Design and Development, Tata McGraw-Hill, ISBN- 978-0-070-58513-3.
2. James G. Bralla (1986), Hand Book of Product Design for Manufacturing, McGraw Hill co, ISBN- 978-0-071-50178-1.
3. Jonathan C. Borg, Philip J. Farrugia, Kenneth P. Camilleri (1987), Knowledge based design for manufacture, Kogan Page Ltd, ISBN- 978-1-402-07732-6.
4. Boothroyd, G., (1994), Product Design for Manufacture and Assembly, Marcel Decker, ISBN- 978-1-420-08927-1.

5. Bralla, J.G., (1999), Design for Manufacturability Handbook, McGraw-Hill.ISBN- 978-0-070-07139-1.

Unit-1 Introduction 8 hours
General design principles for manufacturability – strength and mechanical factors, evaluation method, Process capability - Feature tolerances-Geometric tolerances-Assembly limits- Datum features- Tolerance stacks
Unit-2 Factors influencing form Design 10 hours
Working principle, Material, Manufacture, Design – Possible solutions – Materials choice – Influence of materials on form design – form design of welded members, forgings and castings.
Unit-3 Component Design – Machining Consider 9 hours
Design features to facilitate machining – drills - milling cutters – keyways – Doweling procedures, counter sunk screws – Reduction of machined area – simplification by separation – simplification by amalgamation – Design for Machinability – Design for accessibility – Design for assembly.
Unit-4 Robust Design and Taguchi Method 8 hours
Robust design - Design of experiments – Robust design process- Orthogonal arrays: Two level orthogonal arrays, Three level orthogonal arrays, Combined inner and outer arrays.
Unit-5 Redesign for Manufacture and case studies 9 hours
Design for economy, Identification of uneconomical design – Modifying the design – Computer Applications for DFMA – Case Studies.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Quality Management**
Course Code	**MCDM5015**
Prerequisite	
Corequisite	
Antirequisite	

	L	**T**	**P**	**C**
	2	**1**	**0**	**3**

Course Objectives:

To provide student with the basic understanding of the approaches and techniques to assess and improve process and or product quality and reliability.

Course Outcomes

CO1	Demonstrate a good knowledge of quality management principles
CO2	Correlate the Total Quality Management principles and models
CO3	Apply the problem solving tools and techniques to solve real life problems
CO4	Apply the Quality Management techniques
CO5	Propose quality standards for manufacturing

Text Book (s)

1. DaleH. Beterfield et al (2001), Total Quality Management, Pearson Education Asia, ISBN- 978-8-131-73227-4.

Reference Book (s)

1. John Bank J.E. (1993), *Total Quality Management*, Prentice Hall, India, ISBN- 978-0-132-84902-9.
2. Samuel K.Ho (2002), *TQM- AN Integrated approach*, Kogan Page India Pvt. Ltd, ISBN-978-0-749-41561-7.
3. Jill A.Swift, Joel E. Ross and Vincent K. Omachonn (1998) *Principles of Total Quality*, St.Lucie Press, US, 1998. ISBN-978-1-574-44094-2.

Unit-1 Introduction to Quality Management 6 hours
Business scene in India and world over – quality imperatives – Efficiency & Effectiveness – Definition of Quality – Vision, Mission statement – formulation – Quality policy – Customer orientation – Quality culture and mind set – Qulaity philosophies of Deming, Crosby, Miller Comparison.
Unit-2 Total Quality Management 6 hours
TQM principles – Customer satisfaction model – Customer retention model – QFD – Customer satisfaction measurement – Evolution of TQM –

System & Human components – TQM models – Deming wheel principle – Top management commitment.
Unit-3 Problem Solving Tools 12 hours
Old & QC Tools – Seven new management tools – Problem solving techniques – Case studies – Problems – Continuous improvement tools – Benchmarking, Quality circle.
Unit-4 QM Techniques 10 hours
FMEA, BPR, JIT, KANBAN – Reliability studies – Failure rate analysis – Reliability models.
Unit-5 Quality System Implementation 5 hours
ISO Certification – ISO 9000 – ISO 14000 – Principles & Methodologies, Six Sigma, Taguchi, 5S concepts, Legal aspects, TQM road map, Strategies – case studies.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Reliability Engineering**			
Course Code	**MCDM5016**			
Prerequisite				
Corequisite				
Antirequisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives:

1. To equip the students to analyze reliability data.
2. To introduce the concepts of reliability and useful life availability of products.
3. To impart knowledge on maintainability and availability analyses of products.

Course Outcomes

CO1	Value the concept of reliability of products
CO2	Analyse the reliability through various data analysis techniques
CO3	Predict the reliability using different approaches and models
CO4	Test the reliability and monitor its growth for a given system
CO5	Assess the risk using analysis techniques

Text Book (s) and Reference Book (s)

1. Mohammad Modarres, Mark Kaminskiy, Vasiliy Krivtsov (1999), Reliability Engineering and Risk Analysis: A Practical Guide, CRC Press, ISBN-978-1-420-04705-9
2. John Davidson (1988), The Reliability of Mechanical system, Institution of Mechanical Engineers, London, ISBN-978-0-852-98881-7.
3. Charles E. Ebeling(2004), Introduction to Reliability in Design, McGraw Hill, London, 978-0-070-42138-7.

Unit-1 Reliability Concept 6 hours
Reliability function - failure rate - Mean Time Between Failures (MTBF) - Mean Time to Failure (MTTF) - a priori and a posteriori concept - mortality curve - useful life availability - maintainability - system effectiveness.
Unit-2 Reliability Data Analysis 6 hours
Time-to-failure distributions - Exponential, normal, Gamma, Weibull, ranking of data - probability plotting techniques - Hazard plotting.
Unit-3 Reliability Prediction Models 12 hours
Series and parallel systems - RBD approach - Standby systems - m/n configuration - Application of Baye's theorem - cut and tie set method - Markov analysis - FTA - Limitations.
Unit-4 Reliability Management 10 hours
Reliability testing - Reliability growth monitoring - Non parametric methods - Reliability and life cycle costs - Reliability allocation - Replacement model.
Unit-5 Risk Assessment 5 hours
Definition and measurement of risk - risk analysis techniques - risk reduction resources - industrial safety and risk assessment.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Metrology and Non Destructive Testing**			
Course Code	**MCDM5017**			
Prerequisite				
Corequisite				
Antirequisite				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives:

1. Impart the knowledge of quality assurance and inspection techniques.
2. Familiarize with the various inspection and measurement techniques like contact and non-contact measurement by adapting Computer Aided Inspection.
3. Impart the knowledge of working principles and calibration of various Systems.

Course Outcomes

CO1	Apply the knowledge in CMM and Image Processing
CO2	Apply the concept of Laser Metrology and Computer Integrated Quality Assurance
CO3	Apply the knowledge of magnetic particle testing
CO4	Apply the knowledge of ultrasonic and Acoustic emission techniques.
CO5	Apply the knowledge to solve real life problems

Text Book (s)

1. JAIN.R.K. (1997), Engineering Metrology, Khanna Publishers, ISBN- 978-8-174-09153-6.

Reference Book (s)

1. Barry Hull and Vernon John (1988), Non Destructive Testing, Mac Millan, ISBN-978-0-333-35788-0.
2. *American Society for Metals, Metals Hand Book*, Vol. II, 1976.
3. Progress in Acoustic Emission, Proceedings of 10th International Acoustic Emission Symposium, Japanese society for NDI, 1990.

Unit-1 Measuring Machines 6 hours
Tool Makers's microscope – Co-ordinate measuring machines – Universal measuring machine- Laser viewers for production profile checks – Image shearing microscope – Use of computers – Machine vision technology- Microprocessors in metrology.
Unit-2 Statistical Quality Control 6 hours
Data presentation – Statistical measures and tools – Process capability – Confidence and tolerance limits – Control charts for variables and for fraction defectives – Theory of probability – Sampling –ABC standard – Reliability and life testing.
Unit-3 Liquid Penetrant and Magnetic Particle Tests 12 hours
Characteristics of liquid penetrants – different washable systems – Developers – applications- Methods of production of magnetic fields- Principles of operation of magnetic particle test- Applications- Advantages and Limitations.
Unit-4 Radiography 10 hours
Sources of ray X-ray production-properties of d and x rays – film characteristics – exposure charts – contrasts – operational characteristics of x ray equipment – applications.
Unit-5 Ultrasonic and Acoustic Emission Techniques 5 hours
Production of ultrasonic waves – different types of waves - general characteristics of waves – pulse echo method – A, B, C scans – Principles of acoustic emission techniques – Advantages and limitations - Instrumentation – Applications.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	Design and Analysis of Experiments			
Course Code	MCDM5018			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

The objective of this course is to introduce experimental design techniques and familiarize with all of the best design techniques and study the objectives, similarities, differences, advantages, and disadvantages of each.

Course Outcomes

CO1	Develop Full and Fraction Factorial Experiment Design.
CO2	Test a design using ANOVA and Hypothesis testing.
CO3	Apply Loss function approach to Quality Control.
CO4	Setup and analyse Robust Design.
CO5	Apply orthogonal arrays for design and conduct of experiments
CO6	Apply Response surface method to study the output of the experiment.

Text Book (s) and Reference Book (s)

1. Philip J. Rose, "Taguchi Techniques for Quality Engineering", Prentice Hall, 1989.
2. Montgomery, D.C., "Design and Analysis of Experiments", John Wiley and Sons, 1997.
3. Nicolo Belavendram, "Quality by Design: Taguchi Techniques for Industrial Experimentation", Prentice Hall, 1995.

Unit-1 Introduction 8 hours
Basic principle of DOEs, Guide lines for Designing Experiments, Terminology, ANOVA, Computation of sum of squares and Basics of quality by design
Unit-2 Single Factor Experiments 6 hours
Randomized complete block design, Latin square design, Graeco-Latin square design, Incomplete block design and Tests on means.
Unit-3 Factorial Design 9 hours
Two-Factor factorial design, General factorial design, 2k Factorial design, 3k Factorial design, confounding, Fractional replication and Factors with mixed levels.
Unit-4 Robust Design Process 6 hours
Comparison of classical and Taguchi's approach, variability due to noise factors, principle or robustization, classification of quality characteristics and parameters, objective functions in robust design, S/N ratios.
Unit-5 Orthogonal Experiments 8 hours
Selection and application of orthogonal arrays for design, Conduct of experiments, collection of data and analysis of simple experiments, Modifying orthogonal arrays, Inner and outer OA experiments, Optimization using S/N ratios, attribute data analysis, a critique of robust design.
Unit-6
Introduction; Response surface design: Designs for fitting first order model, Central Composite Design, Box-Behnken Designs; Analysis of data from RSM designs: First order design, second order design

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	Research Methodology			
Course Code	MCDM5019			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	0	0	3

Course Objectives:

The course is aimed at understanding of the following

1. To gain familiarity with the presents status of the research.
2. To measure the frequency of occurrences of various parameters/indicators.
3. To reveal the trend and tendencies in the research, i.e., to assess the development or extension potential of the research.

