Pimpri Chinchwad Education Trust's

PIMPRI CHINCHWAD COLLEGE OF ENGINEERING

SECTOR NO. 26, PRADHIKARAN, NIGDI, PUNE 411044

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

DEPARTMENT OF MECHANICAL ENGINEERING

Curriculum Structure and Syllabus

of

Third Year B. Tech. Mechanical Engineering
(Regulation 2020)

Effective from Academic Year 2024-25

(Updated with minor changes)

Institute Vision

To be one of the top 100 Engineering Institutes of India in coming five years by offering exemplarily Ethical, Sustainable and Value Added Quality Education through a matching ecosystem for building successful careers.

Institute Mission

1. Serving the needs of the society at large through establishment of a state-of-art Engineering Institute.

2. Imparting right Attitude, Skills, Knowledge for self-sustenance through Quality Education.

3. Creating globally competent and Sensible engineers, researchers and entrepreneurs with an ability to think and act independently in demanding situations.

EOMS Policy

"We at PCCOE are committed to offer exemplarily Ethical, Sustainable and Value Added Quality Education to satisfy the applicable requirements, needs and expectations of the Students and Stakeholders.

We shall strive for technical development of students by creating globally competent and sensible engineers, researchers and entrepreneurs through Quality Education.

We are committed for Institute's social responsibilities and managing Intellectual property.

We shall achieve this by establishing and strengthening state-of-the-art Engineering Institute through continual improvement in effective implementation of Educational Organizations Management Systems (EOMS)."

Course Approval Summary

A. Board of study -Department of Mechanical Engineering

Sr. No.	Course Name	Course Code	Page Number	Signature and Stamp of BoS Chairman
	TY B Tech Semester-V			
1	Heat Transfer	BME5410	11	
2	Machine Design	BME5411	13	
3	Fluid Mechanics & Machinery Lab	BME5412	15	
4	Heat Transfer Lab	BME5413	16	
5	Machine Design Lab	BME5414	17	
6	**Professional Elective Course- I (Thermal)**	**BME5501**		
	Design of Fan, Blower and Compressor	BME5501A	18	
	Incompressible Flow Machines	BME5501B	20	
	Steam and Gas Turbine	BME5501C	21	
	Internal Combustion Engines	BME5501D	22	
7	**Professional Elective Course - II**	**BME5502**		
	Product Design and Development	BME5502A	24	
	Smart Manufacturing	BME5502B	26	
	Advanced Materials & Manufacturing	BME5502C	27	
	Design Thinking	BME5502D	28	
	Design for Reliability	BME5502E	29	
8	CAE Analysis	BME5913	43	
	TY B Tech Semester -VI			
9	Numerical Methods & optimization	BME6413	47	
10	Mechatronics	BME6414	48	
11	Design Engineering lab	BME6415	50	
12	Numerical Methods & optimization Lab	BME6416	52	
13	Mechatronics Lab	BME6417	53	
14	Professional Elective- III	BME6503	54-65	
15	Professional Elective- IV (Design)	BME6504	63	
16	Computational Fluid Dynamics	BME6914	88	

B) Board of study – Department of Applied Sciences and Humanities

Sr. No.	Course Name	Course Code	Page Number	Signature and stamp of BoS Chairman
1	Statistical Data Analysis Using R	BAS5607	31	
2	Principles of Management	BHM5113	42	
3	Professional Development Training-I	BHM5917	44	
4	Environmental Science	BHM9961	45	
5	Multivariate Data Analysis Using R	BAS6608	65	
6	Project Management	BHM6114	85	
7	Financial Management	BHM6115	86	
8	Entrepreneurship Development	BHM6116	87	
9	Professional development Training-II	BHM6918	89	
10	Constitution of India	BHM9962	90	

C) Board of study -Department of Civil Engineering

Sr. No.	Course Name	Course Code	Page Number	Signature and stamp of BoS Chairman
1	Total Quality Management	BCI5602A	32	
2	Intelligent Transportation System	BCI5602B	33	
3	Remote Sensing and GIS	BCI6603A	67	
4	Building Services and Maintenance	BCI6603B	69	
5	Smart Cities & Building Automations	BCI6604A	70	
6	Mechanical Electrical Plumbing Systems	BCI6604B	72	

D) Board of study-Department of Computer Engineering

Sr. No.	Course Name	Course Code	Page Number	Signature and stamp of BoS Chairman
1	Data Structures Using Python	BCE5601	35	
2	Programming with C++	BCE5602	36	
3	Information Security	BCE6603	74	
4	Principles of Software Engineering	BCE6604	75	
5	Fundamentals of Machine Learning	BCE6605	76	
6	JAVA Programming	BEC6606	78	

E) Board of study- Department of Electronic and Telecommunication

Department of Mechanical Engineering

Sr. No.	Course Name	Course Code	Page Number	Signature and stamp of BoS
1	Smart City:An Electronic Perspective	BET5601	38	
2	Modeling and Simulation	BET5602	40	
3	Designing with Raspberry Pi	BET6601	79	
4	Basics of Automotive Electronics	BET6602	80	
5	Designing with Arduino Platform	BET6603	81	
6	Communication Protocols for e-Vehicle	BET6604	82	

F) Board of study -Department of Information Technology

Sr. No.	Course Name	Course Code	Page Number	Signature and stamp of BoS
1	Object Oriented Programming	BIT5601	41	
2	Web Technology	BIT6601	83	
3	Mobile Application Development	BIT6602	84	

Approved by Academic Council:

Chairman, Academic Council
Pimpri Chinchwad College of Engineering

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LIST OF ABBREVIATIONS IN CURRICULUM STRUCTURE

Sr. No.	Abbreviation	Type of Course
1.	BSC	Basic Science Course
2.	ECC	Engineering Core/ Science Course
3.	HSMC	Humanities, Social Sciences and Management Course
4.	PCC	Programme / Professional Core Course
5.	PEC	Programme / Professional Elective Course
6.	OEC	Open Elective Course
7.	PROJ	Project
8.	INTR	Internship
9.	AC	Audit Course
10.	MC	Mandatory Course
11.	LS	Life Skill
12.	PFC	Proficiency Course
13.	MO	MOOC Course
14.	L	Lecture
15.	P	Practical
16.	T	Tutorial
17.	H	Hours
18.	CR	Credits
19.	FA	Formative Assessment
20.	SA	Summative Assessment
21.	TW	Term Work
22.	OR	Oral
23.	PR	Practical

CURRICULUM FRAMEWORK

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

The Course and Credit Distribution

Sr. No.	Type of Courses	No of Courses	Total Credits No
1.	Basic Science Course (BSC)	8	23
2.	Engineering Core/ Science Course (ECC)	13	22
3.	Humanities, Social Sciences And Management Course (HSMC)	6	13
4.	Professional Core Course (PCC)	17	48
5.	Professional Elective Course (PEC)	6	18
6.	Open Elective Course (OEC)	6	18
7.	Project (PROJ)	2	16
8.	Internship (INTR)	1	3
9.	Audit Course (Audit)	3	-
10.	Mandatory Course (MC)	2	-
11.	Life Skill (LS)	4	-
12.	Proficiency Course (PFC)	4	-
	Total	**72**	**161**

COURSE DISTRIBUTION : SEMESTER WISE									
Sr. No.	Type of Course	No of Courses/ Semester							Total
		1	2	3	4	5	6	7	8	
1.	Basic Science Course (BSC)	3	3	2	-	-	-	-	-	8
2.	Engineering Core Course (ECC)	6	5	1	1	-	-	-	-	13
3.	Humanities, Social Sciences And Management Course (HSMC)	1	1	1	1	1	1	-	-	6
4.	Professional Core Course (PCC)	-	-	5	4	3	3	2	-	17
5.	Professional Elective Course (PEC)	-	-	-	-	2	2	2	-	6
6.	Open Elective Course (OEC)	-	-	-	1	1	2	2	-	6
7.	Project (PROJ)	-	1	-	-	-	-	-	1	2
8.	Internship (INTR)	-	-	-	-	-	-	-	1	1
9.	Audit Course (Audit)	-	-	-	1	1	1	-	-	3
10.	Mandatory Course (MC)	-	-	-	-	1	1	-	-	2
11.	Life Skill (LS)	1	1	1	1	-	-	-	-	4
12.	Proficiency Course (PFC)	-	-	1	1	1	1	-	-	4
Total		**11**	**11**	**11**	**10**	**10**	**11**	**6**	**2**	**72**

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

Curriculum structure

TY B Tech

Mechanical Engineering

CURRICULUM STRUCTURE FOR 3rd YEAR B. TECH. MECHANICAL ENGINEERING

SEMESTER – V

Course Code	Course Type	Course Name	Teaching Scheme							Evaluation Scheme					
			L	P	T	H	CR			FA	SA	TW	PR	OR	Total
							TH	PR	Total						
BME5410	PCC	Heat Transfer	3	-	-	3	3	-	3	40	60	-	-	-	100
BME5411	PCC	Machine Design	3	-	-	3	3	-	3	40	60	-	-	-	100
BME5412	PCC	Fluid Mechanics & Machinery Lab	-	2	-	2	-	1	1	-	-	25	-	25	50
BME5413	PCC	Heat Transfer Lab	-	2	-	2	-	1	1	-	-	25	50	-	75
BME5414	PCC	Machine Design Lab	-	2	-	2	-	1	1	-	-	25	-	50	75
BME5501	PEC	Professional Elective Course- I (Thermal)	3	-	-	3	3	-	3	40	60	-	-	-	100
BME5502	PEC	Professional Elective Course - II	3	-	-	3	3	-	3	40	60	-	-	-	100
---	OEC	Open Elective - II	3	-	-	3	3	-	3	40	60	-	-	-	100
BHM5113	HSMC	HSMC-V	2	-	-	2	2	-	2	30	20	-	-	-	50
BME5913	PFC	CAE Analysis	-	2	-	2	-	-	-	GRADE					
BHM5917	MC	Professional Development Training-I	3	-	-	3	-	-	-						
BHM9961	AUDIT	Environmental Science	1	-	-	1	-	-	-						
		Total	**21**	**8**	**-**	**29**	**17**	**3**	**20**	**230**	**320**	**75**	**50**	**75**	**750**

Abbreviations are: *L-Lecture, P-Practical, T-Tutorial, H- Hours, FA- Formative Assessment, SA-Summative Assessment, TW –Term work, PR-Practical, OR - Oral*

Semester - V

List of courses – Professional Elective Course – I

Course Code	Course Name	
BME5501A	Design of Fan, Blower and Compressor	Choose any one
BME5501B	Incompressible Flow Machines	
BME5501C	Steam and Gas Turbine	
BME5501D	Internal Combustion Engines	

List of courses – Professional Elective Course – II

Course Code	Course Name	
BME5502A	Product Design and Development	Choose any one
BME5502B	Smart Manufacturing	
BME5502C	Advanced Materials & Manufacturing	
BME5502D	Design Thinking	
BME5502E	Design for Reliability	

List of courses – Open Elective Course – II

Course Code	Department	Course Name	
BAS5607	AS&H	Statistical Data Analysis Using R	Choose any one
BCI5602A	CIVIL	Total Quality Management	
BCI5602B		Intelligent Transport System	
BCE5601	COMPUTER	Data Structures Using Python	
BCE5602		Programming with C++	
BET5601	E&TC	Smart City: An Electronic Perspectives	
BET5602		Modeling and Simulation	
BIT5601	IT	Object Oriented Programming	

List of courses – Humanities, Social Sciences and Management Course – V

Course Code	Course Name
BHM5113	Principles Management

List of courses – Proficiency Course – III

Course Code	Course Name
BME5913	CAE Analysis

List of courses – Mandatory Course – I

Course Code	Course Name
BHM5917	Professional Development Training- I

List of courses – Audit Courses – II

Course Code	Course Name
BHM9961	Environmental Science

CURRICULUM STRUCTURE FOR 3rd YEAR B. TECH. MECHANICAL ENGINEERING

SEMESTER –VI

Course Code	Course Type	Course Name	Teaching Scheme							Evaluation Scheme					
			L	P	T	H	CR			FA	SA	TW	PR	OR	Total
							TH	PR	Total						
BME6413	PCC	Numerical Methods & optimization	2	-	-	2	2	-	2	40	60	-	-	-	100
BME6414	PCC	Mechatronics	3	-	-	3	3	-	3	40	60	-	-	-	100
BME6415	PCC	Design Engineering lab	-	2	-	2	-	1	1	-	-	25	-	25	50
BME6416	PCC	Numerical Methods & optimization Lab	-	2	-	2	-	1	1	-	-	-	25	-	25
BME6417	PCC	Mechatronics Lab	-	2	-	2	-	1	1	-	-	-	-	25	25
BME6503	PEC	Professional Elective- III	3	-	-	3	3	-	3	40	60	-	-	-	100
BME6504	PEC	Professional Elective- IV (Design)	3	-	-	3	3	-	3	40	60	-	-	-	100
---	OEC	Open Elective - III	3	-	-	3	3	-	3	40	60	-	-	-	100
---	OEC	Open Elective - IV	3	-	-	3	3	-	3	40	60	-	-	-	100
BHM6114 To BHM6116	HSMC	HSMC-VI	2	-	-	2	2	-	2	30	20	-	-	-	50
BME6914	PFC	Computational Fluid Dynamics	-	2	-	2	-	-	-	GRADE					
BHM6918	MC	Professional Development Training-II	3	-	-	3	-	-	-						
BHM9962	AUDIT	Constitution of India	1	-	-	1	-	-							
Total			**23**	**8**	**0**	**31**	**19**	**3**	**22**	**270**	**380**	**25**	**25**	**50**	**750**

Abbreviations are: *L-Lecture, P-Practical, T-Tutorial, H- Hours, FA- Formative Assessment, SA-Summative Assessment, TW –Term work, PR-Practical, OR - Oral*

Semester - VI

List of courses – Professional Elective Course – III

Course Code	Course Name	
BME6503A	Non - Conventional Energy Systems	Choose any one
BME6503B	Biomechanics and Biomedical Engineering.	
BME6503C	Hydraulics & Pneumatics	
BME6503D	Industrial Engineering	
BME6503E	Design of Transmission Systems	
BME6503F	Alternative Energy Sources for I. C. Engines	
BME6503G	Electric, autonomous and connected vehicles-I	
BME6503H	Strategic Engineering Solutions in Mechanical Applications	

List of courses – Professional Elective Course – IV

Course Code	Course Name
BME6504	Mechanical System Design (Design Module)

List of courses – Open Elective Course - III

Course Code	Department	Course Name	
BAS6608	AS&H	Multivariate Data Analysis Using R	Choose any one
BCI6603A	CIVIL	Remote Sensing and GIS	
BCI6603B		Building Services and Maintenance	
BCE6603	COMPUTER	Information Security	
BCE6604		Principles of Software Engineering	
BET6601	E&TC	Designing with Raspberry Pi	
BET6602		Basics of Automotive Electronics	
BIT6601	IT	Web Technology	
BIT6602		Mobile Application Development	

List of courses – Open Elective Course - IV

Course Code	Department	Course Name	
BCI6604A	CIVIL	Smart Cities & Building Automations	Choose any one
BCI6604B		Mechanical Electrical Plumbing (MEP) Systems	
BCE6605	COMPUTER	Fundamentals of Machine Learning	
BCE6606		JAVA Programming	
BET6603	E&TC	Designing with Arduino platform	
BET6604		Communication Protocols for e-Vehicle	
BIT6602	IT	Mobile Application Development	

List of courses – Humanities, Social Sciences and Management Course – VI

Course Code	Course Name	
BHM6114	Project Management	Choose any one
BHM6115	Financial Management	
BHM6116	Entrepreneurship Development	

List of courses – Proficiency Course – IV

Course Code	Course Name
BME6914	Computational Fluid Dynamics

List of courses – Mandatory Course – II

Course Code	Course Name
BHM6918	Professional Development Training- II

List of courses – Audit Courses - III

Course Code	Course Name
BHM9962	Constitution of India

Course Syllabus

TY B Tech

Semester-V

Program:	B. Tech. (Mechanical Engineering)					Semester : V
Course:	Heat Transfer					Code : BME5410
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior knowledge of:

a. Mathematics: Integration and derivatives

b. Steady flow energy equation

c. Concept of boundary layer….. are essential

Course Objectives:

1. To understand the application of conduction equation to various geometries with and without heat generation
2. To get conversant with transient analysis of lumped systems.
3. To get conversant with methods of determining heat transfer coefficient in natural and forced convection heat transfer
4. To learn estimation radiation heat transfer between objects with simple geometries
5. To get conversant with methods of design and analysis of heat exchanger.

Course Outcomes:

After learning the course, students should be able to

1. **Analyze** the basic heat conduction equation for steady, one dimensional thermal systems with and without internal energy generation.
2. **Compare** insulation thickness and **evaluate** heat augmentation by fin application.
3. **Analyze** transient one dimensional thermal system by using governing equations and charts.
4. **Analyze** the heat transfer phenomenon in natural and forced convection.
5. **Evaluate** heat transfer by radiation between objects with simple geometries
6. **Design** and **evaluate** the performance of parallel/ counter/ cross flow heat exchangers.

Detailed Syllabus:

Unit	Description	Duration (H)
1	**Modes of Heat Transfer and General Heat Conduction Equation:** Modes and Laws of heat transfer, thermal conductivity, thermal diffusivity. Boundary and initial Conditions, Solution of Steady one dimensional heat conduction Problems by applying boundary conditions. One dimensional steady state heat conduction with and without heat generation in plane wall, solid cylinder & sphere, with different boundary conditions.	7
2	**Composite Materials and Extended Surfaces:** Electrical analogy, thermal contact resistance, Thermal resistance network, Application to multi-layered (Composite) plane wall, hollow cylinder and hollow sphere, critical thickness of insulation for cylinder and sphere, economical and cost consideration. Heat transfer from finned surfaces, Types of fins, Governing Equation for constant cross sectional area fin, Solution for infinitely long fin, negligible heat loss from fin tip, short fins (corrected length), Fin efficiency & effectiveness.	8
3	**Transient heat conduction:** Validity and criteria of lumped system analysis, Biot and Fourier number, Transient analysis using lumped system analysis, Time constant and response of thermocouple, Transient heat analysis with special effects by using Heisler and Grober charts.	7

4	**Convective Heat Transfer:** Fundamentals of convection: Mechanism of natural and forced convection; local and average heat transfer coefficient, concept of velocity & thermal boundary layers, External Forced Convection: Dimensionless numbers and their physical significance; Flow over flat plates, cylinders, spheres, empirical correlations for both laminar and turbulent flows; Internal Forced Convection : General Thermal analysis with Constant surface heat flux and constant surface temperature conditions , Empirical correlations for both laminar and turbulent flows in tubes .natural convection: Introduction, dimensionless numbers and their physical significance, Empirical correlations for natural convection over surfaces.	**8**
5	**Thermal Radiation:** Fundamental concepts of radiation, Different laws of radiation, Radiation shape factor, Radiation heat transfer between black surfaces, Radiation heat transfer between Diffuse Gray surfaces, Radiation Shield **Boiling and condensation:** Pool boiling curve, different regimes of boiling heat transfer, critical heat flux, Film and drop wise condensation	**7**
6	**Heat Exchanger:** Classification, applications, concept of overall heat transfer coefficient, fouling factor, Heat exchanger analysis using LMTD for parallel flow and counter flow heat exchange, LMTD correction factor for multi-pass and cross flow heat exchangers by using charts, Effectiveness– NTU method for parallel flow heat exchanger and counter flow heat exchanger, use of charts for multi-pass and cross flow heat exchangers selection of heat exchangers.	**8**
	Total	**45**

Text Books:

1. Y.A. Cengel and A. J. Ghajar, Heat and Mass Transfer – Fundamentals and Applications, Tata McGraw Hill Education Private Limited, 2019
2. F.P. Incropera, D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley, 2009.

Reference Books:

1. J. P. Holman, Heat Transfer, McGraw – Hill publication, 2002.
2. P. K. Nag, Heat and Mass Transfer, McGraw Hill Education Private Limited, 2011
3. R.C. Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, New Age Science, 2009.
4. C.P. Kothandaraman, S.V.Subramanyam, Heat and Mass Transfer Data Book, New Academic, 2008.

Program:	B. Tech. (Mechanical Engineering)			Semester : V		
Course :	Machine Design			Code : BME5411		
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior knowledge of:

a. Engineering Mechanics,
b. Elements of Mechanical Engineering
c. Strength of Materials
d. Engineering Materials and metallurgy
e. Kinematics and Theory of machines
f. Manufacturing Science……. are essential

Course Objectives:

This course aims at enabling the students to:

1. Analyze and define the industrial problem in the domain of machine design, and provide alternate solutions.
2. Choose best solution by evaluation of alternate solutions
3. Present the solution graphically using modern tools for modeling with representation of GD&T.

Course Outcomes:

After learning the course, the students will be able to

1. **Decide** the appropriate design considerations and design the simple machine parts..
2. **DESIGN** the shaft and helical springs for strength and rigidity.
3. **DESIGN** the machine elements subjected to fluctuating stresses.
4. **DESIGN** the power screws and bolted connections for the industrial applications.
5. **SELEC**T a rolling contact bearing for the given application.
6. **DESIGN** the spur gears for the industrial applications

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Design of simple machine elements**- Design, types of design, design cycle, design considerations, Design for manufacture, design for assembly, preferred number and series, use of standards and code in design, Material selection methods, Design of Knuckle joint, design of axially and eccentrically loaded parts.	8
2.	**Design of Machine elements for Strength and Rigidity** Design of shafts, helical compression spring based on strength and rigidity. Design of Splines, Keys, Flange couplings.	8
3.	**Design of Machine elements subjected to fluctuating stresses** S N Diagram, Endurance limit, endurance strength, design of components for infinite and finite life under cyclic loading, Design of parts for infinite and finite life under fluctuating stresses based on Soderberg, Goodman diagrams and Gerber parabola.	8
4.	**Design of Power Screws and bolted connections** **Power screws**- Suitable thread forms, Torque required in overcoming thread friction while lifting and lowering the load, efficiency and self-locking/ overhauling conditions, compound and differential screws,	7

	Bolted connections- Design of eccentrically loaded bolted connections.	
5.	**Rolling Contact Bearings** Classification, selection of bearing type for given application, Static and dynamic load carrying capacity, selection of deep groove and taper roller bearings, Design for varying load and speeds, Bearings with life other than rated life., Bearing mounting and preloading of bearings.	**7**
6.	**Design of Spur Gears** Design of spur gears- Selection of appropriate gear drive for given application, Fundamental geometric relations, Gear tooth failures, Design based on reversed bending stress fluctuating contact stresses, Gear lubrication.	**7**
	Total	**45**

Text Books:

1. V B Bhandari, Design of Machine Elements, Tata McGraw Hill Publication, 4th Edition 2017
2. J K Gupta, R S Khurmi, A test Book of Machine Design, S Chand Publication, 2005.
3. Kamlesh Purohit, K. C. Sharma, Design of Machine Elements - Prentice Hall India Publication, 2002.
4. N. C. Pandya, C. N. Shah, Machine Design, Charotar Publishing, 2006.
5. P C Gope, Machine Design Fundamentals and Applications, , PHI, EEE, 2012.

Reference Books:

1. Robert L Norton, Machine Design: An Integrated Approach, Pearson Education, 2000
2. George E. Dieter, George Ellwood Dieter, Linda C. Schmidt, Engineering Design, McGraw-Hill Education, 2008
3. Richard Gordon Budynas, J. Keith Nisbett, Shigley's Mechanical Engineering Design, McGraw Hill, 2015.
4. V B Bhandari, Machine Design Data Book, , TMH Publication, 2019.
5. Paul H. Black, O. Eugene Adams, Paul H. Black, O. Eugene Adams, Machine Design by, McGraw Hill, 1981
6. Merhyle Franklin Spotts, Terry E. Shoup, Lee Emrey Hornberger, Design of Machine Elements Vol 1 and 2, 2004

e-sources:

NPTEL Course lectures links:

https://www.youtube.com/watch?v=ofmbhbVCUqI&list=PL3D4EECEFAA99D9BE&index=3
https://www.youtube.com/watch?v=__py5xbKHGA
https://www.youtube.com/watch?v=SL21aDqgs8Q
https://youtu.be/PEKfS2Q1WqM
https://www.youtube.com/watch?v=PEKfS2Q1WqM&list=PL3D4EECEFAA99D9BE&index=19
https://www.youtube.com/watch?v=TPURJnlekeo
https://www.youtube.com/watch?v=WRoPQGE0WdI
https://www.youtube.com/watch?v=WRoPQGE0WdI
https://www.youtube.com/watch?v=WRoPQGE0WdI
https://www.youtube.com/watch?v=__py5xbKHGA
https://www.youtube.com/watch?v=YZYcMtkZiDY
https://www.youtube.com/watch?v=__py5xbKHGA
https://www.youtube.com/watch?v=__py5xbKHGA
https://www.youtube.com/watch?v=YZYcMtkZiDY
https://www.youtube.com/watch?v=tTBnW5gAieM
https://www.youtube.com/watch?v=46quOD7V-cQ
https://youtu.be/T4IgtIkBnOo

Program:	B. Tech. (Mechanical Engineering)				Semester : V		
Course :	Fluid Mechanics & Machinery Lab				Code : BME5412		
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Hours	Credit	PR	TW	OR	Total
--	2	2	1	--	25	25	50

Prior knowledge of:

a. Fundamental concepts and laws/governing equations of Fluid Mechanics.
b. Fundamental concepts and laws/governing equations of physics and Mathematics.
are essential

Course Objectives:

1. To learn to use various instruments related to measurement of Pressure, Temperature, Velocity, Flow rate etc.
2. To experimentally verify the principles of Fluid Mechanics
3. To learn to conduct trials of various equipment like turbine, pumps, compressors
4. To learn to evaluate and analyze the performance of equipment like turbine, pumps, compressors

Course Outcomes:

After learning the course, students should be able to

1. Do measurements of flow properties like Pressure, Temperature, Velocity, Flow rate etc
2. To identify the types of flows
3. To experimentally verify the impulse momentum principle
4. To use and calibrate various flow measurement devices
5. To conduct trials on impulse and reaction turbines and analyze the performance.
6. To conduct trials on centrifugal Pump and Compressor and analyze the performance.

Detailed Syllabus:

LIST OF EXPERIMENTS

Any four experiments out of **1 to 7** and **any four** out of **8 to 14** are to be conducted

1. Determination of viscosity of liquids and its variation with temperature.
2. Determination of Laminar and Turbulent flow by Reynolds's apparatus.
3. Verification of modified Bernoulli's equation.
4. Calibration of Orifice meter/ Venturimeter.
5. Determination of hydraulic coefficients of orifice/ V-notch
6. Determination of Major and minor losses through pipes.
7. Measurement of static pressure distribution, lift and drag around an aerofoil using wind tunnel apparatus.
8. Verification of Impulse Momentum Principle
9. Design of Pumping system using industrial manuals.
10. Performance analysis of Impulse Turbine under different conditions.
11. Performance analysis of Reaction Turbine under different conditions.
12. Performance analysis of Centrifugal Pump under different conditions.
13. Performance analysis of Centrifugal Compressor under different conditions.
14. Case study on 'Use of fans/blowers/compressor/pumps in Process Industry. (Student has to visit process industry using any of the listed turbo machines and prepare case study report on the same.)

Text Books:

1. Modi P N & Seth S N, Hydraulics, Fluid Mechanics and Machinery, Standard Book House, New Delhi, 2017
2. Manish Dubey, BVSSS Prasad, Archana Nema ,Turbo-Machinery, , McGraw Hill,2018
3. Chow, V.T. and Maidment, Hydrology for Engineers, McGraw-Hill Inc., Ltd,2014

Reference Books:

1. William W. Perg, Fundamentals of Turbomachinery, John Wiley & Sons,2007
2. S.M. Yahya ,Turbines, Compressors & Fans, Tata-McGraw Hill, 1983
3. B. U. Pai ,Turbomachines, Wiley India,2018
4. Johann Friedrich Gülich ,Centrifugal Pump ,2007cae

Program:	B. Tech. (Mechanical Engineering)			Semester : V			
Course :	Heat Transfer Lab			Code : BME5413			
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Hours	Credit	TW	PR	OR	Total
--	2	2	1	25	50	--	75

Prior knowledge of:

a. Mathematics: Integration and derivatives
b. Steady flow energy equation
c. Concept of boundary layer ……..are essential

Course Objectives:

1. To understand the application of conduction equation to various geometries with and without heat generation
2. To get conversant with transient analysis of lumped systems.
3. To get conversant with methods of determining heat transfer coefficient in natural and forced convection heat transfer
4. To learn estimation radiation heat transfer between objects with simple geometries
5. To get conversant with methods of design and analysis of heat exchanger.

Course Outcomes:

After learning the course, students should be able to

1. Understand the fundamental principles and concept of heat transfer, including conduction, convection and radiation.
2. Acquire practical skills in measuring and analyzing temperature distributions, heat fluxes, and thermal properties of materials.
3. Enhance team work and communication skill through collaborative laboratory work and reporting of experimental result.
4. Understand the importance of safety procedure and precautions when working with high temperature, and heat transfer equipment.
5. Apply theoretical knowledge of heat transfer to real world engineering problems and systems.

Detailed Syllabus:

LIST OF EXPERIMENTS

Any eight experiments (1-11) and two assignments (12-14) from the following list

1. Determination of Thermal Conductivity of metal rod
2. Determination of Thermal Conductivity of insulating powder
3. Determination of Thermal Conductivity of Composite wall
4. Determination of Thermal Contact Resistance
5. Determination of heat transfer coefficient in Natural Convection
6. Determination of heat transfer coefficient in Forced Convection
7. Determination of temperature distribution, fin efficiency in Natural / Forced Convection
8. Determination of Emissivity of a Test surface
9. Determination of Stefan Boltzmann Constant
10. Determination of effectiveness of heat exchanger
11. Study of pool boiling phenomenon and determination of critical heat flux
12. Assignment on 1-D transient heat transfer program using finite difference methods.
13. Assignment to solve transient heat transfer problem using Heisler and Grober charts.
14. Assignment on multi-pass / cross-flow heat exchanger using effectiveness charts.

Text Books:

1. Y.A. Cengel and A. J. Ghajar, Heat and Mass Transfer – Fundamentals and Applications, Tata McGraw Hill Education Private Limited, 2019
2. F.P. Incropera, D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley, 2009.

Reference Books:

1. J. P. Holman, Heat Transfer, McGraw – Hill publication, 2002.
2. P. K. Nag, Heat and Mass Transfer, McGraw Hill Education Private Limited, 2011
3. R.C. Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, New Age Science, 2009.
4. C.P. Kothandaraman, S.V.Subramanyam, Heat and Mass Transfer Data Book, New Academic, 2008.

Program:	B. Tech. (Mechanical Engineering)			Semester : V			
Course :	Machine Design Lab			Code : BME5414			
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Hours	Credit	TW	OR	PR	Total
--	2	2	1	25	50	--	75

Prior knowledge of:

a. Engineering mechanics
b. Strength of materials
c. Engineering materials and metallurgy
d. Kinematics and theory of machines
e. Manufacturing science.
f. Computer-aided machine drawing I & II is essential

Course Objectives:

This course aims at enabling the students to:

1. Conduct Problem analysis, define the real-life problem, and provide the solution.
2. Present the design decisions graphically using modern tools for modeling and drafting.

Course Outcomes:

After completion of the course, students will be able to

1. Design Mechanical components based on design considerations such as strength, rigidity, wear, manufacture, assembly, and weight.
2. Represent the design decisions through the production drawings.

Detailed Syllabus:

Term work shall consist of the following

Design Project: Any ONE topic based on real-life application

i. Design of Power screw in real-life application.

ii. Design of gearbox for industrial applications.

iii. Design of automotive valve operating mechanism.

Design data book shall be used wherever necessary to achieve a selection of standard components leading to a minimum cost of the product being developed.

- The detailed design report containing problem selection, problem analysis, problem definition, Solution based on all applicable design considerations, exclusive summary reflecting final dimensions of parts, Leaflet comprising the final specifications of the product design, cost, and Instructions to the users shall be submitted.
- 2D Part drawing in two views (preferably one sectional view exploring internal features of the parts) with the representation of geometric, dimensional tolerances, surface roughness symbols, and other instructions such as the surface coating and heat treatments to be submitted.
- 2D assembly drawing in two views (preferably one sectional view exploring internal features of the assembly), with the representation of overall dimensions, center distances, dimensions ensuring alignment of parts in assembled condition, locations at which a particular fit is to be achieved, bill of materials representing the OEM parts and parts to be manufactured in-house with a correct representation of materials quantity, costing, Warranty applicable to OEM parts.

Note: 4-5 students shall work together on the design project.

Reference books:

1. V B Bhandari, Machine Design Data Book, , TMH Publication, 2019.
2. Design databook, PSG College of Engineering, Coimbator

Program:	B. Tech. (Mechanical Engineering)					Semester : V
Course :	Design of Fans, Blowers and Compressors (Professional Elective-I)					Code : BME5501A
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	--	3	3	40	60	100

Prior knowledge of:

a. Fundamental concepts and laws/governing equations of Fluid Mechanics.

b. Fundamental concepts and laws/governing equations of Engineering Thermodynamics.

c. Fundamentals of Mathematics…..are essential

Course Objectives:

This course aims at enabling the students to

1. To make the students conversant with the basic principles, governing equations and applications of Fans, Blowers and Compressors in real life and industrial domain.
2. To understand the construction, working principle and evaluate the performance characteristics of Fans, Blowers and Compressors.
3. To develop the competency to identify and analyze the losses and flow instabilities in Fans, Blowers and Compressors.
4. To create awareness about present energy scenario and energy conservation in compressible flow machines through the design modifications.
5. To create awareness about the recent innovations in compressible flow machines

Course Outcomes:

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

1. Apply the impulse momentum principle to different plate profiles and recognize use of turbo machines for enabling a sustainable society.
2. Design Centrifugal Compressors under different fluid flow conditions.
3. Analyze the performance of Axial flow Compressors under different fluid flow conditions.
4. Analyze the performance of Fans and blowers under different fluid flow conditions.
5. Identify the opportunities of energy conservation in the applications of compressed air
6. Identify and appreciate the recent developments in fans, blowers and compressor technology and improvement in their performance

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Fundamentals of Turbomachinery** Classification of Turbomachines, Basic equation of energy transfer between fluid and rotor, Navier Strokes Equation, Impulse Momentum principle and its applications, force exerted by jet of water on flat plate(Fixed, Moving),curved plate at its center or one of the tip(Fixed and Moving),Series of plates(Flat and Curved), Performance analysis of above cases in terms of efficiency and work done.	7
2.	**Centrifugal Compressor** Classification of rotodynamic compressors, blowers and fans.	8

	Centrifugal compressor: Construction and working, flow process on T-S Diagram, velocity diagram and Euler's work, slip factor and its effect on work input, actual work input, dimension parameters, pre-whirl losses, performance characteristics ,surging, choking, and stalling characteristics.	
3.	**Axial Flow Compressor** Construction and working, stage velocity triangles and its analysis, flow process on T-S Diagram , dimensionless parameters, flow through the blade rows, pressure rise across the stage, stage losses and efficiencies, performance characteristics.	**7**
4.	**Fans and Blowers** Classification of Fans and blowers, Basics of stationary and moving air, Eulers characteristics, velocity triangles and operating pressure conditions, governing equations for blowers, Losses and hydraulic efficiency, surge and stall, Applications of blowers and fans.	**8**
5.	**Energy Conservation in Compressed air system** Present energy scenario, Applications of compressed air in industry, Compressed air network, Leak detection in compressed air network, Methods to improve the performance.	**7**
6.	**Recent innovations in compressible flow machines** Recent developments/innovations in fans, blowers and compressor technology for improvement in performance metrics and functionality.	**8**
	Total	**45**

Text Books:

1 Manish Dubey, BVSSS Prasad, Archana Nema ,Turbo-Machinery, McGraw Hill,2018

2 S.M. Yahiya, Turbines, Compressors &Fans,, Tata-McGraw Hill,2005.

3 R. K. Rajput, Thermal Engineering, 2009.

Reference Books :

1 William W. Perg, Fundamentals of Turbomachinery, John Wiley &Sons, 2007.

2 L.C. Witte, P.S. Schmidt, D.R. Brown, Industrial Energy Management and Utilization, Hemisphere Publication Washington, 1988.

3 W.C. Turner, Energy Management Handbook, Wiley, New York, 1982.

Program:	B. Tech. (Mechanical Engineering)				Semester : V	
Course :	Incompressible Flow Machines (Professional Elective-I)				Code : BME5501B	
Teaching Scheme				Evaluation Scheme		
Lecture	Tutorial	Hours	Credits	FA	SA	Total
3	--	3	3	40	60	100

Prior knowledge of:

a. Fundamental concepts and laws/governing equations of Fluid Mechanics.
b. Fundamental concepts and laws/governing equations of Engineering Thermodynamics.
c. Fundamentals of Mathematics……are essential

Course Objectives: Students are expected to study,

1. To make the students conversant with the basic principles, governing equations and applications of Hydraulic turbines and water resource devices in real life and industrial domain.
2. To understand the construction, working principle and evaluate the performance characteristics of Hydraulic Turbines and rotary pumps.
3. To develop the competency to identify & analyze the losses and flow instabilities in Hydraulic Turbines & rotary pump
4. To create awareness about present energy scenario and hydro potential.
5. To make the students conversant with the various industrial pumps.

Course Outcomes: The Students will be able to,

1. Apply the impulse momentum principle to different plate profiles and recognize use of Turbomachines for enabling a sustainable society.
2. Estimate load factor, utilization factor, capacity factor of Hydropower plants
3. Design Impulse water Hydraulic Turbines and Analyze the performance of under different fluid flow conditions.
4. Design Reaction water Hydraulic Turbines and Analyze the performance of under different fluid flow conditions.
5. Design rotary pumps and Analyze the performance under different fluid flow conditions.
6. Select pumps for various industrial applications

Detailed Syllabus:

Unit	Description	Duration (H)
1	**Fundamentals of Turbomachinery:** Classification of Turbomachines, Basic equation of energy transfer between fluid and rotor, Impulse Momentum principle and its applications, force exerted by jet of water on flat plate(fixed, moving),curved plate at its center or one of the tip(Fixed and Moving),Series of plates(flat and curved), Performance analysis of above cases in terms of efficiency and work done.	8
2	**Basics of Hydropower Plants:** Classification of Hydropower plants, Definition of terms – load factor, utilization factor, Capacity factor, estimation of hydropower potential. Hydropower development in India.	7
3	**Impulse Water Turbine:** Classification of Hydraulic Turbines, Working principle, construction, velocity diagram, Multijet Pelton Wheel, design aspects ,Performance parameters, characteristics curves, Unit Quantities, specific speed, Selection of Turbines	8
4	**Reaction Water Turbine:** Classification of Reaction water turbines, Working principle, construction, velocity diagram, degree of reaction, Performance parameters, characteristics curves, Draft Tube-types and analysis, Cavitation, Governing of water Turbines	7
5	**Rotary Pumps:** Classification of rotodynamic pumps, components of centrifugal pump, types of heads, velocity triangles and their analysis, effect of outlet blade angle, cavitation, NPSH, Thoma‟s cavitation factor, priming of pumps, specific speed, performance characteristics of centrifugal pump, series and parallel operation of pumps, system resistance curve, selection of pumps.	8
6	**Industrial Pumps:** Turbine Pumps, API Process Pumps, Canned Motor Pumps, Circulator Pumps, Drum Pumps, Submersible Pumps, End Suction Pumps, Grinder Pumps, Chopper Pumps, Booster Pumps, Syringe Pumps.	7
	Total	45

Text Books:

1. Manish Dubey, BVSSS Prasad, Archana Nema ,Turbo-Machinery,McGraw Hill,2018.
2. Chow, V.T. and Maidment, “Hydrology for Engineers”, McGraw-Hill Inc., Ltd,1987.
3. P N Modi &Seth ,Fluid Mechanics and Hydraulic Machines , Standard book house,2006.

Reference books:

1. Subramanya, K., “Engineering Hydrology”, Tata McGraw-Hill Publishing Co., Ltd,1994.
2. Johann Friedrich Gülich,Centrifugal Pump ,2007.

Program:	B. Tech. (Mechanical Engineering)				Semester : V	
Course:	Steam & Gas Turbines (Professional Elective-I)				Code: BME5501C	
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credits	FA	SA	Total
3	-	3	3	40	60	100

Prior Knowledge of:

a. Fundamental concepts and laws/governing equations of Fluid Mechanics.
b. Fundamental concepts and laws/governing equations of Engineering Thermodynamics.
c. Fundamentals of Mathematics…….. are essential.