4. To test the significance and validity and reliability of the results.

Course Outcomes

CO1	Analyze a research problem using the literature survey with systematic methods (K4)
CO2	Apply data collection and sampling techniques for a given research problem (K3)
CO3	Analyse the collected and sampled data applying statistical methods (K4)
CO4	Apply non-traditional algorithms for optimization of a proposed solution (K3)
CO5	Create valid research reports (K6)
CO6	Student will able to apply the linear regression models in practice

Text Book (s) and Reference Book (s)

1. Beri, (2005), Statistics for Management 3E. Tata McGraw-Hill Education, ISBN- 978-0-070-08323-3.
2. Donald R. Cooper, Pamela S. Schindler (2011.), Business Research Methods, 8/e, Tata McGraw-Hill Co. Ltd., ISBN- 978-0-071-28922-1.
3. U.K. Srivastava, G.V. Shenoy and S.C. Sharma(2005), Quantitative Techniques for managerial decisions, New Age International, Mumbai, ISBN- 978-8-122-40189-9.
4. William G. Zikmund (2006), Business Research Methods, Thomson,ISBN- 978-1-285-40118-8
5. D.M.Pestonjee,(2005) (Ed.) Second Handbook of Psychological and Social Instruments, Concept Publishing, New Delhi,ISBN- 978-8-170-22652-9.

Unit-1 Introduction 8 hours
Definition of Research, Qualities of Researcher, Components of Research Problem, Various Steps in Scientific Research, Types of Research; Hypotheses Research Purposes - Research Design - Survey Research - Case Study Research.
Unit-2 Data Collection 8 hours
Sources of Data: Primary Data, Secondary Data; Procedure Questionnaire - Sampling Merits and Demerits - Experiments - Kinds - Procedure; Control Observation - Merits - Demerits - Kinds - Procedure - Sampling Errors - Type-I Error - Type-II Error.
Unit-3 Statistical Analysis 10 hours
Introduction to Statistics - Probability Theories - Conditional Probability, Poisson Distribution, Binomial Distribution and Properties of Normal Distributions, Point and Interval Estimates of Means and Proportions; Hypothesis Tests, One Sample Test - Two Sample Tests / Chi-Square Test, Association of Attributes - t-Test - Standard deviation - Co-efficient of variations - Index Number, Time series and forecasting: Components of time series, Analysis of time series, Measurement of trend, Measurement of seasonal variations.
Unit-4 Genetic Algorithms 8 hours
Working principle-Genetic operators-Simulated Annealing - Neural network based optimization-Optimization of fuzzy systems-fuzzy set theory-computational procedure
Unit-5 Research Reports 6 hours
Structure and Components of Research Report, Types of Report, Good Research Report, Pictures and Graphs, Introduction to SPSS.
UNIT 6
Regression analysis Purposes, Types of Regression, Simple Regression, multiple Regression, Building Regression Model, regression analysis in excel , Interpretation of regression result.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Optimization Methods**			
Course Code	**MCDM5020**			
Prerequisite				
Corequisite				
Antirequisite				
	L	**T**	**P**	**C**
	2	**1**	**0**	**3**

Course Objectives:

1. To understand the role of optimization in Engineering design and its importance
2. To introduce the different optimization algorithm in linear programming and non-linear programming

Course Outcomes

CO1	Formulate the design problem in mathematical form which can be solved by suitable optimization algorithm (K3)
CO2	Apply optimization techniques, linear as well as non-linear, for solving constrained as well as unconstrained design problems.(K4)
CO3	Employ the advanced non-linear optimization techniques to solve complex optimization problems (K3)
CO4	Compare the efficiency of different algorithms and employ the most efficient for a given set of problems (K2)
CO5	Apply the techniques to produce optimum designs in engineering (K4)
CO6	Conduct experiments based on desig of experiments

Text Book (s)

1. Rao, S.S. (1978), *Optimization - Theory and Applications*, Wiley Eastern, New Delhi, ISBN- 978-0-852-26756-1.

Reference Book (s)

1. Wilde, D.J. (1964), *Optimization seeking Methods*, Prentice – Hall, Englewood Cliffs, New Jersey.
2. Johnson, Ray C., *Optimum Design of Mechanical Elements*, 2nd Ed., John Wiley & Sons, Ic., New York, 1980. ISBN-978-0-471-03894-8.
3. Kalyanmoy Deb (1996), *Optimization for Engineering Design-Algorithms and Examples*, Prentice-Hall of India, 1996. ISBN- 978-8120309432

Unit-1 Linear Optimization 7 hours
Optimization problem statement – classification - single variable - multivariable unconstrained – equality constrained and inequality constrained. Simplex methods – dual simplex method – bounded variable technique for linear programming problems. Integer Programming & Dynamic Programming; Gomary's cutting plane method - branch and bound method – Bellman's principle of optimality-inventory, capital budgeting, reliability problems and simplex problem.
Unit-2 Unconstrained Non-linear Optimization 6 hours
Unimodal function – Region elimination methods: Unrestricted, Dichotomous, Fibonacci, Golden Section, Bi-section - Direct search methods: Random, Univariate, Pattern search methods – Descent methods: Steepest descent, Conjugate gradient and Variable metric.
Unit-3 Constrained Non-linear Optimization 9 hours
Characteristics of a constrained optimization problem - Direct methods: Cutting plane method, methods of feasible directions – Indirect methods: Interior and exterior penalty function methods – Geometric programming – Solution from differential calculus point of view – Solution from arithmetic-geometric inequality point of view.
Unit-4 Advanced Non-linear Optimization 8 hours
Genetic Algorithms -Working principle-Genetic operators-Numerical problem-Simulated Annealing - Numerical problem - Neural network based optimization-Optimization of fuzzy systems-fuzzy set theory computational procedure.
Unit-5 Optimization Design of Machine Elements 12 hours
Unit-6
Optimization of process parameters by Taguchi method, response surface methodology, AI and neural netwoks

GALGOTIAS UNIVERSITY

(Established under Galgotias University Uttar Pradesh Act No. 14 of 2011)

School of Mechanical Engineering

Program: M.Tech (Auto)

Scheme: 2019 – 2020

Vision

To be known as a premier department in mechanical engineering by synergizing teaching, learning and research to produce competent Mechanical Engineers with an exposure to interdisciplinary engineering knowledge.

Mission

MD1: Create an effective foundation in the field of production, design, thermal, industrial and automation engineering by imparting quality education.

MD2: Conduct interdisciplinary research leading to the delivery of innovative technologies through Problem and Research Based Learning.

MD3: Provide relevant industrial experience that instills the problem solving approach; integrate the product design to manufacturing life cycle management.

MD4: Prepare students for careers in academia and various industrial organization related to mechanical and allied engineering.

Program Educational Objectives

PEO1: Graduates of Mechanical Engineering shall be engineering professionals and innovators in core engineering, service industries or pursue higher studies.

PEO2: Graduates of Mechanical Engineering shall be competent in latest technologies by exploiting automation and smart manufacturing tools to address various industry 4.0 problems.

PEO3: Graduates of Mechanical Engineering shall leverage their imbibed skill through continuous working on technologies like drone and additive manufacturing knowledge to transform the society.

Program Outcomes

13. Engineering Knowledge : Apply the knowledge of Mathematics, Science, and Engineering fundamentals, and an engineering specialization to solution of complex engineering problems.
14. Problem analysis : Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
15. Design/development of solutions : Design of solutions for complex engineering problems and design of system components or processes that meet the specified needs with appropriate considerations of public health and safety, and cultural, societal, and environmental considerations.
16. Conduct investigations of complex problems : Use research based methods including design of experiments, analysis and interpretation of data and synthesis of information leading to logical conclusions.
17. Modern tool usage : Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling complex engineering activities with an understanding of limitations.

18. The engineer and society : Apply reasoning within the contextual knowledge to access societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
19. Environment and sustainability : Understand the impact of the professional engineering solutions in the societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable developments.
20. Ethics : Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
21. Individual and team work : Function effectively as an individual independently and as a member or leader in diverse teams, and in multidisciplinary settings.
22. Communication : Communicate effectively on complex engineering activities with the engineering community and with society at large such give and receive clear instructions.
23. Project management and finance : Demonstrate knowledge and understanding of engineering management principles and apply those to one's own work as a member and leader of a team to manage projects in multidisciplinary environments.
24. Life-long Learning : Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Curriculum

Semester 1									
Sl. No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MATH5001	Advanced Numerical and Statistical Methods	3	1	0	4	20	50	100
2	MAUE5001	Automotive Engine & Emission	3	0	0	3	20	50	100
3	MAUE5002	Transmission System Theory & Design	3	0	0	3	20	50	100
4	MAUE5003	Engine Design	3	0	0	3	20	50	100
5	MAUE5004	Chassis and Body Engineering	3	0	0	3	20	50	100
6	MAUE5005	Automotive Vehicle Dynamics	3	0	0	3	20	50	100
		Total	18	1	0	19			
Semester II									
Sl No	Course Codee	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	CENG5001	Professional and Communication Skills	0	0	4	2	70	-	30
2	MCDM5006	Finite Element Methods	2	1	0	3	20	50	100
3	MAUE5007	Combustion Engineering	3	0	0	3	20	50	100
4	MAUE5008	Computational Fluid Dynamics	3	0	0	3	20	50	100
5	MAUE5009	Transmission System Design Lab	0	0	2	1	70	-	30
6	MAUE5010	Engine Testing and Pollution Measurement Lab	0	0	2	1	70	-	30
7		Elective 1	3	0	0	3	20	50	100
8		Elective 2	3	0	0	3	20	50	100
9		Data Analysis	0	0	2	1	70	-	30
		Total	14	1	10	20			
Semester III									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MAUE6001	Vehicle Testing Lab	0	0	2	1	70	-	30
2	MAUE6002	Automotive Engine and Chassis Components Lab	0	0	2	1	70	-	30
3	MAUE9998	Dissertation-1	-	-	-	5	50	-	50
4		Elective 3	3	0	0	3	20	50	100
5		Elective 4	3	0	0	3	20	50	100
6		Elective 5	3	0	0	3	20	50	100
		Total	9	0	6	16			
Semester IV									
Sl No	Course Code	Name of the Course					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MAUE9999	Dissertation-2	-	-	-	15	50	-	50