Course Objectives:

This course aims at enabling the students to

1. To make the students conversant with the basic principles, governing equations & applications of Steam & Gas Turbine.
2. To understand the construction, working principle & evaluate the performance characteristics of Steam and Gas Turbine.
3. To create awareness about the present energy scenario and the recent innovations in Steam and Gas Turbine.

Course Outcomes:

After learning the course, students should be able to

1. Apply the impulse momentum principle to different plate profiles and recognize use of turbomachines for enabling a sustainable society.
2. Analyze the energy transfer through the steam nozzles.
3. Analyze the performance of Steam Turbine under various conditions.
4. Analyze the performance of Gas turbine under various conditions.
5. Apply the principle of energy conversion, design parameters and recognize use of Steam and Gas Turbine for enabling a sustainable society.
6. Identify and appreciate the recent innovations in design and performance of steam and gas turbines and improvement in their performance.

Detailed Syllabus:

Unit	Description	Duration (H)
1	**Fundamentals of Turbomachinery:** Classification of Turbomachines, Basic equation of energy transfer between fluid and rotor, Navier Strokes Equation, Impulse Momentum principle and its applications, force exerted by jet of water on flat plate(fixed, moving),curved plate at its center or one of the tip(Fixed and Moving),Series of plates(flat and curved), Performance analysis of above cases in terms of efficiency and work done.	**8**
2	**Steam Nozzle:** Stagnation Properties- Function of nozzle – Applications and Types- Flow through nozzles- Thermodynamic analysis – Assumptions -Velocity of nozzle at exit-Ideal and actual expansion in nozzle- Velocity coefficient- Condition for maximum discharge, Critical pressure ratio- Criteria to decide nozzle shape- Super saturated flow, its effects, Degree of super saturation and Degree of under cooling - Wilson line.	**7**
3	**Basics of Steam Turbines** Construction and working of Impulse and Reaction steam turbine, velocity diagram, characteristics curves, governing of steam turbines, losses in steam turbine.	**8**
4	**Multistage Steam Turbine** Need, significance and types of multistaging of steam turbine, Velocity Triangles ,Stage Efficiency, The Stage Inlet Flow Profiles, Selecting the Blade Row Geometry, Dimensionless Performance Parameters, Airfoil Geometry, Selection of blade geometry	**8**
5	**Gas Turbines:** General layout of GTPP, components of GTPP, open, closed &semi- closed cycle gas turbine plant, Brayton cycle analysis for thermal efficiency, work ratio, maximum &optimum pressure ratio, inter-cooling; reheating & regeneration cycle gas and steam turbine combined cycle plant, environmental impacts of GTPP.	**7**
6	**Recent developments in steam and gas turbine technology** Recent innovations in design and other aspects to improve the performance metrics of steam and gas turbine.	**7**
	Total	**45**

Text Books:

1. R. Yadav, Steam and Gas Turbines and Power Plant Engineering, VII edition, Central Publ. House,2021.
2. R. K. Rajput,Thermal Engineering ,2009

Reference Books:

1. Manish Dubey, BVSSS Prasad, Archana Nema ,Turbo-Machinery, McGraw Hill,2018
2. A.S. Leyzerovich, Steam Turbines for Modern Fossil-Fuel Power Plants, 2006.
3. Claire Soares, Gas Turbines: A Handbook of Air, Land and Sea Applications, 2014.

Program:	B. Tech. (Mechanical Engineering)			Semester : V		
Course :	Internal Combustion Engines (Professional Elective-I)			Code: BME5501D		
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior knowledge of:

a. Fundamental concepts of Thermodynamics
b. Air standard cycles for I. C. Engines….. are essential

Course Objectives:

1 To get familiar with the construction and working various engine systems
2 To understand the methods of theoretical analysis of I. C. engines
3 To learn the theory of combustion of S. I. and C. I. engines
4 To have understanding of various engine performance parameters and methods of measurement
5 To get familiar with the alternative fuels , pollution form I.C. engine and methods of controlling it

Course Outcomes:

After learning the course, the students will be able to

1 Compare various Engine sub systems based on their advantages, drawbacks and applications.
2 Analyze Fuel-Air cycles and actual cycles of I. C. Engines based on various parameters.
3 Analyze the P-theta diagram of S.I. Engine for stages of combustion, rate of pressure rise, abnormal combustion etc
4 Analyze the P-theta diagram of C.I. Engine for stages of combustion, rate of pressure rise, abnormal combustion etc.
5 Calculate the performance parameters of I. C. Engines and analyze the performance characteristics curves.
6 Compare various alternative fuels based on the desirable properties for their utilization in I.C. Engines

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Engine systems :** Heat Engine, IC and EC engines, Engine classification ,I.C. Engine construction - components and materials, Engine nomenclature, Comparison of S.I. & C.I., 4-s and 2-s Engines, Applications. Valve operating system, Valve timing diagram (Theoretical & Actual), Cooling System, Lubrication System, Ignition System, Governing system, Starting System	8
2.	**Engine Cycles:** Fuel air cycle analysis and its importance, Assumptions and considerations, Effect of variables specific heat, dissociation, Effect of A/F ratio, Comparison with air standard cycle, Comparison of Fuel Air cycle, Air Standard cycle and Actual cycle, various losses in actual cycles, Effect of parameters on losses in actual cycle.	8
3.	**SI Engines:** Fuel supply system of S. I. Engine: Air Fuel mixture requirements, Simple carburetor, systems of carburetor, Electronic fuel injection system T.B.I , M.P.F.I., G.D.I. System, sensors, actuators and ECU. Combustion in spark Ignition engines, stages of combustion, factors affecting combustion, rate of pressure rise, abnormal combustion: Detonation, Preignition. Combustion chambers of S.I. Engine, Rating of fuels in SI engines, Additives.	8

4.	**CI Engines:** Fuel supply system of C.I. engine, Mechanical Fuel Injection system, Quantity of fuel injected and size of nozzle, Electronic Diesel Injection system, sensors, actuators and ECU. Combustion in compression ignition engines, stages of combustion, factors affecting combustion, Phenomenon of knocking in CI engine. Types of combustion chambers, rating of fuels in CI engines, Dopes & Additives, Comparison of knocking in SI & CI engines, Supercharging and turbo-charging methods and their limitations	**7**
5.	**Engine Performance & Testing:** Engine performance parameters, Methods of determination of various performance parameters, Engine performance characteristic curves, heat balance sheet.	**7**
6.	**Fuels and Emissions Control:** Important qualities of S.I. & C.I. Engine fuels, Possible alternative fuels: Alcohols, C.N.G., L.P.G., Biodiesel, Hydrogen etc. Engine modifications for use of alternative fuels. Air pollution due to IC engine and its effect, Emissions Norms, Sources of emissions, Components of emission from S.I. & C.I. Engines and their causes, Measurement of emission, Emission control methods for SI and CI engines.	**7**
	Total	**45**

Text Books:

1 M.L. Mathur and R.P. Sharma, A course in Internal combustion engines, Dhanpat Rai Publication, New Delhi,2016
2 V. Ganesan: Internal Combustion Engines, Tata McGraw-Hill,2012
3 S. Shrinivasan, Automotive Engines, Tata McGraw-Hill,2019

Reference Books:

1 John B. Heywood, Internal Combustion Engine Fundamentals, Tata McGraw-Hill,1988
2 R. Yadav, Internal Combustion Engine, Central Book Depot, Ahmedabad, 2003
3 H.N. Gupta, Fundamentals of Internal Combustion Engines, PHI Learning Pvt. Ltd.,2011

Program:	B. Tech. (Mechanical Engineering)					Semester: V
Course:	Product Design and Development (Professional Elective-II)					Code: BME5502A
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior knowledge of:

a. Basic Engineering Science
b. Material Science
c. Engineering Metallurgy
d. Manufacturing processes…..are essential

Course Objectives:

To explain student's significance of

1. Product design and Product development process
2. Concept design and detailed design related aspects.
3. Design Aspects (DFA, DFMEA, Design for Reliability)
4. Human factors in design and importance of patents in PDD process.

Course Outcomes:

On completion of the course, students will be able to –

1. Analyze Product Design and its specifications.
2. Evaluate the product design using engineering simulation.
3. Measure the product dimensions to understand reverse engineering.
4. Apply various design processes as DFA, DFMEA, and design for reliability.
5. Integrate the Rapid Prototyping knowledge with available systems for better product development.
6. Compare the product features for the product validation plan.

Detailed Syllabus:

Unit	Description	Duration, (H)
1.	**Introduction to the Product Design Process and its specifications** Types of design, essential factors of product design vs. analysis, influence of design on cost and quality, product life-cycle, Problem statement, customer needs, product design specifications, Quality Function Deployment.	7
2.	**Conceptual Design** Establishing product functions; functional decomposition, morphological analysis; concept creation, concept selection. **Detail Design** Computer aided design (CAD) modeling, design simulation, manufacturing documentation, engineering drawings.	8
3.	**Reverse Engineering** Product Teardown Process, Tear Down Methods, Force Flow Diagrams, Measurement and Experimentation, Applications of Product Teardown, Benchmarking Approach and Detailed Procedure, Tools Used in Benchmarking Indented Assembly Cost Analysis, Function -Form Diagrams, Trend Analysis, Setting Product Specifications, Introduction to Product Portfolio and Architecture.	8
4.	**Design for X**	7

	Factors influencing process selection; fabrication guidelines; design for manufacturing, design for assembly. Design for Reliability Failure modes and effects analysis (FMEA).	
5.	**Additive manufacturing and tooling** Need of Additive manufacturing, Classification of AM processes-Benefits- Applications. Stereolithography Apparatus (SLA), Fused deposition Modeling (FDM), Laminated Object Manufacturing (LOM), Selective Laser Sintering (SLS), Rapid Tooling.	**8**
6.	**Human Factors in Design** Principles of user-friendly designs; human factors engineering, Validation plan, Digital Vs Actual. Design for Sustainability, Green design; design for zero waste; design for disassembly, Intellectual property, Intellectual property and patents	**7**
	Total	**45**

Textbooks:

1. A. K. Chitale and R.C. Gupta, Product Design and Manufacturing, PHI Learning Pvt. Ltd., 2013

2. George Dieter, Engineering Design, McGraw Hill Pub. Company, 2012.

References:

1. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson Education, 2001
2. Michael Grieves, Product Lifecycle Management, TATA McGraw Hill Publication, 2006
3. James Bralla, Handbook of Product Design for Manufacturing, McGraw Hill, 1996
4. Karl Ulrich, product design and development, TATA McGraw Hill Publication, 2020
5. Rochelle Cooper Dreyfuss and Jane C. Ginsburg, Intellectual Property at the Edge: The Contested Contours of IP2, Cambridge University Press., 2014

E-Sources:

NPTEL Course lectures links:

https://nptel.ac.in/courses/112107217 (Product Design and Development-IIT Roorkee)

https://onlinecourses.nptel.ac.in/noc21_me83/preview(Product Design and Development-IIT Roorkee)

https://onlinecourses.nptel.ac.in/noc22_hs59/preview (Intellectual Property By Prof. Feroz Ali | IIT Madras)

Program:	B. Tech. (Mechanical Engineering)					Semester: V
Course:	Smart Manufacturing (Professional Elective-II)					Code: BME5502B
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	--	3	3	40	60	100

Prior knowledge of:

a. Mathematical skills
b. Basic programming skills
c. Traditional manufacturing processes….are essential

Course Objectives:

1. The concept of smart factories for the future, especially the various technical pillars of smart manufacturing.
2. The role and importance of each technical pillar involved within smart manufacturing.
3. The applications and scope for technological pillars involved in smart manufacturing.

Course Outcomes:

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

1. Understand the key concepts and describe the technological pillars of smart manufacturing.
2. Comprehend the relevance of big data in smart manufacturing and compare the different tools used for big data analytics.
3. Understand the role of cloud computing and how cloud computing is applied to protect cyber-physical systems in smart manufacturing.
4. Apply the knowledge of sensors and robots for designing a smart manufacturing system.
5. Understand the role of simulation techniques and how these software tools used for advanced simulations in smart manufacturing.
6. Explain the hardware and software technologies used in AR and VR.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Technological Pillars of Smart Manufacturing:** Background of industrial revolution, Concept of smart factories, PLC system, Technological pillars of Smart Manufacturing, Technological impact of smart manufacturing, Framework, Applications.	8
2.	**Big data in Smart Manufacturing:** Overview of big data, data driven smart manufacturing, data lifecycle, introduction to big data analytics, different tools used for analytics, its application and limitations	6
3.	**Cloud computing and Cybersecurity in Industry 4.0:** Introduction to computing and its types, cloud computing and its benefits, cloud computing in industry 4.0, introduction to cybersecurity, security principles, risk and opportunities in cyber security technology	8
4.	**Industrial Robotics and Sensors in Smart Manufacturing:** Introduction, Recent Technological Components of Robots- Advanced Sensor Technologies, Internet of Robotic Things, Cloud Robotics, and Cognitive Architecture for Cyber-Physical Robotics, Industrial Robotic and sensors,0- Applications, Manufacturing, Maintenance and Assembly	8
5.	**Simulation and Artificial Intelligence in Smart Manufacturing:** Introduction to different simulation techniques, applications of simulation for smart industry, Interactive simulation, software for advance simulations and its limitations	8
6.	**Virtual and Augmented Reality in Smart Manufacturing:** Introduction, Difference in AR and VR, Hardware and Software Technology, Industrial Applications of Augmented reality and Virtual reality	7
	Total	45

Text Books:

1. Smid P., CNC Programming Handbook, Industrial Press, 2005
2. Leong W., Nine pillars of technologies for Industry 4.0, IET publishers, 2020
3. Gilchrist A., Industry 4.0: The Industrial Internet of Things, Apress, 2017

Reference Books:

1. Alp Ustundag and Emre Cevikcan, Industry 4.0: Managing the Digital Transformation, Springer, 2018.
2. Bartodziej, Christoph Jan, The Concept Industry 4.0: An Empirical Analysis of Technologies and Applications in Production Logistics, Springer, 2016
3. Klaus Schwab, The Fourth Industrial Revolution, World Economic Forum, 2017
4. Christian Schröder, "The Challenges of Industry 4.0 for Small and Medium-sized Enterprises, Friedrich-Ebert-Stiftung, 2016
5. Chua C K, Leong K F, Lim C S, Rapid Prototyping, World Scientific, 2012

E-sources: www.nptel.ac.in/courses/108105003

Program:	B. Tech. (Mechanical Engineering)					Semester : V
Course :	Advanced Materials & Manufacturing (Professional Elective-II)					Code : BME5502C
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	--	3	3	40	60	100

Prior knowledge of:

a. Materials Engineering
b. Manufacturing Science……are essential

Course Objectives:

1. To introduce advanced and exotic materials.
2. To establish the significance of material selection in engineering design.
3. To explore new design opportunities.
4. To select and analyze special forming processes for the product under consideration.
5. To select and analyze advanced joining processes for the product under consideration.
6. To understand and analyze the basic mechanisms of hybrid non-conventional machining techniques.

Course Outcomes:

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

1. **Analyze** different materials in advanced engineering applications.
2. **Relate** structure and properties of new materials in engineering applications.
3. **Evaluate and select** materials for advanced engineering applications.
4. **Classify and analyze** special forming processes.
5. **Analyze and identify** the applicability of advanced joining processes.
6. **Understand and analyze** the basic mechanisms of hybrid non-conventional machining techniques.

Detailed Syllabus:

Unit	Description	Duration (H)
1	Advanced and exotic materials: Biomaterials, Nanomaterials, Aerogels, Superconductors, Carbon Nanotubes.	7
2	Smart Materials, Piezoelectricity, Magnetostriction, Smart Polymers, Shape Memory Alloys.	7
3	Introduction to Nano, Nano-biomimicry, Synthesis of nanomaterials by physical and chemical methods, Synthesis of nanomaterials by biological methods, Characterization of nanomaterials.	8
4	Special Forming Processes: Principle, machines, process variables, process capabilities and applications of High Energy Rate Forming process (HERF), High-Velocity Forming (HVF), Explosive Forming, Magnetic Pulse Forming, Electro-Hydraulic Forming, Petro-Forge Forming, Micro Forming, Micro Bending/Laser Bending.	8
5	Advanced Joining Techniques: Principle, process variables, process capabilities and applications of Friction Stir Welding, Electron Beam Welding, Laser Beam Welding, Explosive Joining, Cold Metal Transfer Welding, Ultrasonic Welding, Cryogenic Welding, Thermal Spray Coatings.	7
6	Advanced Machining Techniques: Diamond Turn Machining, Ultrasonic Micromachining, Focused Ion Beam Machining, Photochemical Machining, Introduction to hybrid processes, Magnetic Abrasive Finishing, Electrochemical Grinding (ECG), Shaped Tube Electrolytic Machining (STEM), Electro-jet Machining (EJM), Electrolytic In-process dressing (ELPD), Ultrasonic assisted EDM, Rotary EDM, Electrochemical Discharge Machining (ECDM), Laser surface treatments.	8
	Total	45

Text Books:

1. W.D. Callister, Material Science and Engineering: An Introduction, Wiley publication, 2014.
2. V. K. Jain, Advanced Machining Processes", Allied Publishers Pvt. Ltd., 2009
3. M. P Groover., Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Wiley 2015.
4. A. Ghosh, A. K. Mallik, Manufacturing Science, Affiliated East-West Press Pvt. Ltd., New Delhi, 2010.

Reference Books:

1. Malsch, N.H., Biomedical Nanotechnology, CRC Press. 2005.
2. L.F. Pease, R.M. Rose and J. Wulff, Electronic Properties (Volume IV: Structure and Properties of Materials), Pearson, 2015.
3. ASM: Metal Handbook, Volume 6, "Welding, Brazing and Soldering", Metal Park, Ohio, ASM International, 2011.
4. ASM: Metal Handbook, Volume 1indust4, "Forming", Metal Park, Ohio, ASM International, 2011
5. R. Balasubramaniam, RamaGopal V. Sarepaka, Sathyan Subbiah, Diamond Turn Machining: Theory and Practice, CRC Press, 2017.
6. V. K. Jain, Micromanufacturing Processes, CRC Press, 2018.

Program:	B. Tech. (Mechanical Engineering)			Semester: V		
Course:	Design Thinking (Professional Elective-II)			Code: BME5502D		
Teaching Scheme				Evaluation Scheme		
Lecture	Tutorial	Hours	Credit	FA	SA	Total
3	--	3	3	40	60	100

Prior knowledge of:

a. Problem solving and Analytical skill is essential

Course Objectives:

1. To highlight the importance of thinking and creativity and impart the skills needed for enhancing design thinking
2. To introduce the concept of design thinking and understanding of design process

Course Outcomes:

The students will be able to,

1. Develop a user centric mindset while designing, innovating and creative problem-solving.
2. Understand challenges and benefits of design Thinking.
3. Investigate design problems and generate ideas by creative thinking.
4. Practice design Thinking for defining the Problem

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Design Thinking tools** Concept of Design Thinking and Its Role within NPD and Innovation, Framework of Design Thinking, Principles and the "Mindset" of Design Thinking, Identifying Customer Needs, Product Specifications	8
2.	**Phases of Design Thinking** - Empathize, Define	7
3.	**Applied Creativity** Creativity, brainstorming, and concept generation process in designing.	8
4.	**Phases of Design Thinking** - Ideate, Design Heuristics – Opposite, Concept, User needs,	7
5.	**Phases of Design Thinking** - Prototype and Test	8
6.	Apply Agile method to developing software, Design an App using the principles of Design Thinking, Develop an App for Android	7
	Total	45

Text Books:

1. Design Thinking, M G Luchs, K C Swan, Wiley-Blackwell, 2015

Reference books:

1. Design Thinking Methodology, Emrah Yayici , Publisher Emrah Yayici, 2016
2. Designing for Growth: A design thinking toolkit for Managers, Tim Ogilvie ,Columbia Business School Publishing
3. Integrated Design Engineering - Interdisciplinary and Holistic Product Development, Sándor Vajna, Springer International Publishing,Springer (2020)

Assignments:

1. Use of Idea Generation software
2. Case Study - Analyzing existing product for improvement.

Program:	B. Tech. (Mechanical Engineering)			Semester: V		
Course:	Design for Reliability (Professional Elective-II)			Code: BME5502E		
Teaching Scheme				Evaluation Scheme		
Lecture	Tutorial	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior knowledge of:

a. Probability and statistics
b. Numerical methods……are essential

Course Objectives:

1. To impart a basic understanding of probability and statistical techniques used in reliability engineering.
2. To make the learner aware of applications of probability distributions in modeling and analyzing failure data.
3. To be familiar with the techniques used in system reliability modeling and analyze warranty data.
4. To provide a basic understanding of the use of probabilistic approaches to design components and predict reliability
5. To explain the concept of reliability allocation
6. To introduce the concepts of reliability testing.