List of Electives

Sl No	Course Code	Name of the Electives					Assessment Pattern		
			L	T	P	C	IA	MTE	ETE
1	MAUE5011	Simulation of Automobile Systems	3	0	0	3	20	50	100
2	MAUE5012	Automobile Air Conditioning	3	0	0	3	20	50	100
3	MAUE5013	Transport Management	3	0	0	3	20	50	100
4	MAUE5014	Vehicle Maintenance and Fleet Management	3	0	0	3	20	50	100
5	MAUE5015	Tractor and Farm Equipments	3	0	0	3	20	50	100
6	MCDM5018	Design and Analysis of Experiments	3	0	0	3	20	50	100
7	MAUE5017	Alternative Fuels and Power Systems	3	0	0	3	20	50	100
8	MAUE5018	Special Purpose Vehicles	3	0	0	3	20	50	100
9	MAUE5019	Safety,Health and Environment	3	0	0	3	20	50	100
10	MAUE5020	Hydraulics and Pneumatics	3	0	0	3	20	50	100
11	MAUE5021	Vehicle Aerodynamics	3	0	0	3	20	50	100
12	MAUE5022	Automotive Safety	3	0	0	3	20	50	100
13	MAUE5023	Advanced Heat and mass Transfer	3	0	0	3	20	50	100

Name of The Course	Professional and Communication Skills			
Course Code	CENG 5001			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	0	0	4	2

Course Objective:

1. To develop the professional and communicational skills of learners in a technical environment.
2. To enable students acquire functional and technical writing skills.
3. To enable students acquire presentation skills to technical and non-technical audience.

Course Outcomes:

CO1	Improve their reading fluency skills through extensive reading
CO2	Use and assess information from academic sources, distinguishing between main ideas and details
CO3	Compare and use a range official support through formal and informal writings
CO4	The students will be able to exhibit language proficiency in comprehending, describing, and investigating.

Text Books

Rajendra Pal and J.S.Korlahalli. Essentials of Business Communication. Sultan Chand & Sons. New Delhi.

Reference Books

5. Kaul. Asha. Effective Business Communication.PHI Learning Pvt. Ltd. New Delhi.2011.
6. Murphy, Essential English Grammar, CUP.
7. J S Nesfield, English Grammar: Composition and Usage
8. Muralikrishna and S. Mishra, Communication Skills for Engineers.

UNIT 1: Aspects of Communication; Sounds of syllables; Past tense and plural endings; Organizational techniques in Technical Writing; Paragraph Writing, Note taking, Techniques of presentation
UNIT 2: Tense, Voice, conditionals, Techno-words; Basic concepts of pronunciation; word stress; Business letters, email, Techniques for Power Point Presentations; Dos and don'ts of Group Discussion
UNIT 3: An introduction to Modal and Phrasal verbs; Expansion; Word formation; Technical Resume; Company Profile Presentation; Interview Skills

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
70	-	30	100

Name of The Course	Advanced Numerical and Statistical Methods			
Course Code	MATH5001			
Prerequisite				
Corequisite				
Antirequisite				
	L	T	P	C
	3	1	0	4

Course Objectives:

With ever growing demand of computational techniques, scope of numerical methods is penetrating aggressively into major and important fields including Science, Engineering &Technology, Medical, Space Science, Economics, Business and Environment. The objective is to achieve knowledge and understanding of numerical methods and to apply appropriate methods to model and solve problems where ordinary analytical methods fail.

Statistical methods are used in manufacturing, development of food product, computer software, energy sources,

pharmaceuticals and many other areas. The objective of statistics and probability is to analyze data to make scientific judgments in the face of uncertainty and variation for the improvement of the desired quality.

Course Outcomes

CO1	Apply various numerical methods to solve system of linear and non-linear equations.
CO2	Apply standard interpolation methods to interpolate required/ missing value.
CO3	Apply appropriate methods of numerical differentiation /integration to solve related problems.
CO4	Solve ordinary differential equations and partial differential equations using appropriate numerical methods.
CO5	Identify the type of distributions and apply a suitable test to draw the conclusion.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Exam (MTE)	End Term Exam (ETE)	Total Marks
20	30	50	100

Course Content:

Unit I: System of Linear Equations 8
System of Linear Equations: Direct Methods- Gauss elimination – Pivoting, Partial and Total Pivoting, Triangular factorization method using Crout LU decomposition, Cholesky method, Iterative Method- Gauss- Seidel and Jacobi method, ill conditioned matrix System of Non-linear equation- Newton Raphson and Modified Newton Raphson Method. Iterative methods
Unit II: Interpolation and Approximation
Interpolation and Approximation: Lagrange, Spline and Hermite interpolation, Approximations, Error of approximation, Norms for discrete and continuous data, Least square approximation.
Unit III: Numerical Integration: 6 Hours
Numerical Integration: Newton Cotes closed Quadrature, Gauss Legendre Quadrature, Multiple Integration An introduction to Modal and Phrasal verbs; Expansion; Word formation; Technical Resume; Company Profile Presentation; Interview Skills
Unit IV: Numerical Solution of Differential Equations 9 Hours
Numerical Solution of Differential Equations: Finite Difference Schemes, Numerical solution of Ordinary differential equation using Modified Euler's method, Runge-Kutta method of 2nd, 3rd and 4th orders, Predictor- Corrector method, Solution of Laplace's and Poisson's equations by Liebman's method, Solution of one dimensional time dependent heat flow.
Unit V: Probability and statistics 9 Hours
Probability and statistics: Review of concept of probability, Random Variables, Continuous and discrete distribution function, moments and moments generating functions, Binomial, Poisson, Negative Binomial, Geometric and Hyper-geometric Distributions, Uniform, Normal, Exponential, Gamma and Beta distributions. Point and Interval estimation, Testing of Hypothesis (t-test and chi square test), Analysis of variance and Introduction of Design of experiments.

Suggested Reading

1. Numerical Methods for Scientific and Engineering Computation (6th edition) by Jain, Iyengar & Jain, New Age International publishers.
2. Probability & Statistics for Engineers & Scientists (9th edition) by R.E.Walpole, R,H,Myers & K.Ye.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	Automotive engines and emission			
Course Code	MAUE5001			
Prerequisite	IC Engines			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

Course Objectives:

This subject is taught to impart knowledge of working principle of engines, fuel combustion, emission and emission control.

Course Outcomes

CO1	Summarize the principle and need of carburetion, lubrication and cooling in vehicles (K3)
CO2	Analyze different combustion mechanisms and flame propagation (K4)
CO3	Investigate the emission characteristics of vehicle engine and control mechanisms (K4)
CO4	Identify the need for alternative fuels, their sources and properties(K3)
CO5	Solve the heat transfer problems using FEM (K3)

Text Book (s) and Reference Book (s)

1. Richard Stone, *Introduction to Internal Combustion Engines*, McMillan, London. ISBN-978-0-333-37593-8.

2. Hein Heister, *Vehicle and Engine Technology*, Butterworth-Heinemann Ltd ISBN- 978-0-340-69186-1.

3. Hein Heister, *Advance Vehicle Technology*, Society of Automotive Engineers Inc. ISBN- 978-0-768-01071-8.

4. E. F. Obert, (1973), *I. C. Engine & Air Pollution*, Harper & Row Publishers, New York. ISBN 0-352-04560-0.

5. C. Fayette Taylor & Edward S. Taylor, *I. C. Engines*, International text book com, ISBN-978-0-700-22096-0.

6. V. L. Maleev, *I.C. Engine*, McGraw Hill Book, Co. ISBN- 978-0-070-85471-0.

7. Ferguson, *Internal Combustion Engines: Applied Thermosciences*, John Wiley & Sons, ISBN- 978-0-471-35617-2.

8. Charles A. Fisher, *S.I. Engine – Fuel Injection Development*, Chapman & Hall.

9. Herbert E. Ellinger, *Automotive Engines*. ISBN-978-0-130-55426-0.

10. John B. Heyhood, *Internal Combustion Engines Fundamentals*, McGraw Hill. ISBN-978-0-070-28637-5.

Unit-1 Introduction 6 hours
Fuel Supply, Ignition, Cooling2 and Lubrication Systems – Theory of carburetion and carburettors, A/F ratio, petrol injection, diesel fuel injection pumps, conventional and electronic ignition systems for SI engines, cooling systems, design aspects, lubrication systems.
Unit-2 Combustion of fuel and combustion chambers 6 hours
Air Motion Combustion and Combustion Chambers: Swirl and turbulence – swirl generation, combustion in SI & CI engines, flame travel and detonation, Ignition delay, Knock in CI engines, combustion chamber design.
Unit-3 Automobile emission and control 9 hours
Sources of Emission, Exhaust gas constituents & analysis, Ingredients responsible for air pollution, Smoke, odour, Smog formation. Exhaust Emission Control: Basic method of emission control, catalytic converter, After burners, reactor manifold, air injection, crank case emission control, evaporative loss control, Exhaust gas recirculation, Fuel additives. Pollution Norms : European pollution norms, Indian pollution norms as per Central Motor Vehicle Rules (C.M.V.R.).
Unit-4 Exhaust Emission Measurement and alternative fuel 10 hours
Instrumentation for Exhaust Emission Measurement: Measurement procedure, Sampling Methods, Orsat Apparatus, Infrared Gas analyzer, Flame Ionization Detector (FID), Smoke meters. Alternative Fuels: CNG, LPG, Bio-Diesel,

Hydrogen, fuel cells, Eco-friendly vehicles, Electric & Solar operated vehicle.
Unit-5 Dynamic Analysis using Finite Elements 9 hours
Introduction to vibration problems, Consistent and Lumped mass matrices, Form of finite element equations for vibration problems, Eigen value Problems, Transient vibration analysis and unsteady heat transfer problem

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	Transmission system theory and design			
Course Code	MAUE5002			
Prerequisite	Machine Design, Dynamics of Machinery			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

Course Objectives:

The objective of teaching this subject to the students is to acquaint them with the detailed knowledge of transmission systems, braking system and steering system of an automobile.