Course Outcomes: The students will be able to,

1. Use the basics of reliability and its measures for analyzing components and systems.
2. Apply probability distributions to estimate reliability functions such as reliability, CDF, PDF, hazard rate, etc.
3. Develop system reliability models to solve system reliability problems and analyze warranty data.
4. Apply probabilistic approaches for components design and reliability prediction.
5. Use reliability allocation methods to allocate reliability requirements at product design stage.
6. Select a suitable reliability testing method.

Detailed Syllabus:

Unit	Description	Duration (H)
1	**Introduction and Basic Reliability Mathematics** Reliability Engineering in 21st Century, Concept of failure, reliability, maintainability and availability, Reliability objectives, How to meet reliability objectives. **Basic reliability mathematics:** Universe, Population, Sample, PDF, Reliability function, CDF, Moments of time to failure - MTTF, MTBF, the median time to failure, mode, skewness, kurtosis, variance and standard deviation, Hazard rate function, Bathtub curve	7
2	**Probability Distributions and Their Applications in Product Design** Discrete probability distribution - Binomial distribution, Poisson distribution. **Continuous Probability Distributions** – Weibull, exponential, normal (Gaussian), lognormal, estimation of reliability metric such as life of the component, warranty period, reliable life, etc. Concept of confidence interval	8
3	**System Reliability Modeling and Warranty Analysis** Failure Modes and Effects Analysis (FMEA), Fault Tree Analysis (FTA), Reliability Block Diagrams (RBDs), Root cause analysis **Warranty Analysis** Product warranties, warranty return information, warranty policies, warranty and reliability, warranty cost analysis, warranty and reliability management, Use of software for warranty analysis	8

4	**Probabilistic Design for Reliability and factor of safety –** Design for reliability, Design of a tension element, Reliability models for probabilistic design, Relationship between reliability, the factor of safety and variability, Functions of random variables, Steps for probabilistic design. **Reliability Predictions from Stress-Strength Models -** Physics of failure, Reliability from stress-strength distributions, Reliability from similar stress-strength distribution**s,** Maintainability – types of maintenance, models for maintenance data modeling, Availability – types, steady-state availability, Markov chains	**8**
5	**Reliability Allocation** Definition, Reliability allocation methods – equal allocation, weighting factor, and optimal reliability allocation. **Weighting factor methods –** ARINC, AGREE, Feasibility of objectives, Aggarwal's method, Integrated factor. **Optimal reliability allocation methods:** Redundancy allocation, Cost minimization problem formulation.	**7**
6	**Reliability Testing** Introduction to reliability testing, Stress strength interaction, Introduction to Markov model Testing for Reliability and Durability- Accelerated Life Testing and Highly Accelerated Life Testing (HALT), highly accelerated stress Screening (HASS). Reliability in manufacturing- Production FRACAS.	**7**
	Total	**45**

Text Books:

1. An Introduction to Reliability and Maintainability Engineering by C. E. Ebeling, Waveland Press inc., 2019.
2. Reliability Engineering by K. C. Kapur, and M. Pecht, Wiley, 2014.
3. Design Reliability: Fundamentals and Application by B. S. Dhillon, CRC Press, 1999.
4. Reliability Engineering and Life Testing by V. N. A. Naikan, PHI Learning, 2008.

Reference books:

1. Reliability Engineering by E. Balagurusamy, Tata McGraw Hill, 2017.
2. Reliability Engineering and Risk Analysis – A practical Guide by M. Modarres, K. Kaminsky, and V. Krivstov, CRC Press, Taylor and Francis Group, 2017.
3. Practical Reliability Engineering by P. D. T. O'Conner, John Wiley and Sons, 2012.
4. Life cycle reliability engineering by G. Yang, John Wiley and Sons, 2007.
5. Engineering Maintainability by B. S. Dhillon, Prentice Hall of India, 1999.

Program	B. Tech. (Mechanical Engineering)			Semester : V		
Course :	Statistical Data Analysis Using R (Open Elective – II)			Code : BAS5607		
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior Knowledge of:

a. Descriptive Statistics
b. Inferential Statistics
c. Probability…….are essential.

Course Objectives:

1. This course aims at enabling the students to learn data collection, visualization, and preprocessing techniques for data science.

Course Outcomes:

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

1. **Understand** the data properties and **identify** the R packages related to data science.
2. **Make use of** data preprocessing methods and generate quality data for analysis.
3. **Apply** different data visualization techniques to understand the data.
4. **Analyze** the data using analytical methods for regression for numerical data using the R.
5. **Develop** a model for Prediction and Decision Making for a data set along with some of their characteristics, strengths, limitations, and applications.
6. **Construct** the hypothesis for the data and test it for data set in R.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Introduction to data analysis and R Software fundamentals** Understanding the Data, R Packages for Data Science, Importing and Exporting Data in R Software, Getting Started: Analyzing Data in R Software, Accessing Databases with R Software.	7
2.	**Data Wrangling** Pre-processing Data in R Software, Dealing with Missing Values in R Software, Data Formatting in R Software, Data Normalization in R Software, Binning in R Software, Turning categorical variables into quantitative variables in R Software.	8
3.	**Data Visualization in R Software** Histogram, Bar/ Line Chart, Box Plot (including group-by option), Scatter Plot (including 3D and other features), Mosaic Plot, Heat Map, Correlogram (GUIs)	8
4.	**Data Analysis** **Statistical Data Analysis:** Probability, Sampling & Sampling Distributions **Exploratory Data Analysis:** Central & Descriptive Statistics, Hypothesis Testing.	7
5.	**Model Development** Linear regression and multiple linear regression, model evaluation using visualization, prediction and decision making	8
6.	**Data Analysis Using R** Use a dataset from kaggle (Link is given below). Identify the problem statement for the given data and by applying data analysis techniques analyze the data. Draw inferences from the data. https://www.kaggle.com/code/cvaisnor/heart-2020/data https://www.kaggle.com/code/kailash068/crop recommendation/data https://www.kaggle.com/datasets/debajyotipodder/co2-emission-by-vehicle https://www.kaggle.com/datasets/csafrit2/higher-education-students-performance-evaluation	7
	Total	**45**

Reference Books:

1. Montgomery and Runger, “Applied Statistics and Probability for Engineers”, Wiley, India, 6 Edition, ISBN: 9788126562947.
2. R. Johnson, “Probability and Statistics for Engineers”, Prentice India Ltd, 8 Edition, ISBN 13:978-8120342132.
3. S.P.Gupta, “Statistical Methods”, Papperbook publication, 43 edition, ISBN: 9788180549892, 8180549895.
4. Victor A. Bloomfield, “Using R for Numerical Analysis in Science and Engineering”, CRC Press, First Edition, ISBN: 9781315360492

e-sources: NPTEL Course lectures links:

1. https://www.youtube.com/watch?v=VVYLpmKRfQ8&list=PL6C92B335BD4238AB (Probability)
2. https://nptel.ac.in/courses/111104100 (Introduction to R software)
3. https://www.youtube.com/watch?v=WbKiJe5OkUU&list=PLFW6lRTa1g83jjpIOte7RuEYCwOJa- 6Gz (Descriptive statistics using R software)

Program:	B. Tech. (Mechanical Engineering)			Semester : V		
Course:	Total Quality Management (Open Elective – II)			Code: BCI5602A		
Teaching Scheme				Evaluation Scheme		
Lecture	Tutorial	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior Knowledge of:

a. Quality and need of Quality in any work

Course Objectives: After Completing this course, student will have adequate background :

1. To understand the importance of Quality
2. To understand the need of Total Quality Mgmt & its tools.
3. To understand role of ISO in quality management

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

1. Articulate quality and quality ideas as presented by many gurus and philosophers after learning.
2. Apply different quality control tools.
3. Apply ISO concepts and the cost of quality to quality assurance.
4. Apply various methods of TQM.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Quality in Construction** a) Quality – Various definitions and interpretation. Importance of quality on a project in the context of global challenges, Factors affecting quality, Reasons for poor quality & measures to overcome, Contribution of various Quality Gurus (Juran, Deming, Crossby, Ishikawa). b) Evolution of TQM- QC, TQC, QA, QMS, TQM.	7
2.	**TQM & Six Sigma** a) TQM – Necessity, advantages, Quality Function Deployment (QFD). b) Six sigma – Importance, levels.	8
3.	**Cost of Quality and ISO** a) Categories of cost of Quality. b) Study of ISO 9001 principles., Quality manual – Importance, contents, documentation, Corrective and Preventive actions, Conformity and NC reports	8
4.	**Techniques in TQM Implementation** a) Benchmarking in TQM, Kaizen in TQM, b) '5-S'techniques, Zero Defects.	8
5.	**Applications of Quality Control tools through Case study** a) Quality Circle Concept and applications through Quality Circle Formation b) Implementation of 7 QC tools through case study	7
6.	**Failure Mode Effect Analysis** a) FMEA problems b) Decision Tree problems	7
	Total	45

Text Books:

1. Total Quality Management-- Dr. Gunmala Suri and Dr. Puja Chhabra Sharma—Biztantra.
2. Quality Control and Total Quality Management by P.L.Jain- Tata McGraw Hill Publ.
3. Total Quality Management - Dr. S.Rajaram and Dr. M. Sivakumar—Biztantra.
4. Total Engineering Quality Management – Sunil Sharma – Macmillan India Ltd.

Program:	B. Tech. (Mechanical)			Semester : V		
Course :	Intelligent Transport System (Open Elective – II)			Code: BCI5602B		
Teaching Scheme				Evaluation Scheme		
Lecture	Tutorial	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior Knowledge of:

a. Fundamentals of Transportation and Traffic engineering

b. Transportation Planning and Designing……..are essential

Course Objectives: After Completing this course, student will have adequate background :

1. To learn all the aspects related to intelligent transportation system and its application
2. To use the fundamental concepts of transportation system management.
3. To train the students to develop their career in transportation industry

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

1. Describe the fundamentals and principles of Intelligent transport system and its background
2. Demonstrate the knowledge of telecommunication practices in Intelligent transport system
3. Distinguish the physical architecture and hardware composition in the implementation of Intelligent transport system
4. Implement the Intelligent transport system concepts in various transportation domains
5. Explain the user needs and services in the context of implementing effective strategies
6. Identify and evaluate the practical constraints in the implementation of the technology and the grass root level.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Introduction:** Introduction to Intelligent Transportation Systems (ITS) – Definition of ITS and Identification of ITS Objectives, Historical Background, Benefits of ITS - ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection	7
2.	**Telecommunications in Intelligent Transport System:** Telecommunications in ITS – Importance of telecommunications in the ITS system, Information Management, Traffic Management Centers (TMC). Vehicle – Roadside communication – Vehicle Positioning System	8
3.	**Intelligent Transport System architecture and Hardware:** Architecture – ITS Architecture Framework – Hardware Sensors – Vehicle Detection – Techniques – Dynamic Message Sign – GPRS – GPS – Toll Collection	8
4.	**Intelligent Transport System Functional Area:** Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS).	7
5.	**Intelligent Transport System User Needs and Services:** Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management.	8

6.	**Case Studies:** Automated Highway Systems - Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries	**7**
	Total	**45**

Text Books:

1. Ghosh, S., Lee, T.S.,"Intelligent Transportation Systems: New Principles and Architectures", CRC Press, 2000.
2. Mashrur A. Chowdhury, and Adel Sadek, "Fundamentals of Intelligent Transportation Systems Planning", Artech House, Inc., 2003.

Reference Books:

1. Intelligent Transport Systems, Intelligent Transportation Primer, Washington, US, 2001.
2. Henry F.Korth, and Abraham Siberschatz, Data Base System Concepts, McGraw Hill, 1992.
3. Turban E.,"Decision Support and Export Systems Management Support Systems", Maxwell Macmillan, 1998.
4. Sitausu S. Mittra, "Decision Support Systems – Tools and Techniques", John Wiley, New York, 1986.
5. Cycle W.Halsapple and Andrew B.Winston, "Decision Support Systems – Theory and Application", Springer Verlog, New York, 1987.

Standard Codes:

1. ITS Hand Book 2000: Recommendations for World Road Association (PIARC) by Kan Paul Chen, John Miles.
2. Automotive Industry Standard by MoRTH, 2017 https://morth.nic.in/sites/default/files/Finalized_Draft_AIS_140_regarding_Intelligent_Transportation_Systems_.pdf

E-Resources:

1. **https://nptel.ac.in/courses/105105204**
2. **https://archive.nptel.ac.in/courses/105/101/105101008/**
3. **https://www.civil.iitb.ac.in/tvm/nptel/591_ITS_1/web/web.html**
4. **https://ocw.mit.edu/courses/1-212j-an-introduction-to-intelligent-transportation-systems-spring-2005/pages/lecture-notes/**

Program:	B. Tech. (Mechanical Engineering)			Semester: V		
Course:	Data Structures Using Python (Open Elective-II)			Code: BCE5601		
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior knowledge of:

a. Python Programming is essential.

Course Objectives:

1. To understand Python Specific Data Structures.
2. To illustrate and demonstrate Stacks, Queues.
3. To understand how searching and sorting is performed in Python.
4. To understand how linear and non-linear data structures.
5. To learn the fundamentals of writing Python scripts.
6. To learn the operations on tree and graph data structure.

Course Outcomes:

After learning the course, students will be able to:

1. Elaborate the basic concepts of data structure and python programming
2. Comprehend the searching & sorting algorithms.
3. Explore the data structures using Python Programming.
4. Apply concepts of linear and non-linear data structures.
5. Use effective data structures for solving real-time problems.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Introduction to Data Structures** Introduction to Python programming, Data Structures – Definition, Linear Data Structures, on-Linear Data Structures, Python Specific Data Structures - List, Tuples, Set, Dictionaries, Comprehensions and its Types, Strings, slicing. Arrays - Overview, Types of Arrays, Operations on Arrays, Arrays vs. List.	8
2.	**Searching and Sorting Techniques** Searching - Linear Search and Binary Search Sorting - Bubble Sort, Selection Sort, Insertion Sort, Merge Sort and Quick Sort.	7
3.	**Linked List** Linked Lists – Introduction, Implementation of Singly Linked Lists, Doubly Linked Lists, Circular Linked Lists	8
4.	**Stack & Queue** Stacks - Overview of Stack, Implementation of Stack, Applications of Stack, Queues- Overview of Queue, Implementation of Queue, Applications of Queues, Priority Queues.	8
5.	**Tree** Trees - Overview of Trees, Tree Terminology, Binary Trees - Introduction, Implementation. Tree Traversals, Binary Search Trees- Introduction	7
6.	**Graph** Introduction, directed vs. Undirected Graphs, Weighted vs. Unweighted Graphs, Representations - Adjacency Matrix, Adjacency list, Graph Traversals - Breadth First Search, Depth First Search.	7
	Total	45

Text Books:

1. Data structures and algorithms in python by Michael T. Goodrich, ISBN-13: 978-1118290279, ISBN-10: 1118290275, Publisher: Wiley; 1st edition (March 18, 2013).
2. Problem Solving with Algorithms and Data Structures Using Python by Bradley N Miller and David L. Ranum. ISBN-13: 978-1590282571, ISBN-10: 1590282574, Publisher: Franklin, Beedle & Associates; 2nd edition (August 22, 2011).

Reference Books:

1. Hands-On Data Structures and Algorithms with Python: Write complex and powerful code using the latest features of Python 3.7, 2nd Edition by Dr. Basant Agarwal, Benjamin Baka. ISBN: 9781788991933, 2018.
2. Core Python Programming -R. Nageswara Rao, ISBN-10: 9789351199427, ISBN-13: 978-9351199427, Willy; 1st edition (January 1, 2016).

Program:	B. Tech. (Mechanical Engineering)			Semester: V		
Course:	Programming with C++ (Open Elective-II)			Code: BCE5602		
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior knowledge of:

a. Python Programming is essential.

Course Objectives:

1. To explore the principles of Object-Oriented Programming (OOP).
2. To use the concept of inheritance and polymorphism.
3. To understand the use of exception handling in C++ programs.
4. To provide a foundation for advanced programming using File handling and STL.
5. To provide lifelong learning attitude towards problem solving.

Course Outcomes:

After learning the course, students will be able to:

1. Identify the need of object-oriented programming to solve computational problems.
2. Demonstrate the use of inheritance in object-oriented programming.
3. Apply the concept of overloading and virtualization.
4. Illustrate exception handling in object-oriented programming.
5. Discuss the use of input and output stream in C++.
6. Analyze the usage of template classes and the STL library in C++.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Introduction of OOPs Concepts** Overview of procedural programming and object-oriented programming, Syntax of variables declaration, Classes and objects, Member functions, memory management. **Case Study:** Write a program in c++ to create an employee class with appropriate features.	8
2.	**Inheritance** Introduction, benefits, Access specifiers, Types of inheritance - single, multiple, multilevel, hybrid and hierarchical. **Case Study:** Write a program in c++ to derive class bicycle from class vehicle with appropriate syntax.	7
3.	**Polymorphism** Introduction, Types of polymorphism: function and operator, Virtual functions, Pure virtual functions, Virtual base class, Overloading and overriding. **Case study:** Write a program in c++ to overload '+' and '-' operator.	8
4.	**Exception Handling** Introduction to exception, Benefits of exception handling, try, throw and catch blocks, pre-defined exceptions in c++, Re-throw. **Case Study:** Write a program in c++ to create a class student with name, age, roll no and telephone number as parameters. Program should throw an exception if telephone_number >10.	7

5.	**File Handling** Classes for file stream operation, Opening and closing a file, File pointers and their manipulation, File operations on binary files – variables, class objects, sequential file organization, Direct access files. **Case Study:** Write a program in c++ to create a database for airline reservation system using file handling.	**8**
6.	**Templates** Introduction, Function templates, Class template with multiple parameters. **Introduction to STL: Introduction** of STL components, Sequential container, Algorithms, Iterators. **Case Study:** Write a program in c++ to create vector template using STL container.	**7**
	Total	**45**

Text Books:

1. E. Balagurusamy, "Object -Oriented Programming with C++", McGraw Hill Education, Eighth Edition, Sept. 2020, ISBN-13: 978-9389949186.
2. Ivor Horton, Peter Van Weert, "Beginning C++20", Novice Professional, Sixth Edition, 2020, ISBN-13: 978-1484258835 (ISBN-10: 1484258835)
3. Robert Lafore, "OOP in C++", Pearson Publishing, 4th Edition, 2001, ISBN:0672323087 (ISBN 13: 9780672323089).

Reference Books:

1. Bjarne Stroustrup, The C++ Programming language, Third edition, 2008, Pearson Education. ISBN 9780201889543.
2. Deitel, C++ How to Program, 4 th Edition, Pearson Education,2002, ISBN:81-297-0276-2.
3. Herbert Schildt, C++ the complete reference, Eighth Edition, McGraw Hill Professional, 2011, ISBN:978-00-72226805.

MOOC Courses:

1. An Introduction to Programming Through C++, NPTEL, 12 weeks

Program:	B. Tech. (Mechanical Engineering)					Semester: V
Course:	Smart City: An Electronic Perspective (Open Elective-II)					Code: BET5601
Teaching Scheme				Evaluation Scheme		
Lecture	Tutorial	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior knowledge of:

a. Basic Electronics
b. Basics of electronic communications……are essential

Course Objectives:

1. To explore need and basics of smart city and fundamental concepts of IoT.
2. To elucidate the roles of sensors and protocols in IoT
3. To explain different IoT framework and networking protocols.