Course Outcomes

CO1	Identify the various elements of transmission system of an automobile
CO2	Summarize the different joints and axles
CO3	Apply different breaking system in different vehicles
CO4	Explain various component of steering system

Text Book (s) and Reference Book (s)

1. Reimpell J., *The Automotive Chassis – Engineering Principle*, ISBN- 978-0-750-65054-0.
2. P. Lukin, G. Gasparyarts, V. Rodionov, *Automotive Chassis-Design & Calculation*, MIR Publishing, Moskow ISBN- 978-5-030-00081-7.
3. P. M. Heldt, *Automotive Chassis*, Chilton Co. NK
4. W. Steed, *Mechanics for Road Vehicles*, Illiffe Books Ltd., London

Unit-1 Introduction Transmission system 6 hours
Transmission systems : Clutch, types of clutch, clutch design, Gear box, types of gear boxes, gear box design, overdrive gears, Fluid flywheel & torque converter, Epicyclic gear box, semi-automatic & automatic transmission.
Unit-2 Propeller Shaft and Final Drive 6 hours
Propeller shaft, design of propeller shaft, slips joint, universal joint, Final drive, differential, Dead & live axle, axle design, Constant velocity joints.
Unit-3 Braking System 9 hours
Braking system – types of brakes, brake-actuating mechanisms, factors affecting brake performance, power & power assisted brakes, Brake system design, recent developments in transmission & braking system
Unit-4 Steering System 9 hours
Steering systems : Front axle types, constructional details, front wheel geometry, Condition for True rolling, skidding, steering linkages for conventional & independent suspensions, turning radius, wheel wobble and shimmy, power and power assisted steering

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	Engine Design			
Course Code	MAUE5003			
Prerequisite	-			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

Course Objectives:

This subject acquaints students with the engine design and various parameters dealing with the engine design.

Course Outcomes

CO1	Examine basic design parameter of engine cylinder head
CO2	Calculate forces and moments in the design of cylinder head, cylinder block, piston, piston ring, fly wheel and valve mechanism.
CO3	Point out the correct firing order based on forces and design principal of cooling system, inlet and outlet valve system.
CO4	Calculate various dimensions of fuel injection systems.
CO5	Calculate various dimensions of carburetor

Text Book (s) and Reference Book (s)

1. E. F. Obert, (1973), *I. C. Engine & Air Pollution*, Harper & Row Publishers, New York. ISBN 0-352-04560-0.

2. Giles J. G., *Engine Design*, Lliffe Book Ltd.

3. W. H. Crouse ,*Engine Design*, Tata McGraw Publication, Delhi ISBN-978-0-070-14671-6.

4. V. L. Maleev, *I.C. Engine*, McGraw Hill Book, Co. ISBN- 978-0-070-85471-0.

5.Litchy, *I. C. Engine*

6. SAE Handbooks

Unit-1 Engine Cylinder Design 10 hours
Determination of engine power, Engine selection, swept volume, stroke, bore & no. of cylinders, Arrangement of cylinders stroke to bore ratio.
Unit-2 Engine Head Design 10 hours
Design procedure of theoretical analysis, design considerations, material selection & actual design of components - cylinder block deign, cylinder head design, piston & piston pin design, piston ring design, connecting rod design, crankshaft design, flywheel design, design of valve mechanism.
Unit-3 Various Forces and Moments in Engine Design 9 hours
Engine balancing, firing order, longitudinal forces, transverse forces, pitching moments, yawing moments, Engine layout, major critical speed & minor critical speed, design of engine mounting, design of cooling system, design principles of exhaust & inlet systems
Unit-4 Fuel Injection Design 9 hours
Primary design calculation of major dimensions of fuel injection system.
Unit-5
Common rail direct injection engine, dual fuel and multi fuel engine, gasoline direct injection engine stirling engine, wankel engine, variable compression ratio engine

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	Chassis and body engineering			
Course Code	MAUE5004			
Prerequisite	Automobile Engineering			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

Course Objectives:

This subject makes students familiar with the aerodynamics, body details, body design and stress analysis of the automobile.

Course Outcomes

CO1	Identify the various types of aerodynamics drag, forces and moment in vehicle body. (K3)
CO2	Understand the details of vehicle body, roofs, under floor, bonnet, boot and wings (K2)
CO3	Summarise various design parameters of vehicle body (K3)
CO4	Analyze the stresses in the bus body under bending and torsion (K4)
CO5	Demonstrate various case studies on chassis frame related to stress and deflection analysis (K3)

Text Book (s) and Reference Book (s)

1. J. Y. Woung, *Theory of Ground Vehicles*, John Willey & Sons, NY ISBN- 978-0-471-35461-1.

2. J. G. Giles, *Steering, Suspension & Tyres*, Illefe Books Ltd. London ISBN- 978-0-592-00620-8.
3. W. Steed, *Mechanics of Road Vehicles*, Illefe Books Ltd. London
4. P. M. Heldt, *Automotive Chassis*, Chilton Co. NK

Unit-1 Vehicle Aerodynamics 7 hours
Vehicle Aerodynamics : Objects- vehicle drag and types, various types of forces and moments, effects of forces and moments, various body optimization techniques for minimum drag, principle of wind tunnel technology, flow visualization techniques, tests with scale models
Unit-2 Car Body Details 6 hours
Car Body Details : Types of car bodies, visibility, regulations, driver's visibility, methods of improving visibility, safety design, constructional details of roof, under floor, bonnet, boot, wings etc, Classification of coach work.
Unit-3 Design of Vehicle Bodies 9 hours
Design of Vehicle Bodies: Vehicle body materials, Layout of the design, preliminary design, safety, Idealized structure- structural surface, shear panel method, symmetric and asymmetrical vertical loads in car, longitudinal loads, different loading situations- load distribution on vehicle structure.
Unit-4 Stress Calculation and Analysis 9 hours
Calculation of loading cases, stress analysis of bus body structure under bending and torsion, stress analysis in integral bus body, Design of chassis frame, Rules and regulations for body, Recent safety measures, Testing of body
Unit-5 Case study report and review 9 hours
Case study on Heavy commercial vehicle chassis frame, detailed design of chassis frame, stress and deflection analysis of chassis frame.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	Automotive Vehicle Dynamics			
Course Code	MAUE5005			
Prerequisite	-			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

Course Objectives:

The aim of teaching this subject is to make students aware of the suspension system, handling characteristics of an automobile like steering geometry and vibrations.

Course Outcomes

CO1	Understand the basics of suspension system and its types (K2)
CO2	Identify with steering dynamics according to road (K2)
CO3	Use stability analysis for better control (K3)
CO4	Apply ride characteristics for better design (K3)
CO5	Understand vibration in order to ride comfortable (K2)

Text Book (s) and Reference Book (s)

1. J. Y. Woung, *Theory of Ground Vehicles*, John Willey & Sons, NY ISBN- 978-0-471-35461-1.
2. J. G. Giles, *Steering, Suspension & Tyres*, Illefe Books Ltd. London ISBN- 978-0-592-00620-8.
3. W. Steed, *Mechanics of Road Vehicles*, Illefe Books Ltd. London
4. P. M. Heldt, *Automotive Chassis*, Chilton Co. NK

Unit-1 Suspension System 8 hours
Suspension system - requirements, types, air suspension, rubber suspension, Shock absorbers, design of leaf spring, coil spring and torsion bar, types of drives-Hotchkiss and torque tube, wheel alignments, wheel wobble, wheel shimmy, pitching, bouncing and rolling, roll centre and roll axis, anti-roll bar, road holding.
Unit-2 Handling Characteristics 8 hours
Handling Characteristics: Steering geometry, Fundamental condition for true Rolling,

Ackerman's Steering Gear, Davis Steering gear, Steady state Handling - Neutral steer, Under steer and over steer, Steady state response, Yaw velocity, Lateral Acceleration.
Unit-3 Stability 8 hours
Curvature response & Directional stability, jack-knifing in articulated vehicle, loading of automobile chassis due to road irregularities, comfort criteria, load transferred while braking and cornering, equivalent weight of vehicle
Unit-4 Ride Characteristics 8 hours
Ride Characteristics: Human response to vibrations, Single degree & Two degree freedom, Free & Forced vibrations, Vehicle Ride Model, Two degree freedom model for sprung & un-sprung mass, Two degree freedom model for pitch & bounce.
Unit-5 Vibration Analysis ` 8 hours
Vibrations due to road roughness and engine unbalance, Transmissibility of engine mounting, Motion of vehicle on undulating road & Compensated suspension systems. Noise, Vibration and Harshness – Random Processes.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	Finite Element Methods				
Course Code	MCDM5006				
Prerequisite	-				
Corequisite	-				
Antirequisite	-				
		L	T	P	C
		2	1	0	3

Course Objectives:

1. To enable the students understand the mathematical and physical principles underlying the Finite Element Method (FEM) as applied to solid mechanics and thermal analysis
2. To understand the characteristics of various finite elements.
3. To develop finite element equations for simple and complex domains.

Course Outcomes

CO1	Apply the knowledge of mathematics and engineering to solve problems in structural and thermal engineering by approximate and numerical methods.
CO2	Design a new component or improve the existing components using FEA.
CO3	Solve the problems in solid mechanics and heat transfer using FEM.
CO4	Analyze the vibration problems and transient state problems dynamically.
CO5	Use commercial FEA packages like ANSYS and modern CAD/CAE tools for solving real life problems.

Text Book (s)

1. Seshu, P.(2010), *Textbook of Finite Element Analysis*, Prentice-Hall of India Pvt. Ltd. ISBN- 978-8-120-32315-5.
2. Tirupathi R. Chandrapatla, Ashok D. Belegundu, *Introduction to Finite Element in Engineering Prentice-Hall of India Private limited*, New Delhi – 110 001. ISBN-978-0-130-61591-6.

Reference Book (s)

1. Bathe, K.J, (1996), *Finite Element Procedures*, Prentice-Hall of India Pvt. Ltd., third Edition. ISBN- 978-0-979-00490-2.
2. Zienkiewicz O.C. (1989), *The Finite Element Method*, McGraw-Hill. ISBN- 978-0-070-84072-0.
3. Reddy J.N. (1993), *The Finite Element Method*, McGraw-Hill, Third Edition, 1993. ISBN- 978-0-072-46685-0.
4. C.S. Krishnamoorthy, (1994), *Finite Element Analysis Theory and Programming*, Tata McGraw-Hill, ISBN- 978-0-074-62210-0.
5. Robert cook, R.D. et. Al., (2004), *Concepts and Applications of Finite Element Analysis*, John Wiley & sons, ISBN- 978-0-471-35605-9.