Course Outcomes:

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

1. Understand the conceptual basis of a smart city.
2. Analyze physical and logical designs for IoT systems with communication protocols.
3. Analyze the different wireless communication protocols used in sensor networks.
4. Compare the features, addressing, packet fragmentation, operation, and security of the different wireless protocols.
5. Describe distributed intelligence and central planning in a smart city.
6. Interpret the role of ICTs in the development of smart cities using IoT applications.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Necessity of SMART CITY**: The Smart City Philosophy, Development of Asian Cities, Megacities of India, : Current Challenges, The India Story of Smart Cities, Conceptual Basis of a Smart City, Global Smart City Programs, Recommendations for Smart City Framework.	7
2.	**Fundamentals of IOT:** History of IoT, Introduction, definition and characteristics of IoT, architecture of IoT, Physical & logical design of IoT, Enabling technologies in IoT, Identifiers in IoT,M2M communication verses IoT.	8
3.	**Sensor Networks:** Definition, types of sensors & actuators, examples & working, RFID Principles and components, Wi-Fi, Bluetooth, etc. ireless sensor network: History, sensor node, networking nodes, WSN versus IoT.	7
4.	**Wireless Protocols for Smart Cities:** IPv6overLow-Power Wireless Personal Area Network: Features, Addressing, Packet fragmentation, Operation, Security. ZigBee: Architecture Objectives, Wireless Networking Basics, Wireless Networking Assumptions, Bluetooth Low Energy, IoT data protocols: MQTT Protocol. COAP Protocol, AMQP Protocol.	8
5.	**Distributed Intelligence and Central Planning:**On the Interplay between Humans and Smart Devices, Theoretical Tools, Intelligence-artificial Intelligence (Machine Intelligence), Information Dynamics, Synergetic, Information Dynamics and Algometry in Smart Cities.	7
6.	**Applications of IoT in smart city: The Role of ICTs:**Applications in smart city & their distinctive advantages -smart environment, smart street light and smart water & waste management. Smart transportation and hospitality, Role and scope of IOT in present and future marketplace. Industrial IoT.	8
	Total	45

Text Books:

1. Surjeet Dalal ,Vivek Jaglan “Green Internet of Things for Smart Cities: Concepts, Implications, & challenges” , CRC Press; 1st edition.
2. Sudip Misra, Anandarup Mukherjee, Arijit Roy, “Introduction to IoT” Cambridge University Press.
3. HakimaChaouchi,“TheInternetofThingsConnectingObjectstotheWeb”ISBN:978-1-84821-140-7, Wiley Publications
4. Olivier Hersent, David Boswar thick, and Omar Elloumi,“The Internet of Things: Key Applications and Protocols”, Wiley Publications.

Reference Books:

1. Vincenzo Piuri, Rabindra Nath Shaw,“AI and IoT for Smart City Applications” ,Springer; 1st ed. 2022 edition.
2. Alfredo Barton, Raymond Manning, “Smart Cities:Technologies, Challenges and Future Prospects” Nova Science Pub Inc
3. Ibrahim El Dimeery, Moustafa Baraka, Syed M. Ahmed, “Design and Construction of Smart Cities” Amin Akhnoukh,Springer; 1st ed. 2021 edition
4. Ricardo Armentano, Robin Singh Bhadoria ,Parag Chatterjee , “The Internet of Things: Foundation for Smart Cities”, eHealth, and Ubiquitous Computing” Chapman and Hall/CRC; 1st edition
5. DanielMinoli,“BuildingtheInternetofThingswithIPv6andMIPv6:TheEvolvingWorldofM2MCommunications”,ISBN: 978-1-118-47347-4,WillyPublications
6. PethuruRajandAnupamaC.Raman,"TheInternetofThings:EnablingTechnologies,Platforms,andUseCases",CRCPress

NPTEL Online Courses / MOOCs

1. NPTEL course on Fundamentals of Electric vehicles: Technology & Economics, IIT Madras, Prof. Ashok Jhunjhunwala Prof. Prabhjot Kaur Prof. Kaushal Kumar Jha Prof. L Kannan

   https://nptel.ac.in/courses/108106170
2. NPTEL course on Electric Vehicles - Part 1, IIT Delhi, Prof. Amit Jain https://nptel.ac.in/courses/108102121
3. NPTEL Archives on Electric vehicles and renewable energy, IIT Madras https://archive.nptel.ac.in/courses/108/106/108106182/
4. Electric Vehicles Comprehensive Course, Udemy.com https://www.udemy.com/course/electric-vehicles-comprehensive-course/

Program:	B. Tech. (Mechanical Engineering)					Semester: V
Course:	Modeling and Simulation with MATLAB (Open Elective-II)					Code: BET5602
Teaching Scheme				Evaluation Scheme		
Lecture	Tutorial	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior knowledge of:

a. Engineering Mathematics
b. Basics of OOPs .....are essential

Course Objectives:

1. To apply basic modeling techniques and tools to develop Simulink block diagrams.
2. To Model and simulate continues and discrete systems in Simulink.
3. To get acquainted with neural networks and its modeling
4. To get acquainted with fuzzy set and its modeling.

Course Outcomes:

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

1. Understand the basic tools used in Matlab programming
2. Understand the techniques of modeling in the context of hierarchy of knowledge about a system and develop the capability to apply the same to study systems.
3. Understand different types of simulation techniques.
4. Understand different optimization methods.
5. Simulate the models for the purpose of optimum control by using software.
6. Design and simulate the Fuzzy controllers to solve engineering problems

Detailed Syllabus:

Unit	Description	Duration (H)
1	**Introduction to Matlab:** Programming environment, input and output variables, State variables, basic syntax; Deterministic linear model, Array mathematics in Matlab, Plotting, Static and Dynamic systems; Hierarchy of knowledge about a system and Modeling Strategy.	6
2	**Physical Modeling:** Dimensions analysis, Dimensionless grouping of input and output variables of find empirical relations, similarity criteria and their application to physical models. Stochastic modeling.	7
3	**Modeling of System with Known Structure:** Review of conservation laws and the governing equation for heat, mass and momentum transfer, Deterministic model: distributed parameter models in terms of partial identification and their solutions and lumped parameter models in terms of differential and difference equations, state space model, transfer functions block diagram and sub systems, stability of transfer functions, modeling for control.	8
4	**Optimizations and Design of Systems:** Summary of gradient based techniques: Nontraditional Optimizations techniques, genetic Algorithm (GA)- coding, GA operations, elitism, Application using MATLAB: Simulated Annealing, Introduction to GUI,GUI Programming.	7
5	**Introduction to Neural Network Modeling**: Basics of Neural Network, Neural Network Modeling of Systems only with Input-output Database: Neurons, architecture of neural networks, knowledge representation, learning algorithm. Multilayer feed forward network and its back propagation learning algorithm, Application to complex engineering systems and strategy for optimum output.	9
6	**Modeling Based on Expert Knowledge**: Fuzzy sets, Membership functions, Fuzzy Inference systems, Expert Knowledge and Fuzzy Models, Design of Fuzzy Controllers, Simulation of Engineering Systems: Monte-Carlo simulation, Simulation of continuous and discrete processes with suitable examples from engineering problems.	8
	Total	45

Text Books:

1. Zeigler B.P. Praehofer. H. and Kim I.G. "Theory of modeling and simulation", 2 nd Edition. Academic press 2000
2. Ogata K “Modern control Engineering" 3 rd edition. Prentice hall of India 2001
3. Jang J.S.R. sun C.T and Mizutani E,, "Neuro-Fuzzy and soft Computing ", 3 rd edition, Prentice hall of India 2002
4. Shannon, R. E., “System Simulation: the Art and Science”, Prentice Hall Inc. 1990
5. Pratab.R " Getting started with MATLAB" Oxford university Press 2009

Reference Books:

1. Steven I Gordon. Brian Guilfoos.“Introduction to modeling and simulation using MATLAB & Python” CRC press.
2. Dr.Shailendra Jain.” Modeling and simulation using MATLAB-Simulink “,2 nd Edition,Wiley

Online course link: https://in.mathworks.com/learn/training/simulink-fundamentals.html

Program:	B. Tech. (Mechanical Engineering)			Semester : V		
Course :	Object Oriented Programming (Open Elective-II)			Code : BIT5601		
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior Knowledge of:

a. C Programming is essential.

Course Objectives:

1. To learn the fundamentals of object-oriented concepts and programming.
2. To develop problem-solving skills using object oriented programming concepts.
3. To apply the concepts of object-oriented paradigm.
4. To develop programming skills using object oriented programming concept.

Course Outcomes:

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

1. Demonstrate the key object oriented concepts.
2. Apply functions for given real life data
3. Apply operator overloading to develop programs
4. Design hierarchy of classes using inheritance.
5. Make use of polymorphism using virtual functions for solving real life problems.
6. Develop application which handles different types of exceptions

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Fundamentals of Object Oriented Programming:** Object Oriented Paradigm, Features of Object-Oriented Programming: Objects and Classes, Data Abstraction and Encapsulation, Inheritance, Polymorphism, Dynamic Binding, Message Communication. Visibility/Access Control, Constructors and Destructors, Operators, Static data members and member functions, Arrays and reference variables.	6
2.	**Functions** :Function prototypes, Default and Const arguments, Object as a function argument and returning object, Passing argument by reference, Returning a reference, Inline functions, Function overloading, Friend function.	7
3.	**Operator Overloading**: Rules of operator overloading, overloading the unary and binary operators using member and friend function, overloading relational and assignment operator.	7
4.	**Inheritance**: Need of inheritance, base and derived classes, member accessibility, types of inheritance, derived class constructor, constructors in multiple inheritance, overriding member functions, virtual base class.	9
5.	**Virtual Functions** : Pointers, Pointers to objects, 'this' pointer, Pointers to derived classes, virtual functions, Pure virtual functions, abstract class, virtual destructors.	7
6.	**Exception Handling:** Introduction, Exception handling mechanism: try, catch and throw, Multiple Exceptions, Exceptions with arguments	9
	Total	45

Text Books:

1. E. Balaguruswamy, "Object-oriented Programming with C++", Tata McGraw Hill, 7th edition.
2. Robert Lafore, "Object-Oriented Programming in C++", SAMS Techmedia

Reference Books:

1. Herbert Schildt, "C++: The Complete Reference", McGraw-Hill.
2. Kogent, "Object-Oriented Programming Methodology", Wiley, ISBN-9789351191841

Online References:

1. Coursera Course on C++ Basics:Selection and iteration offered by C- Codio, available online at https://www.coursera.org/learn/codio-cpp-basics
2. NPTEL Course Lecture Links on "Programming in C++" offered by IIT, Karagpur, available online at "https://nptel.ac.in/courses/106105151"

Program:	B. Tech. (Mechanical Engineering)			Semester: V		
Course :	Principles of Management (HSMC-V)			Code: BHM5113		
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
2	-	2	2	30	20	50

Course Objectives:

This course aims at enabling students

1. To help the students gain understanding of the functions and responsibilities of managers and common frameworks used in business organizations.
2. To enable the students to analyze and understand the environment of the organization.
3. To provide them tools and techniques to be used in the performance of the managerial job.

Course Outcomes:

After learning the course, the students will be able to

1. **Understand** the concept of Management and Strategic Management with their implications.
2. **Identify** the importance of human resource in every organization.
3. **Apply** necessary skills to incorporate innovative management in various business sectors.
4. **Analyze** organizational ecology in various business domains.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Introduction to Management & Strategic Management** Concepts of Management, Definition of Management; Evolution of Management Thought: - Introduction to Scientific Management and Administrative Management, Is Management an Art, Science or Profession, Functions of Management, Levels of Management and Corresponding Skills, Four Roles of Manager, Concept of Strategic Management, Strategic Management Process, Vision and Mission, Contemporary Challenges faced by Management.	7
2.	**Organizational Ecology** : Concept & Definition of Organization, Organization and its Characteristics, Types of Business Organizations, Concept of Business Environment, Internal Factors of Business Environment, SWOT Analysis and PESTLE Analysis, Adapting to the Change in Environment, Assessing Success in Organization and Managing Change, Competitive Dynamics with examples. Case studies based on Business Environment	7
3.	**Organizational Design and Leadership**: Concept of Organization Design, Process of Organizational Design, Types of Organizational Design : Traditional and Contemporary Organizational Designs, Concept of Organizational Development, Process of Organizational Development, Concept of Organizational Culture, 4 Types of Organizational Cultures & their influences, Concept and definition of Leadership, Leader and Manager, Types of Leadership Styles.(Each concept to be explained with Case study / Examples)	8
4.	**Innovative Management** : Concept of Innovation, Creativity & Invention and its need. Concept and Definition of Innovative Management. Definition of Design Thinking, Stages in the Design Thinking Process, The Design Thinking Multi-Stage Model, What is the Difference between Project-Based Learning (PBL), Understanding by Design (UbD), and Design Thinking (DT). (Class Activity : Brain Storming on Innovative Management)	8
	Total	30

Text Books:

1. George R. Terry, Stephen G. Franklin; Principles of Management, A.I.T.B.S. Publishers

Reference Books:

1. Stephen Robbins, Organizational Behavior, New Delhi: Prentice- Hall, 2005
2. Veerabhadrappa and Havinal; Management and Entrepreneurship, New Age International Publishers, 2011
3. Chaudhary Omvir, Singh Prakash; Principles of Management, New Age International Publishers, 2011

e-sources:

1. https://nptel.ac.in/courses/122106031
2. https://www.coursera.org/learn/principles-of-management

Program:	B. Tech. (Mechanical Engineering)			Semester : V		
Course:	CAE Analysis (PFC–III)			Code : BME5913		
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
--	2	2	--	--	--	--

Prior knowledge of:

a. Solid Mechanics,
b. Numerical and Statistical Methods
c. Engineering Mechanics,
d. Manufacturing Science…….are essential

Course Objectives:

The objective of Course is to,

1. To provide the information on various types of CAE analysis and various commercial software available in the market for CAE.
2. To provide a practical knowledge of the finite element methods and the skills required to analyze engineering problems with commercially available FEA software‘s.

Course Outcomes:

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

1. DEFINE the use of CAE tools and DESCRIBE the significance of shape functions in finite element formulations.
2. APPLY the various meshing techniques for better evaluation of approximate results.
3. APPLY material properties and boundary condition to SOLVE 1-D and 2-D element stiffness matrices to obtain nodal or elemental solution.
4. ANALYZE steady state thermal problems.
5. EVALUATE and SOLVE Static structural analysis problems
6. GENERATE the results in the form of contour plot by the USE of CAE tools.

Detailed Syllabus:

Practical	Description	Duration (H)
1	Part I ● Introduction to Computer Aided Engineering (CAE) ● Use of CAE in Product development and its applications to engineering problems ● Discretization method commonly used (FEM) for CAE. ● Use of application software and different available software ● CAE Tools- Pre-processor, Solver and Post-Processor. ● Nodal unknowns and shape function (Quadratic function)	4
2	Part II ● Fundamentals of finite elements, application to solid mechanics: Introduction to bar, truss elements, beam elements, constant strain triangle (CST). ● Meshing Techniques: Discretization of a Structure, 1D, 2D and 3D element Meshing, Use of Symmetry, Mesh quality (Skewness, orthogonal quality, Aspect ratio, etc.), Mesh independent test.	4
3	● 1D Bar Element – Structural Linear Analysis ● Truss Analysis using 1D Element	4
4	● Thermal Analysis – Static Analysis ● Coupled Analysis- (Structural + Thermal)	4
5	● Modal Analysis – Spring -Mass system, simply supported/Cantilever beam, etc. ● Analysis of Machine Component using 3D Elements	4
6	● Mini Project and Presentation on advanced applications of FEA	4
	Total	24

Text Books:

1. Gokhale N. S., Deshpande S. S., Bedekar S. V. and Thite A. N., Practical Finite Element Analysis, Finite to Infinite, Pune, 1st Edition, 2008
2. The Finite Element Method and Applications in Engineering Using ANSYS® by Madenci, Erdogan, Guven, Ibrahim (Springer) Seshu P., ―Text book of Finite Element Analysis‖, PHI Learning Private Ltd., New Delhi, 2010.

Program:	B. Tech. (Mechanical Engineering)			Semester : V		
Course :	Professional Development Training-I (MC-I)			Code : BHM5917		
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Tutorial	Credit	FA	SA	Total
3	-	-	-	-	-	-

Course Objectives:
This course aims at enabling the students
1. To enhance the logical reasoning skills of the students and improve the problem-solving abilities.
2. To improve the overall professional development of students.

Course Outcomes: Students will be able to
After learning the course, the students will be:
1. Having adaptive thinking and adaptability through various Quantitative ability concepts.
2. Having critical thinking and innovative skills
3. Having interest in lifelong learning & developing verbal competencies in the students.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Modern Maths** Profit loss, Ratio & Proportion, LCM & HCF, Time speed and Distance, Average, Mean, mode, median, permutation & combination, Probability, Pipe & systems, Mixture validation, Allegations and Mixtures, Simple Interest and Compound Interest.	6
2.	**Algebra** Linear equations, Quadratic equations, Triplets. **Geometry** Triangles, Polygons (questions on Area Perimeter).	6
3.	**Mensuration** Cube cuboids cone cylinder sphere (questions on volume surface Area) **Trigonometry** **Number System** **Statistics.**	6
4.	**Logical Reasoning** Clocks and Calendar, Direction sense, Family tree, Syllogism, Seating arrangement, Team formation, Coding and Decoding, Number Series and Letter Series, Ranking and Arrangements, Game-Based Aptitude.	6
5.	**Data Interpretation** Data charts, Data tables, Bar, Pie, Line graphs, Venn diagram.	6
6.	**Verbal Ability & Reading Comprehension** Subject-Verb Agreement, Articles and Other Determiners, Prepositions, Tenses, Parts of Speech, Active and Passive Voice, Direct and Indirect Speech, Error Spotting and Sentence Correction, Sentence Completion, Synonyms and Antonyms, Reading Comprehension, Para Jumbles.	6
	Total	36

Reference Books:

1. Arun Sharma, Quantitative Aptitude, 2016, 7th Edition, McGraw Hill Education Pvt. Ltd.
2. ETHNUS, Aptimithra, 2013, 1stEdition, McGraw-Hill Education Pvt.Ltd.
3. R S Aggarwal, Quantitative Aptitude For Competitive Examinations, 2017, 3rd Edition, S. Chand Publishing, Delhi.
4. M. Tyra, Quicker Maths, 2018, 5th edition, 2018, BSC publishing company Pvt. Lt.

** Students should get a passing grade if they will clear at least two online aptitude tests and achieve minimum criteria of attendance.

Program:	B. Tech. (Mechanical Engineering)			Semester: V		
Course :	Environmental Sciences (AUDIT-II)			Code :BHM9961		
Teaching Scheme				Evaluation Scheme		
Lecture	Tutorial	Hours	Credit	FA	ETE	Total
1	-	1	-	-	-	-

Prior knowledge : Nil

Course Objectives:

1. To gain an understanding on the concepts and strategies related to sustainable development and identify and analyze various conservation methods for renewable and non-renewable resources.
2. To examine biotic and abiotic factors within an ecosystem and to identify energy flow in ecosystem.
3. To understand the value of biodiversity and identify current efforts for its conservation at national and local level
4. To provide a comprehensive overview of environmental pollution and technology associated with monitoring and control.

Course Outcomes:

After completion of this course, the students will be able to,

1. Demonstrate an integrative approach to environmental issues with a focus on sustainability and identify the role of organism in energy transfer in different ecosystem.
2. Distinguish between renewable and non-renewable resources and analyze consumption of resources
3. Identify key threats to biodiversity and develop appropriate policy options for it‘s conservation.
4. Analyze the impact of environmental pollution and the science behind those problems and potential solutions.

Detailed Syllabus:

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

Text Books:

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

Reference Books:

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

Course Syllabus

TY B Tech

Semester-VI

Program:	B. Tech. (Mechanical Engineering)					Semester : VI
Course :	Numerical Methods and Optimization					Code : BME6413
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
2	-	2	2	40	60	100

Prior knowledge of:

a. System of linear equations,
b. Partial differentiation
c. Problem-solving and programming …….are essential

Objectives:

Students are expected to study,

1. Effectively use Numerical Techniques for solving complex Mechanical engineering problems
2. Develop logical sequencing for the solution procedure.
3. Optimize the solution for different real-life problems with available constraints.

Outcomes:

The students will be able to,

1. **Use** appropriate numerical methods to solve the root of equations, simultaneous equations, and integration-based mechanical engineering problems.
2. **Develop** regression models and predict the system's behaviour for the experimental data.
3. **Estimate** the solutions for ordinary and partial differential equations.
4. **Generate** solutions for real-life problems using optimization techniques

Detailed Syllabus

Unit	Description	Duration (H)
1.	**Solution of Linear algebraic equations** **Root of an equation:** Bisection Method, Newton Raphson method **Simultaneous equations:** Gauss Elimination Method with Partial pivoting, Gauss-Seidel method and Thomas algorithm for Tri-diagonal Matrix. **Numerical Integration:** Trapezoidal rule, Simpson's 1/3rd Rule, Simpson's 3/8th Rule.	8
2.	**Curve Fitting and Regression Analysis** **Curve Fitting:** Least square technique- Straight line, Power equation, Exponential equation and Quadratic equation. **Regression Analysis:** Nonlinear regression, multi regression analysis, Lagrange's Interpolation, Newton's Forward interpolation.	7
3.	**Solution of Differential Equations** **Ordinary Differential Equations [ODE]:** Euler Method, Modified Euler Method, Runge-Kutta 2nd order and 4th order method. **Partial Differential Equations [PDE]:** Finite difference method, Simple Laplace method, PDEs-Parabolic explicit solution.	8
4.	**Optimization** Introduction to optimization, Classification, Constrained optimization: Graphical and Simplex method (limited to two variables), Nonlinear Optimization, Modern Optimization Techniques (theoretical treatment only)	7
	Total	30

Textbook:

1. Steven C. Chapra, Raymond P. Canale, Numerical Methods for Engineers, McGraw-Hill Higher Education, 2010
2. Dr. B. S. Garewal, Numerical Methods in Engineering and Science, Khanna Publishers, 2013
3. Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, Tata Mc-Graw Hill Publishing, 2022
4. Rao V. Dukkipati, Applied Numerical Methods using Matlab, New Age International Publishers, 2020

References:

1. Gerald and Wheatley, Applied Numerical Analysis, Pearson Education, 2003
2. E. Balagurusamy, Numerical Methods, Tata McGraw Hill, 2017
3. P. Thangaraj, Computer Oriented Numerical Methods, Prentice Hall India, 2008
4. S. S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall India, 2012

Program:	B. Tech. (Mechanical Engineering)					Semester : VI
Course :	Mechatronics					Code : BME6414
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior knowledge of:

a. Applied Mathematics
b. Metrology and Mechanical Measurements is essential

Course Objectives:

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

1. To understand the principles of electrical actuators and its selection according to the applications.
2. To study the data acquisition system and its various components.
3. To understand the different control systems, modeling and analysis of mechanical system.
4. To study the basics of fluid power systems and its applications
5. To utilize the concepts of the PLC system and ladder programming.

Course Outcomes:

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

1. SELECT appropriate electrical actuator for any mechatronics system.
2. UTILIZE the concept of DAQ and signal processing to interface any sensor to acquire the data.
3. DETERMINE the transfer function and PREDICT the stability of the mechanical system.
4. IDENTIFY and APPLY the basics fluid power components to CREATE the hydraulic /pneumatic circuits.
5. DESIGN and DEVELOP a ladder programming for mechanical applications.
6. DESIGN and ANALYSE the PID controller for mechanical system.

Detailed Syllabus:

Units	Description	Duration (H)
1	**Electrical Actuators:** Classification of actuators; DC motors: PMDC and BLDC; AC motors: induction motor; Special purpose motors: Stepper motor and servo motor; Selection of motors and its applications; electro-mechanical solenoid.	7
2	**Data Acquisition & Control System:** Introduction to DAQ, Components of a Data Acquisition System; Sampling, Aliasing, Sample and hold circuit, Quantization; Analog-to-digital converters (4 bit Successive Approximation type ADC); Digital-to-Analog converters (4 bit R2R type DAC); Basics of LabVIEW; Numerical.	8
3	**Mathematical Modelling & Analysis:** Introduction to control systems, need, Types- Open and Closed loop; Concept of Transfer Function, Block Diagram & Reduction principles; Numerical; Transfer Function based modeling of Mechanical system; Concept of Poles & Zeros, Stability Analysis using Routh Hurwitz Criterion; Numerical.	8
4	**Introduction to Fluid Power:** Basics of fluid power, Fluid power system components: Hydraulic Gear Pump; Reciprocating air compressor Linear and rotary actuators (Single acting and double acting cylinder, air motor); Direction control valves, Pressure control valve; Flow control valve, proportional valve; Standard Symbols of fluid power components; Industrial applications.	7
5	**Programmable Logic Controller (PLC) :** Introduction to PLC, Architecture of PLC; Specifications of PLC; Ladder Logic programming for different types of logic gates; Latching, Timers, Counters; PLC programming; and its mechatronics applications.	8

6	**PID control:** Introduction to controllers; Need for control; Proportional (P), Integral (I) and Derivative (D) control actions; PI, PD and PID control systems in parallel form; PID tuning; Numerical.	**7**
	Total	**45**

Text Books:

1. William Bolton, Mechatronics: Electronics Control Systems in Mechanical and Electrical Engineering, 6th Ed, 2019
2. K.P. Ramchandran, G.K. Vijyaraghavan, M.S. Balasundaram, Mechatronics: Integrated Mechanical Electronic Systems, Willey Publication, 2008
3. Esposito A, Fluid Power with application, Prentice Hall
4. Majumdar S.R, Oil Hydraulic system- Principle and maintenance, Tata McGraw Hill
5. Majumdar S.R, Pneumatics Systems Principles and Maintenance, Tata McGraw Hill
6. Stewart H. L, Hydraulics and Pneumatics , Taraporewala Publication

Reference Books:

1. Alciatore and Histand, Introduction to Mechatronics and Measurement Systems, 5th Ed, 2019
2. Bishop (Editor),Mechatronics – An Introduction CRC 2006
3. Mahalik, Mechatronics – Principles, concepts and applications, Tata Mc-Graw Hill publication, New Delhi
4. C.D.Johnson, Process Control Instrumentation Technology, Prentice Hall,New Delhi 5. Bolton, Programmable Logic Controller, 4th Ed, Newnes, 2006
5. Bolton, Programmable Logic Controller, 4th Ed, Newnes, 2006
6. Pipenger J.J, Industrial Hydraulics, McGraw Hill
7. Pinches, Industrial Fluid Power, Prentice Hall
8. Yeaple, Fluid Power Design Handbook
9. Andrew A. Parr, Hydraulics and Pneumatics, Elsevier Science and Technology Books

ISO - 1219, Fluid Systems and components, Graphic Symbols

e-sources:

1. https://www.elprocus.com/what-is-a-biosensor-types-of-biosensors-and-applications/
2. https://www.elprocus.com/color-sensor-working-and-applications/
3. https://www.youtube.com/watch?v=kbjCGGTXqUo&ab_channel=Controlengineering
4. https://youtu.be/clTA0pONnMs?list=PLHMDN3JFtE5wEz95H2XuzRaafK3fUsaki
5. https://nptel.ac.in/content/storage2/courses/108105063/pdf/L12(SS)%20(IA&C)%20((EE)NPTEL).pdf

https://nptel.ac.in/content/storage2/courses/112104158/lecture5.pdf

Program:	B. Tech. (Mechanical Engineering)					Semester : VI	
Course :	Design Engineering Lab					Code : BME6415	
Teaching scheme				Evaluation Scheme			
Lecture	Practical	Hours	Credit	TW	PR	OR	Total
--	2	2	1	25	-	25	50

Prior knowledge of:

a. Engineering Mechanics,
b. Manufacturing Process,
c. Strength of Materials,
d. CAMD I & II
e. Machine Design, is essential

Course Objectives:

After completion of the course, students will have adequate background, conceptual clarity and knowledge of

1. To enable student, select materials and to design internal engine components.
2. To introduce student to optimum design and use optimization methods to design mechanical components.
3. To enable student to design machine tool gearbox.
4. To enable student to design material handling systems
5. To enable student to design cylinders and pressure vessels and to use IS code

Course Outcomes:

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

1. Design various mechanical systems like pressure vessels, machine tool gearboxes, material handling systems, and I C Engine for the specifications stated/formulated problem.
2. Represent the design decisions through production drawing.

Contents of Term Work:

	Description	Duration (H)
	The term work shall include Any one design project as detailed below	
Design Project	A group of 4-5 students will select any One projects out of the following 1. Design of Material Handling Equipment for industrial application. 2. Design of multispeed Gear box for machine tool. 3. Design of unfired pressure vessel for industrial application. 4. Design of I C Engine components The following are the contents of the submission for the design projects. 1. The detailed **design report** containing, problem selection, problem analysis, problem definition, Solution based on all applicable design considerations, exclusive summary reflecting final dimensions of parts, Leaflet comprising the final specifications of the product designed, cost, Instructions to the users shall be submitted. 2. **2D Part drawing** in two views (preferably one sectional view exploring internal features of the parts) with representation of geometric, dimensional tolerances, surface roughness symbols, other instructions such as the surface coating, heat treatments to be submitted 3. **2D assembly drawing** in two views (preferably one sectional view exploring internal	**24**

	features of the assembly), with representation of overall dimensions, centre distances, dimensions ensuring alignment of parts in assembled condition, locations at which a particular fit is to be achieved, bill of materials representing clearly the OEM parts and parts to be manufactured in-house with correct representation of materials quantity, costing, Warrantee applicable to OEM parts	
	Total	**24**

Reference Books:

1. Design Data- P.S.G. College of Technology, Coimbatore, Printed in 2017
2. Bhandari, V. B. Machine Design data book, Tata McGraw Hill Publication Co. Ltd, 5th edition 2017
3. I.S. 2825: Code for unfired pressure vessels.
4. Shigley J. E. and Mischke C.R., ―Mechanical Engineering Design‖, McGraw Hill Pub. Co, 11th edition 2020
5. M. F. Spotts, Design of Machine Elements Prentice Hall Inc, 8th edition 2019
6. Black P.H. and O. Eugene Adams, ―Machine Design‖ McGraw Hill Book Co. Inc.
7. Johnson R.C., ―Mechanical Design Synthesis with Optimization Applications‖, Von Nostrand Reynold Pub.
8. S.K. Basu and D. K. Pal, ―Design of Machine Tools, Oxford and IBH Pub Co, 6th edition 2018
9. Rudenko,‖Material Handling Equipment‖, M.I.R. publishers, Moscow
10. P. Kannaiah ,‖Design of Transmission systems‖, SCIETCH Publications Pvt Ltd, 2nd edition 2015.
11. Pandy, N. C. and Shah, C. S., Elements of Machine Design, Charotar Publishing House.
12. Mulani, I. G., ―Belt Conveyors‖
13. Singiresu S. Rao, Engineering Optimization: Theory and Practice, John Wiley & Sons, 5th edition 2019
14. Joshi's Process Equipment Design, by V V Mahajani and S B Umargi, Mc-Millan, 5th eedition 2016

Program:	B. Tech. (Mechanical Engineering)					Semester : VI	
Course :	Numerical Methods and Optimization Lab					Code : BME6416	
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Hours	Credit	TW	PR	OR	Total
-	2	2	1	-	25	-	25

Prior knowledge of:

a. System of linear equations,
b. Partial differentiation
c. Problem-solving and programming…….are essential

Course Objectives:

Students are expected to study,

1. Effective use of Numerical methods for solving complex Mechanical engineering problems
2. Develop a logical solution for Mechanical engineering problems.

Course Outcomes:

The students will be able to,

1. **Use** appropriate Numerical Methods to solve complex mechanical engineering problems.
2. **Formulate** algorithms and programming.

Detailed Syllabus:

Practical:

1. **Program on Roots of Equation** (Validation using a suitable solver, anyone per student)
   a) Bisection Method, b) Newton Raphson method
2. **Program on Simultaneous Equations** (Validation using a suitable solver, anyone per student)
   a) Gauss Elimination Method, b) Thomas algorithm for tridiagonal matrix, c) Gauss-Seidel method.
3. **Program on Numerical Integration** (Validation using a suitable solver, anyone per student)
   a) Trapezoidal rule, b) Simpson's Rules (1/3rd, 3/8th) [In one program only]
4. **Program on Curve Fitting using Least square technique** (Validation using a suitable solver, anyone per student t)
   a) Straight line, b) Power equation, c) Exponential equation, d) Quadratic equation
5. **Program on Interpolation** (Validation using a suitable solver, anyone per student)
   a) Lagrange's Interpolation, b) Newton's Forward interpolation,
6. **Program on ODE** (Validation using a suitable solver, anyone per student)
   a) Euler Method, b) Runge-Kutta Methods- fourth-order, c) Simultaneous equations. (Runge-Kutta second-order: *One-step only*).
7. **Program on PDE (**Validation using a suitable solver, anyone per student): Laplace equation

NOTE:

- Complete all assignments using suitable software
- Solver is compulsory for all above programs and compared with the actual solution.
- Manual solution for each problem.
- Algorithms and Flowcharts are compulsory for all programs.

Guidelines to conduct practical examination

Anyone program from each set A & B with flowchart and solver: **Duration: 2 hrs.**

Set A: (Weightage – 60 %)

a) Simultaneous Equation, b) Partial Differential Equation (Laplace equation with solver) c) Interpolation: Lagrange's interpolation, Newton's Forward interpolation (Anyone)

Set B: (Weightage – 40 %)

a) Roots of Equations, b) Curve Fitting, c) Ordinary Differential Equations, d) Integration

Program:	B. Tech. (Mechanical Engineering)					Semester : VI	
Course :	Mechatronics Lab					Code : BME6417	
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Hours	Credit	TW	PR	OR	Total
-	2	2	1	-	-	25	25

Prior knowledge of:

a. Applied Mathematics
b. Metrology and Mechanical Measurement……..are essential

Course Objectives:

1. Acquaint with modern tools/software in Mechatronics engineering
2. Learn how to interface different sensors to acquire the data in Mechanical Engineering.

Course Outcomes:

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

1. Develop skills in using software tools and techniques for mechatronics applications.
2. Demonstrate knowledge of interfacing any sensor to acquire the data.

Term Work:

The Term work shall consist of completion of Practical and Self-learning study. Oral examination shall be based on the term work undertaken during the semester**.**

Any eight experiments out of the following:

1. Demonstration of speed control of BLDC motor using PWM.
2. Experiment on interfacing of suitable sensor with DAQ and LabVIEW.
3. Experiment on measurement of displacement/deformation using DAQ and LabVIEW
4. Design and Develop Lab View programme for measurement of any parameter.
5. Modeling and analysis of mechanical system and its verification using MATLAB/SIMULINK software.
6. Speed control of pneumatic cylinder using meter-in and meter-out circuit
7. Ladder logic simulation using suitable software for logic gates.
8. Automatic reciprocation of double acting pneumatic cylinder using PLC ladder programming
9. PID control of mechanical system using suitable simulation software and its experimental verification
10. Design and develop any mechatronics application using software / hardware.
11. Demonstration of any one real life mechatronics system application

e-sources:

1. https://www.elprocus.com/what-is-a-biosensor-types-of-biosensors-and-applications/
2. https://www.elprocus.com/color-sensor-working-and-applications/
3. https://www.youtube.com/watch?v=kbjCGGTXqUo&ab_channel=Controlengineering
4. https://youtu.be/clTA0pONnMs?list=PLHMDN3JFtE5wEz95H2XuzRaafK3fUsaki
5. https://nptel.ac.in/content/storage2/courses/108105063/pdf/L12(SS)%20(IA&C)%20((EE)NPTEL).pdf
6. https://nptel.ac.in/content/storage2/courses/112104158/lecture5.pdf

Program:	B. Tech. (Mechanical Engineering)				Semester : VI	
Course:	Non - Conventional Energy Systems (Professional Elective-III)				Code : BME6503A	
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hour	Credit	FA	SA	Total
3	--	3	3	40	60	100

Prior Knowledge of:

a. Fundamental concepts and laws/governing equations of Engineering Thermodynamics, fluid mechanics.
b. Principles of Heat Transfer
c. Elements of Electrical Engineering is essential

Objectives:

1. To provide a fundamental understanding of:
   - Solar thermal and Photovoltaic energy systems and their performance characteristics
   - Wind power devices systems and their performance characteristics
   - Geothermal and Tidal power generation scheme
2. To be able to understand the application of these technologies to real-world requirements
3. To understand issues in the utilization and economic viability of renewable-powered devices and systems

Course Outcomes:

The students should be able to

1. Estimate solar radiation on a tilted surface.
2. Determine the fundamental performance of characteristics of solar thermal.
3. Determine the fundamental performance of characteristics of photovoltaic energy generation.
4. Estimate the potential of wind resources.
5. To differentiate various routes of biomass energy conversion systems and demonstrate their operation.
6. Illustrate the operation of geothermal and tidal power plants and determine their financial viability.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Solar Energy** Worldwide energy use scenario, Current renewable energy installed capacity, Solar- Earth Geometry, Extraterrestrial Solar Radiation, and Spectral Distribution, Earth-sun angles, observer sun angles, Tilt factor, solar radiation intensity incident on tilted surface. Estimation of cost of energy of renewable energy system using discounted cash flow analysis	7
2.	**Applications of Solar Thermal Energy** Low-temperature applications - Water and air Heating, Flat Plate Collectors, losses, Performance evaluation, applications, Testing and Standards, Medium and high-temperature applications of Solar Thermal Energy – Concentrating collectors, classification, types and suitability, Solar thermal power generation -technologies, Storage issues and challenges in the commercialization**.**	8
3.	**Solar Photovoltaic Conversion** Basic Semiconductor Physics, A generic photovoltaic cell, Modules and Arrays, Impact of Temperature and Shading on the performance of a PV module, Standalone and grid connected Solar Photovoltaic Systems, components, system design	7
4.	**Wind energy** History and types of wind machines, Terminology, Dimensional analysis, Principles of Aerodynamics of a wind turbine blade, Maximum rotor efficiency (Betz Limit), Power output from practical wind turbine generators**,** wind data analysis and site selection considerations	8

5.	**Energy from biomass -** **Sources of biomass** – Different species, Conversion of biomass into fuels – Energy through fermentation – Pyrolysis, gasification and combustion – Aerobic and anaerobic bio-conversion, Properties of biomass **Biogas plants** – Types of plants – Design and operation – Properties and Characteristics of biogas. Biogas / Producer Gas Technology, Engines - Constructional, Operational & Performance aspects	**7**
6.	**Geothermal energy, and Tidal energy** **Geothermal Energy:** Availability of Geothermal Energy-size and Distribution, Recovery of Geothermal Energy, Various Types of Systems to use Geothermal Energy, Direct heat applications, Power Generation, economic analysis **Tidal Energy**: Introduction, Origin, and Nature of Tidal Energy, Advantages of Tidal Energy, Limitations of Tidal Energy, Tidal Energy Plant, Energy Potential Estimation, Ocean Tidal Energy Conversion Schemes.	**8**
	Total	**45**

Text Books

1. S.P. Sukhatme, Solar Energy – Principles of thermal collection and storage, II edition, Tata McGraw Hill, New Delhi, 1996.
2. M.A. Greaen "Solar Cells – Operating Principles, Technology, and System Applications", Prentice Hall, Inc. New Jersey, 1983
3. V.V. N. Kishore, Editor, Renewable Energy Engineering and Technology, A knowledge Compendium, The Energy and Resources Institute, New Delhi, 2008
4. G.L. Johnson ,Wind Energy Systems ,Prentice Hall, 1985

Reference Books:

1. J.A.Duffie and W.A. Beckman, Solar engineering of Thermal processes, II edition,John Wiley, New York, 1991.
2. D.Y. Goswami, F.Kreith and J.F.Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000.
3. D.D.Hall and R.P.Grover, Biomass Regenerable Energy, John Wiley, New York,1987.
4. Mukund R Patel, Wind and Solar Power Systems, CRC Press, 1999.
5. J F Manwell, J.G.McGowan, A.L.Rogers, Wind Energy Explained: Theory, Design and Application, John Wiley and Sons, May 2002.
6. R D Begamudre, Energy Conversion Systems, New Age International (P) Ltd., Publishers, New Delhi ,2000.

Program:	B. Tech. (Mechanical Engineering)					Semester : VI
Course :	Biomechanics and Biomedical Engineering (Professional Elective-III)					Code : BME6503B
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior knowledge of:

a. Metrology and Mechanical Measurement
b. Mechatronics
c. Solid Mechanics is essential

Course Objectives:

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

1. To understand the basic concepts of biomechanics to study the human joint motions and forces.
2. To discuss the fundamentals in material science to solve challenges in the biomaterials domain.
3. To learn about some of the common sensors/transducers used in biomedical field
4. To study the reconstruction of 3D model from medical scan imaging and its FE analysis.