Unit-1 Fundamental Concepts 6 hours
Matrix Algebra, Gaussian Elimination, Definition of Tensors and indicial notations, Plane strain-

Plane stress hypothesis. Physical problems, Mathematical models, and Finite Element Solutions, Finite Element Analysis as Integral part of Computer Aided Design, Stresses and Equilibrium; Boundary Conditions; Strain-Displacement Relations; Stress –strain relations, Temperature Effects.
Unit-2 Finite Element Formulation from Governing Differential Equations and on Stationary of a Functional 6 hours
Weighted Residual Method for Single Continuous Trail Function and General Weighted Residual Statement, Weak Variational Form of Weighted Residual statement, Comparison of Differential Equation, Weighted Residual and Weak forms, Piece-wise Continuous Trail function solution of weak form, One dimensional bar finite element and one dimensional heat transfer element, Functional of a differential equation forms, Rayleigh-Ritz Method, Piece-wise Continuous trail functions, Finite Element Method and Meaning of Finite Element Equations.
Unit-3 One-Dimensional Finite Element Analysis 9 hours
General form for Total Potential for 1-D, Generic form of finite element equations, Linear Bar Finite element, Quadratic Bar Element- Shape function and Element matrices, Beam element- selection of nodal d.o.f., Determination of Shape functions and Element matrices, 1-D Heat transfer problem.
Unit-4 Unit IV: Two-Dimensional Finite Element Analysis 9 hours
Approximation of Geometry and Field variable: Three-noded triangular element, Four-noded rectangular element, six-noded triangular elements, natural coordinates and coordinate transformation, 2-D elements for structural mechanics, Numerical integration, Incorporation of Boundary Conditions and Solution.
Unit-5 Dynamic Analysis using Finite Elements 9 hours
Introduction to vibration problems, Consistent and Lumped mass matrices, Form of finite element equations for vibration problems, Eigenvalue Problems, Transient vibration analysis and unsteady heat transfer problem.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Combustion Engineering**			
Course Code	**MAUE5007**			
Prerequisite	**Thermodynamics, IC Engines, Fuels and Combustion**			
Corequisite	**-**			
Antirequisite	**-**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives:

The aim of teaching this subject is to make students understand the details of different types of combustion concerned to the automobiles.

Course Outcomes

CO1	Summarize the basic mechanism of combustion process (K3)
CO2	Demonstrate the Combustion of gaseous and vaporized fuels (K3)
CO3	Compare the flames using boundary conditions (K6)
CO4	Demonstrate the various types of combustion of liquid fuels (K3)
CO5	Summarize the basic principles of combustion of solid particles (K3)

Text Book (s) and Reference Book (s)

1. Gary L. Borman& Kenneth W. Ragland, *Combustion Engineering*, McGraw Hill. ISBN- 978-0-070-06567-3.
2. Kenneth K. Kuo, *Principles of Combustion*, John Wiley & Sons. ISBN- 978-0-471-04689-9.
3. S. P. Sharma &Chander Mohan, *Fuels & Combustion*, Tata McGraw Hill ISBN-978-0-070-96627-7.
4. Samir Sarkar, *Fuels & Combustion*, ISBN-978-1-439-82541-9.

Unit-1 Introduction to Combustion process 6 hours
Scope and history of combustion, Fuels, Thermodynamics of combustion, Chemical kinetics of combustion, rate of reactions, chain

reactions, opposing reactions, consecutive reactions, competitive reactions, Conservation equation for multi component reacting systems.
Unit-2 Combustion of gaseous and vaporized fuels 6 hours
Combustion of gaseous & vaporized fuels, gas – fired furnace combustion, Premixed charge engine combustion, Detonation of gaseous mixture
Unit-3 Diffusion of flames and boundary conditions 9 hours
Premixed laminar flames, Gaseous diffusion flames & combustion of a single liquid fuel droplet, turbulent flames, combustion in two – phase flame systems, Chemically reacting boundary layer flows, Ignition
Unit-4 Combustion of liquid fuels 9 hours
Combustion of liquid fuels, spray formation & droplet behaviour, Oil – fired furnace combustion, gas turbine spray combustion, direct injection engine combustion, detonation of liquid – gaseous mixture, combustion of solid fuels.
Unit-4 Combustion of liquid fuels 9 hours
Stages of solid fuel combustion, solid fuel combustion process, theory for single coal particle combustion, combustion of carbon sphere with CO burning gas phase.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Computational Fluid Dynamics**			
Course Code	**MAUE5008**			
Prerequisite	**Fluid mechanics**			
Corequisite	-			
Antirequisite	-			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives:

1. To understand the computational techniques useful in the analysis of fluid flow and heat transfer
2. To expose and train in using commercial CFD software and in writing codes for specific CFD applications.

Course Outcomes

CO1	Understand the governing equations of fluid flow and heat transfer (K2)
CO2	Apply finite difference methods and perform stability analysis (K3)
CO3	Solve steady and transient heat conduction equations (K3)
CO4	Solve the Navier-stokes equations for incompressible flows (K3)
CO5	Use commercial CFD software and in writing codes for specific CFD applications (K2)

Text Book (s)

1. S.V. Patankar (1994), *Numerical Heat Transfer and Fluid Flow, Hemisphere Series*, CRC Press, New York. ISBN-978-0-891-16522-4.
2. Y. Jaluria and K.E. Torrance (1986*), Computational Heat Transfer,* Hemisphere Publishing Corp.
3. J.D. Anderson, Jr. (1995), *Computational Fluid Dynamics – The Basic with Applications*, McGraw-Hill. ISBN- 978-0-070-01685-9.

Reference Book (s)

1. K.A. Hoffman (1989), *Computational Fluid Dynamics for Engineering*, Engineering Education System, Austin, Texas. ISBN- 978-0-962-37317-6.

2. K. Muralidhar and T. Sundarajan (1995), *Computatioanl Fluid Flow and Heat Transfer*, Narosa Publishing House, New Delhi. ISBN-978-8-173-19522-8.

3. Fluent 6.1 Manual (2001), Fluent Inc.

Unit-1 Review of the equations governing fluid flow and heat transfer 6 hours
Introduction to equations governing fluid flow and heat transfer - Conservation of mass, conservation of energy - expanded and special forms of Navier-Stokes equations - Potential

theory - Boundary layer theory - Compressible flows - Turbulent flows.
Unit-2 Finite Difference Method 6 hours
Introduction to finite differences, difference equations and discretization – Finite difference Methods: Explicit, implicit and Crank-Nicholson – Convergence and stability conditions - ADI – Boundary conditions - Applications to steady and transient heat conduction equations.
Unit-3 Heat conduction, convection and diffusion 12 hours
One- and two- dimensional steady & transient conduction - Steady one-dimensional convection and diffusion - Solution methodology: upwind scheme, exponential scheme, hybrid scheme, power law scheme – Explicit, Implicit, Crank-Nicolson schemes – Stability criterion.
Unit-4 Solution of Navier-Stokes equations for incompressible flows 10 hours
Sources of ray X-ray production-properties of d and x rays – film characteristics – exposure charts – contrasts – operational characteristics of x ray equipment – applications.
Unit-5 ANSYS 8 hours
Study and simulation for generic fluid flow problems.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Transmission system design lab**				
Course Code	**MAUE5009**				
Prerequisite	-				
Corequisite	-				
Antirequisite	-				
		L	**T**	**P**	**C**
		0	**0**	**2**	**1**

Course Objectives:

To orient the students with various aspects of transmission system design and engines through experiments

Course Outcomes

CO1	Assess the transmission systems used in vehicles
CO2	Visualize the suspension and steering systems of vehicles
CO3	Integrate the components of brakes and clutches

Text Book (s)

Ganesan.V.(2003), *Internal Combustion Engines*, 2nd edition, Tata McGraw Hill Co., ISBN-978-0-070-49457-2

Reference Book (s)

Giles. J.G. (1989), *Vehicle Operation and performance*, IIIiffe Books Ltd., London.

List of Experimments 40 hours
1. Testing of Internal combustion engine according to Indian and International standards. 2. Performance analysis of two stroke Petrol Engine. 3. Performance analysis of four stroke Petrol Engine. 4. Performance analysis of four stroke Diesel Engine. 5. To Study various engine components, material and design aspects. 6. Performance test on variable compression ratio multi fuel diesel engine. 7. Study of ignition, cooling, lubrication systems 8. Assembling and dismantling of clutch and Transmission systems 9. Assembling and dismantling of automotive brakes, suspension and steering systems 10. Study of Recent developments in the field of I.C. Engine and Automobile

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
70	Nil	30	100

Name of The Course	**Engine testing and pollution measurement lab**
Course Code	**MAUE5010**
Prerequisite	-
Corequisite	-
Antirequisite	-

	L	T	P	C
	0	0	2	1

Course Objectives:

To orient the students with various aspects of engine testing and measurement through experiments.

Course Outcomes

CO1	Measure the performance of engine at different load conditions
CO2	Evaluate to determine the different parameters of engine
CO3	Test the engine performance of petrol and diesel engines
CO4	Assess the emission characteristics of internal combustion engines.

Text Book (s) and Reference Book (s)

1. Giles. J.G. (1989), *Vehicle Operation and performance*, IIIiffe Books Ltd., London.
2. Crouse.W.H. andAnglin.D.L.(1978), *Motor Vehicle Inspection,*McGraw Hill Book Co. ISBN-0070148139.
3. Ganesan.V.(2003), *Internal Combustion Engines*, 2nd edition, Tata McGraw Hill Co., ISBN-978-0-070-49457-2.