Course Outcomes:

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

1. Demonstrate the basic principles of biomechanics to analyze the movement, forces at a skeletal joint for various activities.
2. Demonstrate a general understanding of using artificial materials in humans/animals.
3. Learn the use of various sensors/transducers in medical applications.
4. Create a 3D model from medical scan images using modern software tools.
5. Analyze the mechanical properties in biological tissues/implants/fixations.
6. Demonstrate a general understanding of design procedure and Select the appropriate manufacturing process for implant/fixation.

Detailed Syllabus:

Unit	Description	Duration (H)
1	**Fundamental of Biomechanics:** Concepts of biomechanics, Nine principles for application of biomechanics, Anatomical representation terminology, Response of tissues to forces/loads, Mechanics of bone, Joint forces and motions.	7
2	**Biomaterials:** Biomaterials uses, Different biomaterials, Selection of biomaterials, Mechanical and performance requirements, Biomaterials properties.	7
3	**Sensors/Transducers in Biomedical Engineering:** Strain gauges, LVDT, Load cell**,** Biosensors – Enzyme, ECG, and EMG.	8
4	**Medical imaging and 3D model generation:** Medical imaging techniques, Image parameters, General steps to generate 3D model from scan data, list of computing facilities, 3D model generation using software.	8
5	**Finite Element Method in Biomedical Engineering:** 3D modeling, Basics of FEA, Steps to setup bone model, Different loading configurations, Biomechanical analysis of hard tissues.	8
6	**Biomedical Applications:** Orthopedics implants and fixations, General design procedure, Manufacturing processes, Other applications.	7
	Total	45

Reference Books:

1. Duane Knudson, Fundamentals of Biomechanics,2nd Ed,Springer,2007
2. Susan J. Hall, Basic Biomechanics,7th Ed, McGraw Hill,2015
3. Gabor Harsanyi, Sensors in Biomedical Applications, CRC Press,2000
4. Tatsuo To gawa, Biomedical Sensors and Instruments,2nd Ed,2011

E-sources:

1. https://www.elprocus.com/what-is-a-biosensor-types-of-biosensors-and-applications/
2. https://onlinecourses.nptel.ac.in/noc21_me130/preview
3. https://onlinecourses.nptel.ac.in/noc21_me52/preview
4. https://nptel.ac.in/courses/112106248
5. https://nptel.ac.in/courses/112106270
6. https://archive.nptel.ac.in/courses/112/105/112105305/
7. https://nptel.ac.in/courses/10210605

Program:	B. Tech. (Mechanical Engineering)				Semester : VI	
Course :	Hydraulics and Pneumatics (Professional Elective-III)				Code : BME6503C	
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	--	3	3	40	60	100

Prior knowledge of:

a. Fluid Mechanics,

b. Basic Thermodynamics…….are essential

Course Objectives:

Students are expected to study,

1. To study governing laws & symbols used in fluid power system
2. To study fluid power applications
3. To study working principles of various components used in hydraulic/ pneumatic systems.
4. To select different components from the manufacturers catalogue
5. To study Hydraulic/ Pneumatic circuit used in fluid power system
6. To design fluid power system for different applications.

Course Outcomes:

The students will be able to:

1. Understand the basics of fluid power & Symbols.
2. Analyze the performance of the pump & accumulator.
3. Select actuators & control valves for different applications
4. Construct hydraulic circuit diagrams for different industrial applications
5. Apply knowledge of pneumatics for the construction of a pneumatic circuit
6. Design appropriate system according to the requirement by using manufacturers' catalogue.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Introduction to Fluid Power** Fluid power basics, advantages and limitations, Fluid power systems: Components, advantages, applications. Hydraulic fluids, Properties of fluids, selection of fluids, additives, the effect of temperature and pressure on hydraulic fluid, Seals: Types, selection, properties, material, compatibility of the seal with fluids. Fluid Conductors- pipes, hoses, connectors, Pipefittings, Sources of contamination and contamination control, Fluid conditioning through filters, strainers. Standard Symbols of fluid power components.	7
2.	**Sources of power- Pump & Accumulator** Pumps - types, classification, the principle of working and constructional details of vane pumps, gear pumps, radial and axial plunger pumps, screw pumps, power and efficiency calculations, and characteristics curves. Selection of pumps for hydraulic power transmission. Power units and accessories: Types of power units, Reservoir assembly, constructional details, pressure switches, temperature switches, Accumulators: Types, selection/design procedure, application, Intensifier	8
3.	**Hydraulic Actuators & Control valves**	7

	Actuator: Linear and Rotary actuators, types- linear, rotary, limited rotary actuator, constructional details, characteristics, Cylinder mountings, cushioning of cylinders. **Control valves**: Necessity of fluid control, Direction control valves - centre positions, methods of actuation, two-stage valves, Flow control valves - pressure and temperature compensated. Pressure control valves - pressure reducing valve, sequence valve, unloading valve, brake valve, back pressure valve, counterbalance valve, check valves, prefill valve, servo valves, cartridge valves, proportional valves.	
4.	**Hydraulic Circuit** Need of hydraulic circuit, Structure of Hydraulic circuits, Simple reciprocating, regenerative, speed control (meter in, meter out and bleed off), sequencing, synchronization, traverse and feed, automatic reciprocating, fail-safe circuit, counterbalance circuit, actuator locking, unloading circuit, motor braking circuit.	**8**
5.	**Pneumatics** Principle of Pneumatics: Laws of compression, Comparison of Pneumatics with Hydraulic power transmissions, types of compressors, selection of compressors, compressed air distribution system, Types of filters, regulators, lubricators, mufflers, dryers, Pressure regulating valves, Direction control valves, two-way, three-way, four-way valves. Solenoid operated valves, push-button, lever control valves, two pressure valve, quick exhaust valve and time delay valves, electro-pneumatics, Pneumatic actuators- rotary & reciprocating, Air motors- radial piston, vane, axial piston, shuttle valve, Speed regulating methods, pneumatic circuits, reciprocating, cascading time delay etc.	**7**

6.	**System Design** Calculation of piston velocity, thrust under static and dynamic applications, considering friction, inertia loads, design considerations for cylinders, Selection of different components such as reservoir, various valves, actuators, filters, pumps based on a design by using manufacturer's catalogues, Design of hydraulic circuits for practical application.	**8**
	Total	**45**

Text Books:

1. Esposito A, Fluid Power with application, Prentice Hall , 2022
2. Majumdar S.R, Oil Hydraulic system- Principle and maintenance, Tata McGraw Hill, 2017
3. Majumdar S.R, Pneumatics Systems Principles and Maintenance, Tata McGraw Hill, 2002
4. Stewart H. L, Hydraulics and Pneumatics, Industrial Press Inc., 1977

Reference Books:

1. Pipenger J.J, Industrial Hydraulics, McGraw Hill, 1980
2. Pinches, Industrial Fluid Power, Prentice Hall, 2022
3. F. Yeaple, Fluid Power Design Handbook, CRC Press, 1995
4. A. Parr, Hydraulics and Pneumatics, Jaico Publishing House, 1993
5. ISO - 1219, Fluid Systems and components, Graphic Symbols
6. Standard Manufacturer's Catalogues

Program:	B. Tech. (Mechanical Engineering)			Semester: VI		
Course:	Industrial Engineering (Professional Elective-III)			Code: BME6503D		
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior knowledge of:

a. Manufacturing Science

b. Materials Engineering is essential

Course Objectives:

1. To introduce the concepts, principles and framework of contents of Industrial Engineering.
2. To acquaint the students with various productivity enhancement techniques.
3. To acquaint the students with different aspects of Production Planning and Control and Facility Design.
4. To introduce the concepts of various cost accounting and financial management practices as applied in industries.
5. To acquaint the students with different aspects of Human Resource activities and Industrial Safety rules.

Course Outcomes:

1. Apply principles of management and evaluate productivity of an organization/Scenario.
2. Apply different steps in method study/use different Recording methods to an operation.
3. Determine work content and standard time using different methods of work measurement including developing an understanding of Rating.
4. Apply/use different techniques / concepts of production planning and control.
5. Apply different techniques / concepts of work system design and facilities design pertinent to manufacturing industry.
6. Perform break-even analysis for investment decisions.

Detailed Syllabus:

Unit	Description	Duration (H)
1	**Introduction to Industrial Engineering and Productivity** Definition and Role of Industrial Engineering, Functions of management, Types of production systems and organization structure. Measurement of productivity: Factors affecting the productivity, Productivity improvement techniques, Productivity Models and Index. Introduction to Value Engineering and Value Analysis.	7
2	**Method Study** Work Study: Definition, objective and scope of work-study, Human factors in work-study. Method Study: Definition, objective and scope of method study, work content, activity recording and exam aids, micro motion study. Applied Anthropometry, Work-Space Design, and Seating,	8
3	**Work Measurements** Work Measurements: Definition, objectives and uses, Work measurement techniques. Work Sampling: Need, confidence levels, sample size determinations, random observation, conducting study with the simple problems. Time Study: Definition, time study equipment, selection of job, steps in time study. Breaking jobs into elements, recording information, Rating and standard rating, standard performance, scales of rating, allowances and standard time determination. Introduction to PMTS and MTM: (Numerical), Introduction to MOST.	7

4	**Production Planning and Control** Introduction: Types of production systems, Need and functions of PPC, Aggregate production planning. Capacity Planning, ERP: Modules, Master Production Schedule, MRP and MRP-II. Forecasting Techniques: Causal and time series models, moving average, exponential smoothing, trend and seasonality (Numerical), Demand Control strategies (MTO, MTA, MTS). Introduction to Supply Chain Management: Basic terminologies.	**8**
5	**Plant Location and Layout** Plant Location : Need and factors influencing plant location, Plant Layout: Objectives, principles, types of plant layouts, Introduction to Assembly Line Balancing and Layout parameters to evaluate. Introduction to computer aided ergonomic analysis of workstation. Assessment of postures and identification of risks to body regions. Inventory control and Management: Types of inventories, Need of inventories, terminology, costs, Inventory Models: Basic production models, (with and without shortage and discount), ABC, VED Analysis.	**7**
6	**Costing and Human Factor in Industrial Engineering** Introduction to Marginal Costing: Elements of Cost, Break-Even Analysis. Techniques for Evaluation of capital investments. Human factors: Human Error, Accidents, and Safety, Human relation in industry, Performance appraisal, Human Factors in Systems Design	**8**
	Total	**45**

Text Books:

1. M Mahajan, Industrial Engineering and Production Management, Dhanpat Rai and Co., 2015
2. O. P. Khanna, Industrial engineering and management, Dhanpat Rai publication, 2018
3. M. Telsang, Industrial Engineering and Production Management, S. Chand Publication, 2018

Reference books:

1. Introduction to Work Study by ILO, ISBN 978-81-204-1718-2, Oxford & IBHPublishing Company, New Delhi, Second Indian Adaptation, 2008.
2. H. B. Maynard, K Jell, Maynard‘s Industrial Engineering Hand Book, McGraw Hill Education, 2001
3. R. Askin, Design and Analysis of Lean Production System, Wiley, 2001
4. Zandin K.B., Most Work Measurement Systems, ISBN 0824709535, CRCPress, 2002
5. Martin Murry, SAP ERP: Functionality and Technical Configuration, SAP Press, 2010
6. R. Barnes, Motion and time Study design and Measurement of Work, Wiley, 2009
7. R. Al-Aomar, A. Williams, O. M. Uigen ‘Process Simulation using WITNESS’, Wiley, 2015
8. Brien Shakel, Applied Ergonomics, Hand Book, Butterworth Scientific, 1988
9. R. C. Bridger, Introduction to Human factor and Ergonomics, McGraw Hill, 2017
10. M. Sanders and E. McCormick, Human Factor Engineering and Design, McGraw Hill, 1992
11. K. Elbert and H. Kroemer, Ergonomics: How to Design for Ease and Efficiency, Prentice Hall, 2018

Program:	B. Tech. (Mechanical Engineering)					Semester: VI
Course:	Design of Transmission Systems (Professional Elective-III)					Code: BME6503E
Teaching Scheme/week				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior knowledge of:

a. Machine Design
b. Kinematics and Theory of Machines
c. Heat Transfer…..are essential

Course Objectives: To enable students

1. To design flexible drives for industrial applications.
2. To design automotive clutches and brakes.
3. To design gears against fluctuating bending stresses and fluctuating contact stresses.
4. To design the work gears for industrial applications.
5. To analyze the Power slit devices used in Hybrid Electric Vehicles.

Course Outcomes: The student will be able to exhibit

1. Design the belt drives for the industrial applications.
2. Design the automotive clutches and brakes.
3. Design the helical and bevel gears against fluctuating bending stresses and contact stresses.
4. Design the transmission systems in lifting machinery such as Worm gearbox and chain drives.
5. Ability to design the constant mesh gearboxes for industrial applications.
6. Ability to analyze the power split devices used in HEVs

Detailed Syllabus:

Unit	Description	Duration (H)
1	**Design of belt drives**: Design of Belt Drives: Design of flat belts and pulleys-Selection of V belts and pulleys	7
2	**Design of Clutches and Brakes:** Design of friction clutches for maximum torque transmission based on wear and thermal consideration. Design of disc and drum brakes	8
3	**Design of Helical and Bevel Gears:** Design of helical and bevel gears based on fluctuating bending strength and pitting strength.	7
4	**Design of Transmission system in lifting machines:** Design of worm gears using IS 7443-1974, Thermal rating Selection of hoisting wire ropes- Design of transmission chains and Sprockets	8
5	**Design of Gearboxes**: Design of constant mesh single/ multi speed gearboxes with multiple stages. Gearbox components, mountings and accessories.	7
6	**Transmission systems in Hybrid Electric Vehicles**: Power Split Devices in HEVs, Speed and torque analysis of PSD.	8
	Total	45

Text Books:

1. Design of Machine Elements, V B Bhandari, Tata McGraw Hill Publication, 4th Edition 2017
2. Machine Design, R S Khurmi, J K Gupta, S Chand Publication.
3. Design of Machine Elements - Sharma, Purohil. Prentice Hall India Publication.
4. Machine Design by Pandya & Shah, Charotar Publishing.
5. Machine Design Fundamentals and Applications, P C Gope, PHI, EEE.

Reference books:

1. Norton R.L., Design of Machinery, McGraw Hill, 1999.
2. Spots, M. F., Design of Machine Elements, Prentice Hall of India Private Ltd., New Delhi, 1983.
3. William Orthwein, Machine Component Design, Vol. I and II, Jaico Publising house, Chennai,1996.
4. Maitra, Handbook of Gear Design, Tata Mcgraw-Hill, New Delhi, 1986.
5. Design Data, PSG College of Technology, 2006
6. Vehicle Powertrain Systems by Behrooz Mashadi, David Crolla. A John Wiley & Sons, Ltd .
7. Automobiles–Power trains and Automobiles–Dynamics by Crolla, David, A John Wiley &Sons, Ltd
8. Automotive Engineering Powertrain, Chassis System and Vehicle Body by David A Crolla, Elsevier B H New York, London, Oxford.

Program:	B. Tech. (Mechanical Engineering)					Semester: VI
Course:	Alternative Energy Sources for I. C. Engines (Professional Elective-III)					Code: BME6503F
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior knowledge of:

a. Combustion in S. I. and C. I. Engines
b. Fuel Supply systems of S. I. and C. I. Engines…….are essential

Course Objectives: To enable students

1. To get familiar with requirements of normal combustion in I.C. Engines
2. To understand the need of alternative fuel
3. To learn the properties, production methods, engine modifications, performance and emission characteristics by the use of various alternative fuels like alcohols, natural gas, biodiesel, hydrogen etc.

Course Outcomes: The student will be able to

1. Correlate the properties of alternative fuels to the requirements of I. C. Engines
2. Appreciate the need of alternative fuels for I.C. engines in the current energy scenario.
3. Suggest engine modification for the use of alcohols as alternative fuels and Analyze the engine performance and emission characteristics
4. Suggest engine modification for the use of biodiesel as alternative fuels and Analyze the engine performance and emission characteristics
5. Suggest engine modification for the use of natural gases as alternative fuels and Analyze the engine performance and emission characteristics
6. Suggest engine modification for the use of hydrogen as an alternative fuel and Analyze the engine performance and emission characteristics

Detailed Syllabus:

Unit	Description	Duration (H)
1	**Introduction:** A review of working process and stages of combustion of I.C. Engines, requirements of normal combustion in S.I. and C. I. engine. Properties of different types of fuel related to their utilization as an I. C. Engines Fuel (Rating of fuel, Ignition temperature, volatility, Calorific Value etc.)	7
2	**Need for Alternative Fuels:** Sources of fossil fuel, scope of availability of fossil fuel in future. Effects of constituents of Exhaust gas emission on environmental condition of earth (UBHC , CO2, CO, NOx, SOx) Green house effect, Carbon foot print and Carbon credit calculations. Emission norms as per Bharat Standard up to BS – IV	8
3	**Alcohols:** Sources of Methanol and Ethanol, methods production. Properties of methanol & ethanol as engine fuels, Engine modifications required the use of alcohols in I. C. engines, Engine performance of methanol/ethanol blends with gasoline. Emulsification of alcohol and diesel. Dual fuel systems, emission characteristics with blending of Alcohol.	7
4	**Bio Diesels :** Production of Bio Diesel from vegetable oils (Karanji , Neemseed, Sunflower , Soyabeen, Jatropha seeds). Process of separation of Bio Diesel. Properties Biodiesel compared to Diesel, and performance of Engine with biodiesel and Diesel-biodiesel blend.	8
5	**Natural Gas:** **Bio Gas** : Production of biogas from municipal wastes and other sources Composition, Properties of Bio-gas as an alternative fuel for I.C. Engines. Fuel system modifications for Usage of Biogas in SI engine & CI engine. Duel fuel operation in C. I. Engine, effect on performance, emission, cost & safety. **LPG & CNG:** Properties of LPG & CNG as engine fuels, fuel metering systems, combustion characteristics, effect on performance, emission, cost and safety.	7
6	**Hydrogen:** Properties, Sources and methods of Production of Hydrogen, Storage and Transportation of hydrogen. Combustion with hydrogen, safety aspects, engine/vehicle modifications required. **Fuel Cells:** Fuel cells principle, working, Thermodynamic analysis, Types, Fuel cell application in automobiles, Power rating, and performance, Layout of fuel cell vehicle.	8
	Total	45

Text Books:

1. Dr. S. S. Thipse, Alternative fuels: Concepts, Technologies and Developments, Jaico publications,2011
2. Richard L. Bechtold Alternative Fuels Guidebook, SAE International,2003
3. V. Ganesan: Internal Combustion Engines, Tata McGraw-Hill,2011

Reference books:

1. Donald L. Anglin; William H. Crouse, Automotive Emission Control, McGraw-Hill Publication G.L. Johnson,2001
2. John B. Heywood, Internal Combustion Engine Fundamentals, Tata McGraw-Hill,1988
3. M.L. Mathur and R.P. Sharma: A course in Internal combustion engines, Dhanpat Rai Publication, New Delhi,2016

Program:	**B. Tech (Mechanical Engineering)**					**Semester:** VI	
Course:	**Electric, autonomous and connected vehicles-I**					**Code:** BME6503G	
Credit	**Teaching Scheme Hrs./week**			**Evaluation Scheme**			
	Lecture	**Practical**	**Tutorial**	**FA1**	**FA2**	**SA**	**Total**
3	3	-		20	20	60	100

Prior knowledge of

a. Fundamentals of Automotive systems

Objectives:

1. Acquire foundational knowledge and practical skills in electric vehicle (EV) dynamics, component sizing, and simulation techniques.
2. Develop an in-depth understanding of lithium-ion battery technology
3. Develop a thorough understanding of ADAS and autonomous vehicle technologies
4. Understand the principles of wireless networking and their applications in vehicle autonomy

Outcomes:

The students will be able to,

1. Apply simulation tools to model and analyze the performance and sizing of key electric vehicle components.
2. Analyze battery electric and thermal management system
3. Implement safety protocols for battery packs, BMS, and charging systems in EVs.
4. Develop a thorough understanding of ADAS and autonomous vehicle technologies
5. Perform simulations for ADAS using common software tools and platforms.
6. Apply wireless networking technologies to enhance vehicle autonomy and connectivity.