List of experiments 40 hours
1. Study of Pressure pickups, charge amplifier, storage oscilloscope and signal analysers used for IC engine testing. 2. Performance study of petrol and diesel engines both at full load and part load conditions. 3. Morse test on petrol and diesel engines. 4. Determination of compression ratio, volumetric efficiency and optimum cooling water flow rate in engines. 5. Heat balance test on an automotive engine. 6. Testing of 2 and 4 wheelers using chassis dynamometers. 7. Study of NDIR Gas Analyser and FID. 8. Study of ChemiluminescentNOxanalyzer. 9. Measurement of HC, CO, CO2, O2 using exhaust gas analyzer. 10. Diesel smoke measurement.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
70		30	100

Name of The Course	**Vehicle testing lab**			
Course Code	**MAUE6001**			
Prerequisite	-			
Corequisite	-			
Antirequisite	-			
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course Objectives:

To orient the students with the following through experiments:

1. Testing of vehicles using dynamometer
2. Wheel balancing.

Course Outcomes

CO1	Measure the wheel balancing and alignment of vehicles
CO2	Estimate correct ratios of engine parameters using different diagnostic systems
CO3	Test the two and four wheeler automobiles using dynamometers and on Road
CO4	Assess the exhaust gases of internal combustion engines.
CO5	Apply the basic approach for vehicles pollution test and further lab development for biofuel based engine testing perfromance

Text Book (s) and Reference Book (s)

1. Manufacturer's Manual
2. Giles.J.G.(1989), *Vehicle Operation and performance*, lliffe Books Ltd., London.
3. Crouse.W.H. andAnglin.D.L.(1978), *Motor Vehicle Inspection,*McGraw Hill Book Co. ISBN-0070148139.
4. Ganesan.V (2003), *Internal Combustion Engines*, 2nd edition, Tata McGraw Hill Co. ISBN-978-0-070-49457-2.

List of experiments 40 hours
1. Testing of 2 -wheeler using chassis dynamometer.

2. Testing of 4 -wheeler using chassis dynamometer. 3. Road Test of Vehicles for a. Brake b. Acceleration c. Fuel Consumption 4. Engine Analysis using Engine Diagnostic System for a. Petrol Engine. b. Diesel Engine. 5. Wheel Balancing and Wheel Alignment 6. Study of ChemiluminescentNOxanalyzer. 7. Measurement of HC, CO, CO2, O2 using exhaust gas analyzer. 8. Diesel smoke measurement.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
70	-	30	100

Name of The Course	**Automotive engine and chassis component lab**			
Course Code	**MAUE6002**			
Prerequisite	-			
Corequisite	-			
Antirequisite	-			
	L	**T**	**P**	**C**
	0	**0**	**2**	**1**

Course Objectives:

To orient the students with the following through experiments:

1. The design of chassis components
2. The assembly of the chassis.

Course Outcomes

CO1	Plan seat layout of various automobile
CO2	Design the frames of HMV, LMV, Car and Two Wheelers using CAD modelling
CO3	Tabulate different parts of automotive components
CO4	Apply the basic knowledge in industries for Dismantling, study and Assembling of different parts of engine and chassis

Text Book (s)

1. Manufacturer's Manual

List of experiments 40 hours
1. Study of Frames used for HMV, LMV, Car and Two Wheelers. 2. Dismantling and assembling of different types of engines 3. Dismantling and assembling of a. Fuel Supply System b. Steering System, c. Suspension System, d. Braking System, e. Wheels and Tyres f. Propeller Shaft, Universal Joints and Differential 4. Study of Driver Seat 5. Brake adjustment and bleeding.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Dissertation-1**			
Course Code	**MAUE9998**			
Prerequisite	-			
Corequisite	-			
Antirequisite	-			
	L	**T**	**P**	**C**
	-	**-**	**-**	**5**

Course Objectives:

1. To make literature survey for various recently emerging technologies.
2. To select any topic of interest and to review the related literature in detail.
3. To compare and analysis the various topologies for the selected topic of interest.
4. To give more emphasize to the one of best topology and to obtain a network model for it.
5. To analysis the simulation results of the particular topology obtained from various simulation tools.
6. To get realize the hardware implementation of the above topology for which we obtained simulations.

Course Outcomes

CO1	Analyze the relevance of knowledge obtained from literature for the research work taken up
CO2	Evaluate the recently advanced techniques.
CO3	Extract detailed information about the topic of interest
CO4	Plan an innovative work in the area of interest
CO5	Apply the different simulation tools applicable to the area of research

Text Book (s)

Depending upon the area of interest student may choose any text book of relevant field.

Reference Book (s)

As per the chosen area of research.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	Nil	50	100

Name of The Course	**Dissertation-II**				
Course Code	**MAUE9999**				
Prerequisite	-				
Corequisite	-				
Antirequisite	-				
	L	**T**	**P**	**C**	
	-	-	-	**15**	

Course Objectives:

1. To make literature survey for various recently emerging technologies.
2. To select any topic of interest and to review the related literature in detail.
3. To compare and analysis the various topologies for the selected topic of interest.
4. To give more emphasize to the one of best topology and to obtain a network model for it.
5. To analysis the simulation results of the particular topology obtained from various simulation tools.
6. To get realize the hardware implementation of the above topology for which we obtained simulations.

Course Outcomes

CO1	Design a project relevant to the field of study
CO2	Demonstrate expertise in the selected area of research
CO3	Conduct an innovative work in the selected area of research
CO4	Apply the different simulation tools applicable to the area of research
CO5	Demonstrate a thorough understanding of the chosen topic of dissertation

Text Book (s)

Depending upon the area of interest student may choose any text book of relevant field.

Reference Book (s)

As per the chosen area of research.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
50	Nil	50	100

Name of The Course	**Simulation of automobile system**				
Course Code	**MAUE5011**				
Prerequisite	-				
Corequisite	-				
Antirequisite	-				
	L	**T**	**P**	**C**	
	3	**0**	**0**	**3**	

Course Objectives:

To provide knowledge about computer simulation of IC Engines Process.

Course Outcomes

CO1	Summarize the combustion using different thermodynamic process
CO2	Simulate SI engine with air as a working medium
CO3	Simulate the progressive combustion of SI engine
CO4	Simulate two stroke SI engine.

Text Book (s)

1. Ganesan.V.,*Computer Simulation of Spark - Ignition Engine Process*, Universities Press (I) Ltd, 1996. ISBN-978-8-173-71015-5.
2. Ganesan.V.,*Computer Simulation of Compression - Ignition Engine Process*, Universities Press (I) Ltd, 2000. ISBN- 978-8-173-71283-8.

Reference Book (s)

1. Ramoss.A.L. (1992), *Modeling of Internal Combustion Engines Processes*, McGraw Hill Publishing Co..
2. Ashley Campbel (1986), *Thermodynamic analysis of combustion engines*, John Wiley & Sons, New York. ISBN- 978-0-471-03751-4.
3. Benson.R.S.,Whitehouse.N.D.(1979), *Internal Combustion Engines*, Pergamon Press, Oxford. ISBN-978-0-080-22717-7.

Unit-1 Introduction 6 hours
Introduction - Heat of reaction - Measurement of URP - Measurement of HRP - Adiabatic flame temperature:Complete combustion in C/H/O/N Systems, Constant volume adiabatic combustion, constant pressure adiabatic combustion. Calculation of adiabatic flame temperature - Isentropic changes of state.
Unit-2 SI ENGINE SIMULATION WITH AIR AS WORKING MEDIUM 6 hours
SI Engine Simulation With Air As Working Medium Deviation between actual and ideal cycle - Problems, SI engine simulation with adiabatic combustion, temperature drop due to fuel vaporisation, full throttle operation - efficiency calculation, part-throttle operation, super charged operation.
Unit-3 PROGRESSIVE COMBUSTION 9 hours
Progressive Combustion SI Engines simulation with progressive combustion with gas exchange process, Heat transfer process, friction calculation, compression of simulated values, validation of the computer code, engine performance simulation,pressure crank angle diagram and other engine performance.
Unit-4 SIMULATION OF 2-STROKE SI ENGINE 9 hours
Simulation Of 2-Stroke SI Engine Introduction – Air fuel mixture formation – Chemically correct mixture combustion – Scavenging – Exhaust and mixing processes in a two stroke engine. Diesel Engine Simulation Multi zone model for combustion, different heat transfer models, equilibrium calculations, simulation of engine performance and simulation for pollution estimation.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Automobile Air Conditioning**			
Course Code	**MAUE5012**			
Prerequisite	**-**			
Corequisite	**-**			
Antirequisite	**-**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives:

The objective of Automobile Air Conditioning is to

1. make students familiar with the different refrigeration systems, air-conditioning systems, eco-friendly refrigerants used.
2. acquaint the students with the load analysis, air distribution and temperature control of an automobile.

Course Outcomes

CO1	Summarize the basic principles of refrigeration and air conditioning (K1)
CO2	Identify the characteristics required for selection of refrigerants (K2)
CO3	Demonstrate the basic layout and components of air conditioning system (K3)
CO4	Analyze the load and air distribution in refrigeration and air conditioning systems (K4)
CO5	Illustrate the techniques of temperature control, maintenance and servicing of air conditioning system (K3)

Text Book (s) and Reference Book (s)

2. Paul Lung, Automotive Air Conditioning, C.B.S. Publisher & Distributor, Delhi.
3. N.C. Harris (1974), *Modern Air Conditioning*, McGraw-Hill; 2nd edition, ISBN- 978-0-070-26811-1.
4. ASHRAE Handbook – 1985 Fundamentals
5. William H. Crouse & Donald L. Anglin (1990), *Automotive Air Conditioning*, McGraw Hill, Inc. ISBN-978-0-070-14591-7.
7. Paul Weisler (1990), *Automotive Air Conditioning*, Reston Publishing Co. Inc. ISBN- 978-0-835-90261-8.

Unit-1 Refrigeration 6 hours
Refrigeration : Introduction, methods of refrigeration, vapour compression refrigeration system, vapour absorption refrigeration system, applications of refrigeration & air conditioning, Automobile air conditioning, air conditioning for passengers, isolated vehicles, transport vehicles, applications related with very low temperatures.
Unit-2 Refrigerant 6 hours
Refrigerant: Classification, properties, selection criteria, commonly used refrigerants, alternative refrigerants, eco-friendly refrigerants, applications of refrigerants, refrigerants used in automobile air conditioning.
Unit-3 Automobile Air Conditioning Systems 9 hours
Air Conditioning Systems: Classification, layouts, central / unitary air conditioning systems, components like compressors, evaporators, condensers, expansion devices, fan blowers, heating systems, Automotive heaters, Types, Heater Systems, Air conditioning protection, Engine protection.
Unit-4 Load Analysis and air distribution systems 9 hours
Load Analysis: Outside & inside design consideration, factors forming the load on refrigeration & air conditioning systems, cooling & heating load calculations, load calculations for automobiles, effect of air conditioning load on engine performance, Air Distribution Systems : Distribution duct system, sizing, supply / return ducts, type of grills, diffusers, ventilation, air noise level, layout of duct systems for automobiles and their impact on load calculations.
Unit-5 Temperature control and Air conditioning services 9 hours
Air Routine & Temperature Control : Objectives - evaporator care air glow, through the dash re-circulating unit, automatic temperature control, controlling flow, control of air handling systems. Air Conditioning Service : Air conditioner maintenance & service - servicing heater system, removing & replacing components, trouble shooting of air conditioning system, compressor service, methods of dehydration, charging & testing.

1.Michel Information Services (1989), *Mitchell Automotive Heating and Air Conditioning Systems,* Prentice Hall. ISBN-978-0-135-86223-0.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Transport Management**			
Course Code	**MAUE5013**			
Prerequisite	-			
Corequisite	-			
Antirequisite	-			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives:

The objective of transport management subject is to make students familiar with the notion of transport management, vehicle maintenance, supply management, scheduling and motor laws.

Course Outcomes

CO1	Plan the manpower in different sections of transportation
CO2	Develop the schedule for maintenance of automobiles
CO3	Calculate the cost of inventory in transportation using software
CO4	Summarize fare structure, schedules and sections of motor vehicle act

Text Book (s) and Reference Book (s)

1. John Dolce, *Fleet Management*, McGraw-Hill Co. 1984 ISBN- 978-0-070-17410-8.
2. Goverment Publication, *The Motor vehicle Act*, 1989.
3. Rex W Faulks (1987), *Bus and Coach Operation*, Butterworth. ISBN-978-0-408-02810-3.
4. Kitchin.L.D.(1992), *Bus operation*, 3rd Edition, llliffe and Sons Ltd., London.
5. Kadiyali.L.R., *Traffic engineering and Transport Planning*, Khanna Publishers, ISBN- 978-8-174-09220-5.

Unit-1 Organisation and Management 6 hours
Forms of Ownership – principle of Transport Management – Staff administration – Recruitment and Training –welfare – health and safety. Basic principles of supervising. Organizing time and people. Driver and mechanic hiring - Driver checklist - Lists for driver and mechanic - Trip leasing - Vehicle operation and types of operations
Unit-2 Vehicle Maintenance 6 hours
Scheduled and unscheduled maintenance - Planning and scope - Evaluation of PMI programme – Work scheduling - Overtime - Breakdown analysis - Control of repair backlogs - Cost of options.
Unit-3 Vehicle Parts, Supply Management and Budget 9 hours
Cost of inventory - Balancing inventory cost against downtime - Parts control - Bin tag systems – Time management - Time record keeping - Budget activity - Capital expenditures - Classification of vehicle expenses - Fleet management and data processing - Data processing systems - Software. Model - Computer controlling of fleet activity - Energy management. AE – 94 07-08 – SRM – E&T.
Unit-4 Fare structure and motor vehicle Act 9 hours
Scheduling And Fare Structure Route planning - Scheduling of transport vehicles - Preparation of timetable – preparation of vehicle and crew schedule - Costs, fare structure – Fare concessions - Methods of fare collection - Preparation of fare table.Motor Vehicle ActSchedules and sections - Registration of motor vehicles - Licensing of drivers and conductors - Control of permits - Limits of speed - traffic signs - Constructional regulations - Description of goods carrier, delivery van, tanker, tipper, municipal, fire fighting and break down service vehicle.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Tractor and Farm Equipment**			
Course Code	**MAUE5015**			
Prerequisite	-			
Corequisite	-			
Antirequisite	-			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives:

This subject acquaints students with the design and control of tractors, working of engines and farm equipments

Course Outcomes

CO1	Classify various types of tractors, their components and safety aspects
CO2	Summarize the engine design and operation of tractors
CO3	Demonstrate the working principle of cooling and lubrication systems of tractor
CO4	Classify different attachment of tractors used for farming purpose.

Text Book (s) and Reference Book (s)

1.Rodichev and G.Rodicheva(1987), *Tractor and Automobiles*, MIR Publishers. ISBN- 978-5-030-00855-4.
2. Kolchin. A., and V.Demidov (1972), *Design of Automotive engines for tractor*, MIR Publishers.

Unit-1 General Introduction 10 hours
General Design of Tractors : Classification of Tractors-Main components of Tractor-Safety Rules.
Unit-2 Tractor control 10 hours

Control of the Tractor and Fundamentals of Engine Operation: Tractor controls and the starting of the tractor engines-Basic notions and definition-Engine cycles-Operation of multi cylinder engines-General engine design - Basic engine performance characteristics.
Unit-3 Working of Automobile Engines 9 hours
Engine Frame Work and Valve 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. Cooling system, Lubrication System and Fuel System of a Tractor: Cooling system – Classification, Liquid cooling system – Components, Lubricating system servicing and troubles – Air cleaner and turbo charger – Fuel tanks and filters –Fuel pumps.
Unit-4 Farm Equipments 9 hours
Working attachment of tractors-Farm equipment – Classification – Auxiliaryequipment – Trailers and body tipping mechanism.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Alternative Fuels and Power Systems**				
Course Code	**MAUE5017**				
Prerequisite	**-**				
Corequisite	**-**				
Antirequisite	**-**				
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. To introduce the students to different kinds of alternative fuels.
2. To understand the properties and applications of alternative fuels.

Course Outcomes

CO1	Identify the need for alternative fuels and their sources.
CO2	Demonstrate the performance characteristics of alcohol fuels in SI and CI engines.
CO3	Investigate the properties, engine performance and emission characterstics of hydrogen, biogas and vegetable oil fuels.
CO4	Demonstrate the layout of electric, solar powered and hybrid vehicles.

Text Book (s) and Reference Book (s)

1. Osamu Hirao and Richard K. Pefley (1988), *Present and Future Automotive Fuels*, John Wiley and Sons. ISBN-978-0-471-80259-4.
2. Keith Owen and Trevor Eoley (1990), *Automotive Fuels Handbook*, SAE Publications.
3. Richard L.Bechtold (1997), *Automotive Fuels Guide Book*, SAE Publications. ISBN- 978-0-7680-0052-8.

Unit-1 Introduction 10 hours
Estimation of petroleum reserves - Need for alternative fuels - Availability and Suitability to Piston Engines, Concept of conventional fuels, potential alternative fuels - Ethanol, Methanol, DEE/DME - Hydrogen, LPG, Natural gas, producer gas, Bio gas and Vegetable oils - Use in I.C. Engines-Merits and Demerits of various fuels.
Unit-2 ALCOHOL FUELS 10 hours
Properties as engine fuels - Performance in S.I.Engines - Alcohol & Gasoline blends - Flexible Fuel Vehicle -Reformed alcohols - Use in C.I. Engines - Emulsions - Dual fuel systems - Spark assisted diesel engines –AE – 60 07-08 – SRM – E&T Surface ignition engines - Ignition accelerators - Combustion and emission characteristics in engines – emissioncharacteristics.
Unit-3 GASEOUS FUELS and VEGETABLE OILS 9 hours
Hydrogen - Properties - Use in CI Engines - Use in SI Engines - Storage methods - Safety precautions. Producer gas and biogas - Raw materials - Gasification - Properties - Cleaning up the gas - Use in SI and CI engines, LPG & Natural gas - Properties - Use in SI and CI Engines.

Various vegetable oils for engines – Properties - Esterification - Performance in engines - Performance and emission Characteristics.
Unit-4 ELECTRIC AND SOLAR POWERED VEHICLES 9 hours
Layout of an electric vehicle - Advantage and limitations - Specifications - System component. Electronic control system - High energy and power density batteries - Hybrid vehicle - Solar powered vehicles.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Special Purpose Vehicles**			
Course Code	**MAUE5018**			
Prerequisite	-			
Corequisite	-			
Antirequisite	-			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives:

The objective of teaching special purpose vehicles is to make students familiar with the classification of special purpose vehicles based on their applications, wheel tyres and truck type.

Course Outcomes

CO1	Classify the special purpose vehicles based on listed parameters
CO2	Explain working principles and design consideration of different earth moving machines.
CO3	Summarize the elements and working of a farm tractor.
CO4	Summarize elements and design parameters of mobile cranes.

Text Book (s) and Reference Book (s)

1. Y. Pokras and M. Tushnyakov, *Construction Equipment Operation & Maintenance*, MIR, Moscow.
2. A. Astskhov, *Truck Cranes*, MIR, Moscow.
3. E.G. Poninson, *Motor Graders*, MIR, Moscow.
4. N. Rudenko, *Material Handling Equipment*, MIR. Publishers. ISBN-978-0-714-70285-8.
5. Sheldon, R.Shacket, Domus Books, *Electric Vehicles*, New York. ISBN- 978-0-891-96085-0.

Unit-1 Classification of Special Purpose Vehicles 8 hours
Classification of Special Purpose Vehicles: based on applications, wheel types & Truck type.
Unit-2 Construction working principle and working 10 hours
Study of working principles & design considerations: of different systems involved like power system, transmission, final drive, lubrication, electrical, braking, steering, pneumatic & hydraulic control circuits. Constructional & working features: of different types of earth moving machinery such as Tippers, shovels, loaders, Excavators, Dumpers, Dozers, Fork Lift truck, Road rollers.
Unit-3 Farm Tractor 9 hours
Farm Tractor: Layout, Load distribution, Engine, Transmission & Drive line, Steering, Braking system, Wheels & Tyres, Hydraulic system, Auxiliary Systems, Draw bar, PTO Shaft. Different types of Implements, accessories and attachments. Tractor trolley.
Unit-4 Mobile Cranes 10 hours
Mobile Cranes : Basic characteristics of truck cranes, stability & design features, control systems & safety devices. Tracked Vehicles, Articulated Vehicles, Multi-axle Vehicles, fifth wheelmechanism. Semi trailer & Prime mover brakes & electrical systems. Dead Axles. SpecialPurpose Electric Vehicles, Solar Vehicles and Hybrid Vehicles. Types, architecture and parameters of design considerations.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	Safety, Health and Enviornment			
Course Code	MAUE5019			
Prerequisite	-			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

Course Objectives:

The course is intended to

1. Introduce the basics of Air pollution.
2. Understand the measures and technologies required to control the air pollution.

Course Outcomes

CO1	List the Different type of hazards and Vulnerability models
CO2	Identify fire and explosion model for Automotive safety Analysis
CO3	Examine different Air Pollutants
CO4	Investigate wind circulation stability conditions and Maximum Mixing Depths
CO5	Summarize air pollution control technologies
CO6	To apply the design principles of Air Pollution Control Tool

Text Book (s) and Reference Book (s)

1. M N Rao & H V N Rao (2000), *Air pollution*, Tata McGraw Hill Publishing Ltd. ISBN- 978-0-074-51871-7.

Unit-1 Safety 8 hours
Concepts of safety – Hazard classification chemical, physical, mechanical, ergonomics, biological and noise hazards – Hazards from utilities like air, water, steam. Hazard identification - Safety Audits - Checklists - What if Analysis – HAZAN – HAZOP - Vulnerability models - Event tree and Fault tree Analysis - Past accident analysis - Flixborough - Mexico - Bhopal - Madras - Vizag accident analysis.
Unit-2 Automotive safety Analysis 8 hours
Introduction to Consequence Analysis - Fire and Explosion models: Radiation - Tank on fire - Flame length – Risk analysis - Radiation intensity calculation and its effect to plant, people & Property - UCVCE - Explosion due to - Deflatration - Detonation - TNT, TNO & DSM model - Over pressure - Methods for determining consequences effects - Effect of fire- Effects of explosion - Risk contour - Flash fire - Jet fire - Pool fire - BLEVE - Fire ball.
Unit-3 Air Pollution Monitoring 9 hours
Collection of Gaseous Air Pollutants, Collection of Particulate Pollutants, Measurement of SO_2, Nox, CO, Oxidants and Ozone
Unit-4 Meteorology & Dispersion of pollutants 9 hours
Wind Circulation, Lapse Rate, Stability Conditions, Maximum Mixing Depths, Plume Rise & dispersion
Unit-5 Emission Control Systems 9 hours
Air pollution control technologies for particulates and gaseous contaminants, Gravity settlers, Electrostatic precipitators, Bag Filters, Scrubbers, Cyclone, control for moving sources.
Unit-6
Inspection and maintenance of in service vehicles, GAPF emission inventory preparation tool, Air Pollution control model using machine learning and IOT techniques, Canada's pollution control policy tool

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	Hydraulics and Pneumatics			
Course Code	MAUE5020			
Prerequisite	-			
Corequisite	-			
Antirequisite	-			
	L	T	P	C
	3	0	0	3

Course Objectives:

This subject deals with the hydraulic and pneumatic aspects which helps students to understand their applications in automobile engineering.

Course Outcomes

CO1	Explain the fluid power in hydraulic and pneumatic systems
CO2	Summarize the different elements of hydraulic systems and their working
CO3	Summarize the different elements of Pneumatic systems and their working
CO4	Apply Hydraulic and Pneumatic principle in different automotive application

Text Book (s) and Reference Book (s)

1.AnthonyEspisito (2003), *Fluid Power with Application*, Pearson Education (Singapore) Pte.Ltd, Delhi, India, Fifth Edition, First Indian Reprint, ISBN- 978-8-177-58580-3.

2. Werner Deppert and Kurt Stoll (1975), *Pneumatic Controls : An introduction to principles*, Vogel-Druck Wurzburg, Germany. ISBN-978-3-802-30102-5.

3. Pippenger, J.J (2002), *Industrial Hydraulic & Pneumatics*, McGraw Hill.

4. Anderson B W, *The analysis and design of pneumatic systems*, John Wiley.

5. A. B. Goodwin, *Fluid Power Systems*, Mc Millan Pub. Co. ISBN- 978-0-333-19368-6.

Unit-1 Introduction to fluid power 10 hours
Introduction to fluid power – Classification, application in various fluids of engineering, various hydraulic and pneumatic ISO/JIC Symbols, transmission of power at static and dynamic states, Types of hydraulic fluids and their properties, effect of temperature on fluids.
Unit-2 Elements and working of hydraulic systems 10 hours
Different elements of hydraulic system, constructional and working details of each component; Pumps and motors, characteristics, Maintenance of hydraulic system, control valves, actuators and mountings, filter, regulator and lubricator. Selection criteria for cylinders, valves, pipes etc.
Unit-3 Pneumatic Systems 9 hours
Pneumatic Systems : Application of pneumatics, physical principles, basic requirement of pneumatic system. Comparison with hydraulic systems. Elements of Pneumatics, Air compressors, Pneumatic control valves,
Pneumatic actuators - types and the mountings, Air motors – types, Pneumatic circuits – Basic pneumatic circuit, impulse operation, speed control, pneumatic motor circuit, sequencing of motion, time delay circuits and their applications.Pneumatic servo-system for linear and rotary motion.
Unit-4 Automotive Applications of pneumatic systems 9 hours
Typical Automotive Applications: Hydraulic tipping mechanism, power steering, fork lift hydraulic gear, hydro-pneumatic suspension Maintenance and trouble shooting of hydraulic & pneumatic circuits. Introduction to fluidics-study of simple logic gates, turbulence, amplifiers, pneumatic sensors and applications.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Vehicle Aerodynamics**			
Course Code	**MAUE5021**			
Prerequisite	**-**			
Corequisite	**-**			
Antirequisite	**-**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives:

1. To analyze the stability, safety and comfort of the vehicles
2. To understand wind tunnels and testing techniques
3. To apply CFD for aerodynamic design of vehicle

Course Outcomes

CO1	Demonstrate aerodynamic drag and forces in a car body
CO2	Identify the parameters of vehicle body related to car stability, safety and comfort.
CO3	Summarize the wind tunnels and testing methodology.

CO4	Model fluid flow equations around a vehicle body
CO5	Construct the aerodynamic models for cars, buses and trucks.

Text Book (s)

1. DaleH. Beterfield et al (2001), *Total Quality Management*, Pearson Education Asia. ISBN-978-8-131-76496-1.

Reference Book (s)

1. John Bank J.E. (1993), *Total Quality Management*, Prentice Hall, India, ISBN- 978-0-132-84902-9.
2. Samuel K.Ho (2002), *TQM- AN Integrated approach*, Kogan Page India Pvt. Ltd, ISBN-978-0-749-41561-7.
3. Jill A.Swift, Joel E. Ross and Vincent K. Omachonn (1998) *Principles of Total Quality*, St.Lucie Press, US, 1998. ISBN-978-1-574-44094-2.

Unit-1 Fundamentals of Aerodynamics 6 hours
Scope – Development trends – Flow phenomena related to vehicles – External and Internal flow problems – Performance of cars and light vans – Resistance to vehicle motion – Drag – Types of drag – Flow field around car – Aerodynamic development of cars – Optimization of car bodies for low drag.
Unit-2 Stability, Safety and Comfort 6 hours
The origin of forces and moments – effects – vehicle dynamics under side wind – Force and Moment coefficients – Safety limit – dirt accumulation on vehicle - wind noise – Air flow around individual components – High performance vehicles – Very log drag cars – Design alternatives – High efficiency radiator arrangement – Development and simulation methods.
Unit-3 Wind Tunnels and Test Techniques 12 hours
Principles of wind technology – Limitations of simulation – Scale models – Existing automobile wind tunnels – Climatic tunnels – Measuring equipment and transducers. Pressure measurement – velocity measurements – Flow visualization techniques – Road testing methods – Wind noise measurements.
Unit-4 Introduction to CFD 10 hours
Methods to solve Navier–Stokes equation – Forces acting in a fluid element – Compressibility effects in a flow field – Inviscid flow – Governing equations – Irrotation flow field and consequences – Potential flows – Boundary layer methods – Numerical modelling of fluid flow around vehicle body.
Unit-5 Aerodynamic Design 6 hours
Development and simulation methods –cars, buses, trucks studies.

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100

Name of The Course	**Automotive Safety**			
Course Code	**MAUE5022**			
Prerequisite	**-**			
Corequisite	**-**			
Antirequisite	**-**			
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Objectives:

The concept of introducing this subject is to make students familiar with the aspect of vehicle safety and to introduce them with the notion of bus body and commercial vehicle.

Course Outcomes

CO1	Classify different aspects of saftey in automobile
CO2	Categories the suitable active & passive systems
CO3	Applying the knowledge for selecting the suitable safety equipments for designing a vehicle
CO4	Design a collision warning and avoidance system
CO5	Creating the advanced system for increasing the safety in special purpose vehicles

CO6	Understanding the future of automotive safety: autonomous vehicle

Text Book (s) and Reference Book (s)

1. Hucho, W.H. (1997), *Aerodynamics of Road vehicles*, Butterworths Co. Ltd. ISBN- 978-0-750-61267-8.
2. J. Powloski (1969), *Vehicle Body Engineering*, Business books limited, London. ISBN- 978-0-220-68916-2.
3. Ronald. K. Jurgen (1999), *Automotive Electronics Handbook*, Second edition- McGraw-Hill Inc. ISBN- 978-0-070-34453-2.
4. ARAI Safety standards.

Unit-1 Introduction 6 hours
The concept of vehicle safety; Need of safety; active safety: driving safety; conditional safety; perceptibility safety; operating safety- passive safety: exterior safety, interior safety, deformation behaviour of vehicle body.
Unit-2 Vehicle safety 9 hours
Regulations, automatic seat belt Tightener system; Collapsible steering column; Tiltable steering wheel; Electronic system for activating air bags; Bumper design for safety; antiskid brakingsystem; Speed control devices; Causes of rear end collision; Frontal object detection; Rear vehicle object detection system; Object detection system with braking system interactions
Unit-3 SAFETY EQUIPMENTS 9 hours
Seat belt, regulations, automatic seat belt tightener system, collapsible steering column, tiltable steering wheel, air bags, electronic system for activating air bags, bumper design for safety.
Unit-4 COLLISION WARNING AND AVOIDANCE 8 hours
Collision warning system, causes of rear end collision, frontal object detection, rear vehicle object detection system, object detection system with braking system interactions.
Unit-5 COMFORT AND CONVENIENCE SYSTEM 8 hours
Steering and mirror adjustment, central locking system , Garage door opening system, tyre pressure control system, rain sensor system, environment information system
Unit-6
Trust in Autonomous Vehicles, Simulator Study, Individual Driver Characteristics, Educating the Operator, transfer of control to operator, benefits of automation, ADS

Continuous Assessment Pattern

Internal Assessment (IA)	Mid Term Test (MTE)	End Term Test (ETE)	Total Marks
20	30	50	100