Detailed Syllabus

Unit	**Description**	**Duration (H)**
1	Basics of Electric, Vehicle Overview Vehicle Dynamics (Governing Equations and Simulations) Defining the component sizing(Battery Pack, Electrical Machine, Traction Inverter, DC-DC Convertor and Onboard Charger) Drive cycle Simulation of EV Components in MATLAB and Simulink (Battery cell, Power Electronics, Electrical Machine simulation)	**8**
2	Basics of Lithium-ion cells, Battery Management System, Hardware, Software Function, Communication Protocol Battery Thermal Management System	**7**
3	Function Safety associated with Battery Pack and BMS System, Battery charging system: On board charger and charging station	**7**
4	Overview of ADAS and Autonomous vehicle Technology SAE levels of ADAS/ AD Software Stack Architecture, Overview of ADAS Features LDW/ LCA /LKA, ACC, IHC, Blind Spot Detection, Forward Collision Warning, Automatic, Emergency Braking Introduction to Simulation for ADAS/ AD- Commons tools and Platform sensors , Map , Traffic, Introduction to ADAS Software Testing Process- Unit/ System/ Integration Testing	**8**
5	Overview of Wireless Network for Connected Vehicles, Standards for Autonomous Vehicle Applications, Transmission & Receiver Systems , Radio Transmission, Concepts for Automotive Application	**8**
6	Wireless Networking and Applications to Vehicle Autonomy, Basics of Computer Networking – the Internet of Things, Wireless Networking Fundamentals & Overview to 2G to 5G Networks for Automotive Application.	**7**
	Total	**45**

Reference books:

1. Plett, G. Battery Management Systems, Volume I: Battery Modeling; Artech, 2015.
2. Quan Ouyang, Jian Chen, Advanced Model-Based Charging Control for Lithium-Ion Batteries-Springer, 2023
3. Daniel Watzenig, Martin Horn, Automated Driving: Safer and More Efficient Future Driving, Springer, 2016
4. Seth Leitman., Bob Brant. - Build Your Own Electric Vehicle-McGraw-Hill Professional (2009)
5. Umar Zakir, Abdul Hamid ,Fadi Al-Turjman, Towards Connected and Autonomous Vehicle Highways, Technical, Security and Social Challenges, Springer, 2021

Program :	B Tech (Mechanical Engineering)					Semester: VI	
Course :	Strategic Engineering Solutions in Mechanical Applications					Code :	BME6503H
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA1	FA2	SA	Total
3	3	-	-	20	20	60	100

About the Course :

- This course, developed in collaboration with our industry partner Henkel, a pioneer in the chemical sector, provides an integrated framework for analysing safety, sustainability, reliability, and resilience in mechanical engineering systems.
- Through theoretical discussions, case studies, and practical applications, students will develop a holistic understanding of how these principles intersect and influence the design, operation, and maintenance of mechanical systems, while also exploring Strategic Engineering Solutions.
- They will learn to strategically approach engineering challenges, considering long-term goals, resource allocation, and decision-making processes to optimize safety, sustainability, reliability, and resilience outcomes in mechanical applications.

Prior knowledge of

Basic Mechanical Engineering Concepts : Students should have a solid understanding of fundamental principles in mechanical engineering, including mechanics, thermodynamics, materials science, and fluid dynamics..

Course Objectives:

This course aims at enabling students,

1. Integrate principles of safety, sustainability, reliability, and resilience in mechanical engineering systems.
2. Develop analytical skills to assess and enhance safety, sustainability, reliability, and resilience using quantitative and qualitative methods.
3. Apply risk assessment techniques to identify vulnerabilities and mitigate potential failures in mechanical systems.
4. Evaluate strategies for improving safety, sustainability, reliability, and resilience while optimizing system performance.
5. Explore advanced techniques and emerging technologies for enhancing system resilience and sustainability.
6. Collaborate with industry partners to apply course concepts in real-world scenarios.

Course Outcomes:

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

1. **Analyse** the interconnections between safety, sustainability, reliability, and resilience principles in mechanical engineering systems to inform strategic decision-making.
2. **Apply** analytical methods to evaluate and improve safety, sustainability, reliability, and resilience in mechanical systems.
3. **Identify** potential risks and vulnerabilities in mechanical systems and develop strategies to mitigate them.
4. **Analyse and optimize** mechanical systems to enhance safety, sustainability, reliability, and resilience.
5. **Explore** innovative approaches and technologies to enhance system resilience and sustainability.
6. **Collaborate** effectively with industry partners to apply course concepts in practical situations and **solve** real-world problems in mechanical engineering.

Detailed Syllabus:

Unit	Description	Duration [Hrs.]
I	**Unit 1: Fundamentals of Safety, Sustainability, Reliability, and Resilience** Introduction to safety, sustainability, reliability, and resilience, principles, Interconnections and trade-offs between safety, sustainability, reliability, and resilience, Role of mechanical engineers in addressing these principles in system design and operation.	7

2	**Unit 2: Analytical Methods for Safety, Sustainability, Reliability, and Resilience** Quantitative and qualitative methods for analyzing safety, sustainability, reliability, and resilience, Risk assessment techniques for identifying vulnerabilities and mitigating failures, Reliability modelling and simulation approaches, Resilience metrics and assessment methodologies.	8
3	**Unit 3: Safety Engineering and Risk Management** Safety regulations and standards in mechanical engineering, Hazard identification and risk assessment methodologies, Safety protocol development and implementation, Case studies of safety incidents and their implications.	8
4	**Unit 4: Sustainable Design and Environmental Impact Assessment** Principles of sustainable engineering design, Life cycle assessment (LCA) methodologies, Sustainable materials selection and usage, Design for Environment (DfE) strategies.	8
5	**Unit 5: Reliability Engineering and Failure Analysis** Reliability-cantered maintenance (RCM) techniques, Failure mode and effects analysis (FMEA), Root cause analysis methodologies, Case studies of reliability engineering in mechanical systems.	7
6	**Unit 6: Resilience Engineering and System Optimization** Resilience engineering principles and strategies, System optimization techniques for enhancing resilience, Integration of safety, sustainability, reliability, and resilience in system design, Case studies of resilient mechanical systems and their performance in adverse conditions.	7
	Total	45

Text Books:

1. Allen, David T.; Shonnard, David R. (Eds.). "Sustainable Engineering: Concepts, Design and Case Studies." Pearson Education, 2018.
2. Kececioglu, Dimitri B. "Reliability Engineering Handbook." CRC Press, 2017.
3. Spellman, Frank R. "Safety Engineering Principles and Practices." CRC Press, 2016

Program:	B. Tech. (Mechanical Engineering)					Semester :VI
Course :	Mechanical System Design (Professional Elective-IV)					Code : BME6504
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior knowledge of:

a. Engineering Mechanics
b. Applied Mathematics
c. Materials Engineering
d. Strength of Materials
e. Manufacturing Practices
f. Design of Machine Elements
g. Kinematics and Theory of Machines is essential

Course Objectives:

This course aims at enabling the students to

1. To develop competency for system visualization and design.
2. To enable student to select materials and to design internal engine components.
3. To enable student to design cylinders and pressure vessels and to use IS code.
4. To enable student to design machine tool gearbox.
5. To enable student to design material handling systems.

Course Outcomes:

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

1. Select the appropriate material handling equipment for any application and to design the material handling system.
2. CO2 Analyze the stress in thin & thick cylinders under internal and external pressure and design an unfired pressure vessels using IS 2825:1969 and ASME Code.
3. Select suitable materials for various components and design Internal Combustion Engine.
4. Determine the optimum kinematic diagram and identify the various speeds in a multi-speed machine tool gearbox.

Detailed Syllabus: Any three Module

Module	Description	Duration (H)
1	**Design of Unfired pressure vessel** **Design of Cylinders**: Thin and thick cylinders, Lame's equation, Clavarino's and Bernie's equations, Auto-frettage and compound cylinders. **Design of Unfired Pressure vessel** : Classification of pressure vessels as per IS code 2825-1969, Categories and types of welded joints, Weld joint efficiency, Stresses induced in pressure vessels, materials for pressure vessel, Design of cylindrical shells and end closures as per code, Design of nozzles and openings in pressure vessels, Types of vessel supports.	15
2	**Machine Tool Gearbox Design** Introduction to machine tool gearboxes, Design and its applications, Basic considerations in design of drives, Determination of variable speed range, graphical representation of speed and structure diagram, ray diagram, selection of optimum ray diagram, gearing diagram, deviation diagram.	15

3	**Material Handling System Design** System concept, basic principles, Classification of conveyors, Objectives of material handling system, Unit and bulk load. Belt conveyors, Selection Flat and V belt from manufacture's catalogue, Troughed belt conveyors, Capacity of conveyor, Rubber covered and fabric ply belts, belt tensions, Conveyor pulleys, belt idlers, tension take-up systems, Power requirement of belt conveyors for frictional resistance of idler and pulleys. Selection of wires and rope drive from manufacture's catalogue	**15**
4	**Design of I. C. Engine** Introduction to selection of material for I. C. engine components, Design of cylinder and cylinder head, Construction of cylinder liners, Design of piston and piston-pins, rings, Design of connecting rod, Design of crank-shaft and crank-pin, Design of flywheel. Design for Manufacture and assembly of IC Engine parts	**15**
	Total	**45**

Text Books:

1. Bhandari V.B. ―Design of Machine Elements‖, Tata McGraw Hill Pub. Co. Ltd.
2. Juvinal R.C, Fundamentals of Machine Components Design, Wiley, India

Reference Books

1. Design Data- P.S.G. College of Technology, Coimbatore, Printed in 2017
2. Bhandari, V. B. Machine Design data book, Tata McGraw Hill Publication Co. Ltd, 5th edition 2017
3. I.S. 2825: Code for unfired pressure vessels.
4. Shigley J. E. and Mischke C.R., ―Mechanical Engineering Design‖, McGraw Hill Pub. Co, 11th edition 2020
5. M. F. Spotts, Design of Machine Elements Prentice Hall Inc, 8th edition 2019
6. Black P.H. and O. Eugene Adams, ―Machine Design‖ McGraw Hill Book Co. Inc.
7. Johnson R.C., ―Mechanical Design Synthesis with Optimization Applications‖, Von Nostrand Reynold Pub.
8. S.K. Basu and D. K. Pal, ―Design of Machine Tools, Oxford and IBH Pub Co, 6th edition 2018
9. Rudenko,‖Material Handling Equipment‖, M.I.R. publishers, Moscow
10. P. Kannaiah ,‖Design of Transmission systems‖, SCIETCH Publications Pvt Ltd, 2nd edition 2015.
11. Pandy, N. C. and Shah, C. S., Elements of Machine Design, Charotar Publishing House.
12. Mulani, I. G., ―Belt Conveyors‖
13. Singiresu S. Rao, Engineering Optimization: Theory and Practice, John Wiley & Sons, 5th edition 2019
14. Joshi's Process Equipment Design, by V V Mahajani and S B Umargi, Mc-Millan, 5th eedition 2016

Program:	B. Tech. (Mechanical Engineering)			Semester : VI		
Course :	Multivariate Data Analysis Using R (Open Elective-III)			Code : BAS6608		
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior Knowledge of:

a. Descriptive Statistics

b. Inferential Statistics,

c. Probability

d. Statistical Data Analysis using R …….are essential

Course Objectives:

This course aims at enabling the students to learn multivariate data collection, visualization, and preprocessing techniques for data science.

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

1. **Use** data preprocessing methods in R and generate quality data for analysis.
2. **Implement** R packages and related functions to data science to **analyze** multivariate data.
3. **Describe** the multivariate data. using different data visualization techniques to
4. **Analyze** the multivariate data using dependent analysis methods using the R.
5. **Analyze** the multivariate data using independent analysis methods using the R.
6. **Develop** a model for Prediction and Decision Making for a data set.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Data Wrangling** Understanding the multivariate data, Standardizing Variables, Accessing Databases with R Software, Merging multiple data sources into a single dataset for analysis, Dealing with Missing values, dealing with extreme outliers in data, discrepancies or removing.	7
2.	**Multivariate Data and Multivariate Analysis** Calculating Summary Statistics for Multivariate Data: Means and Variances Per Group, Between-groups Variance and Within-groups Variance for a Variable, Between-groups Covariance and Within-groups Covariance for Two Variables, Calculating Correlations for Multivariate Data, The multivariate normal density function.	8
3.	**Multivariate Data Visualization in R Software** Geometric projection techniques: Scatter plot matrix, Hyper box, Trellis display, Parallel coordinates, Icon-based techniques: Chernoff faces, Stick figures, Star plots, Color icons, Pixel-oriented techniques: Query-independent techniques: visualize the entire dataset, **Query-dependent techniques:** visualize a subset of data that are relevant to the context of a specific user query, Hierarchical techniques, Hybrid techniques	8
4.	**Dependent Analysis** Multiple linear regression, Conjoint Analysis, Multiple Discriminant Analysis, Linear Probability Analysis, Multivariate analysis of variance (MANOVA), Canonical Correlation Analysis, Structural Equation Modeling	7

5.	**Independent Analysis** Factor Analysis: Factor analysis model, the k-factor analysis model, Estimating the parameters in the k-factor analysis model. Cluster Analysis: Cluster analysis, K-means clustering, Displaying clustering solutions graphically, multidimensional Scaling, Correspondence Analysis	**7**
6.	**Multidimensional Scaling** Models for proximity data, Spatial models for proximities: Multidimensional scaling, Classical multidimensional scaling, non-metric multidimensional scaling. **Linear Discriminant Analysis :** Loadings for the Discriminant Functions, Separation Achieved by the Discriminant Functions, A Stacked Histogram of the LDA Values, Scatter plots of the Discriminant Functions, Allocation Rules and Misclassification Rate.	**8**
	Total	**45**

Reference Books:

1. Montgomery and Runger, "Applied Statistics and Probability for Engineers", Wiley, India, 6 Edition, ISBN: 9788126562947.
2. R. Johnson, "Probability and Statistics for Engineers", Prentice India Ltd, 8 Edition, ISBN 13:978- 8120342132.
3. S.P.Gupta, "Statistical Methods", Papperbook publication, 43 edition, ISBN: 9788180549892, 8180549895.
4. Everitt and Hothorn , "Use R!" series on using R for multivariate analyses, An Introduction to Applied Multivariate Analysis with R.
5. Barbara G. Tabachnick, Using Multivariate Statistics (4th Edition), Allyn & Bacon; 4th edition (August 9, 2000),
6. Yasunori Fujikoshi, Vladimir V. Ulyanov, Ryoichi Shimizu, Multivariate Statistics: High-Dimensional and Large-Sample Approximations, John Wiley & Sons, 15-Aug-201, ISBN:0470539860

e-sources:

NPTEL Course lectures links:

1. https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ma53 (Introduction to R software)
2. https://nptel.ac.in/noc/courses/noc21/SEM1/noc21-ma37 (Descriptive statistics using R software)

Program:	B. Tech. (Mechanical Engineering)			Semester : VI		
Course :	Remote Sensing and GIS (Open Elective-III)			Code: BCI6603A		
Teaching Scheme				Evaluation Scheme		
Lecture	Tutorial	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior Knowledge of:

a. Fundamental related to Surveying

b. Types and Importance of various surveys

c. Global Positioning System **(GPS)**……. are essential

Course Objectives: After Completing this course, student will have adequate background :

1. To comprehend fundamentals and principles of RS and GIS techniques.
2. To enhance students' capacity to interpret images and extract information of earth surface from multi-resolution imagery at multi-scale level.
3. To develop skills of Image processing and GIS
4. To study satellite image processing, satellite image interpretation, digitization and generation of thematic maps in a GIS.
5. To learn buffering and layer analysis for civil engineering applications

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

1. Articulate fundamentals and principles of RS techniques.
2. Demonstrate the knowledge of remote sensing and sensor characteristics.
3. Distinguish working of various spaces-based positioning systems.
4. Analyze the RS data and image processing to utilize in civil engineering
5. Explain fundamentals and applications of RS and GIS
6. Acquire skills of data processing and its applications using GIS

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Introduction to Remote Sensing:** Definition and scope, history and development of remote sensing technology, electromagnetic radiation (EMR) and electromagnetic spectrum, EMR interaction with atmosphere and earth surface; atmospheric window, RS platforms, elements of remote sensing for visual interpretation viz. tone, shape, size, pattern, texture, shadow and association, applications in civil engineering/town planning	7
2.	**Remote Sensing Satellites and Sensor Characteristics:** Types and their characteristics, types of sensors, orbital and sensor characteristics of major earth resource satellites, Indian remote sensing satellite programs, introduction to various open-source satellite data portals, global satellite programs, sensor classification, applications of sensor, concept of Swath & Nadir, resolutions, digital image. Introduction to spatial resolution, spectral resolution, radiometric resolution and temporal resolution, visual image interpretation, image interpretation	8
3.	**GPS and GNSS:** Introduction to GNSS and Types, IRNSS, GPS, GPS components, differential GPS, types of GPS tracking, application of GNSS in surveying, mapping and navigation	7

4.	**Image Processing and Analysis:** Digital image, visual image interpretation, image interpretation keys, concept of spectral signatures curve, digital image processing, preprocessing and post processing, image registration, image enhancement, image transformations, digital image classification (supervised & unsupervised). Digital elevation model (DEM) and its derivatives, triangular irregular network model (TIN) and other models & their applications.	**8**
5.	**Fundamentals of GIS:** Geographic information system, definition, spatial and non-spatial data, data inputs, data storage and retrieval, data transformation, Introduction to cloud computing (types & applications), data reporting, advantages of GIS, essential elements of GIS hardware, software GIS data types, applications of RS and GIS in civil engineering, hydrogeology, engineering geology, surveying & mapping.	**7**
6.	**GIS Data and Case Studies:** GIS data types and data representation, data acquisition, geo-referencing of data, projection systems, raster and vector data, raster to vector conversion, attribute data models and its types, remote sensing data in GIS, GIS database and database management system. Case studies:	**8**
	Total	**45**

Textbooks:

1. J. George “Fundamentals of Remote Sensing”, Universities Press, Hyderabad, 2005
2. Principles of Remote Sensing, Panda B C, Viva Books Private Limited, 2008
3. Remote Sensing & Geographical Information System, M. Anji Reddy, BS Publications, Hyderabad, 4th Edition, 2022
4. S.K. Sinha “Fundamental of Remote Sensing and GIS”, Ayushman Publication House,2014

Reference Books:

1. Remote Sensing & Digital Image Processing, John R. Jensen, Department of Geography University of South Carolina Columbia, 4th Edition, 2017
2. Remote Sensing and Image Interpretation, Lillesand Thomas M. and Kiefer Ralph, John, 7th Edition, 2015
3. Textbook on Remote Sensing, C. S. Agarwal and P. K. Garg, Wheeler Publishing House, 2000

E-Resources:

1. https://onlinecourses.nptel.ac.in/noc22_ce84/preview
2. https://onlinecourses.nptel.ac.in/noc23_ce52/preview
3. https://onlinecourses.nptel.ac.in/noc22_ce26/preview
4. https://elearn.nptel.ac.in/shop/nptel/remote-sensing-and-gis/
5. https://www.classcentral.com/course/swayam-remote-sensing-and-gis-14272

Program:	B. Tech. (Mechanical Engineering)			Semester : VI		
Course :	Building Services and Maintenance (Open Elective-III)			Code : BCI6603B		
Teaching Scheme				Evaluation Scheme		
Lecture	Tutorial	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Course Objectives:

1. To understand the different building services provisions.
2. To study the suitable electrical and mechanical services, fire protection, acoustic, water supply and sound Insulations.
3. To examine the purpose and type of building maintenance

Course Outcomes:

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

1. Understand different building services provisions.
2. Interpret the importance of building ventilation.
3. Distinguish the suitable electrical as well mechanical services for particular requirements of buildings.
4. Discover the knowledge of Fire Protection, Acoustic, and Sound Insulations.
5. Provide awareness of laws and regulations of water supply systems related to building services.
6. Select different types of maintenance in building services.

Detailed Syllabus:

Unit	Description	Duration (H)
1	**Introduction to Building Services**: Definitions, Objective and uses of services–different types building, Classification of building services, Types of services and selection of appropriate services for given project.	7
2	**Building Ventilation:** Natural and artificial lighting principles and factors, Arrangement of luminaries, Distribution of illumination, Utilization factors, Necessity of Ventilation Types – Natural and Mechanical Factors to be considered in the design of Ventilation.	8
3	**Electrical Services & Mechanical Services in Buildings:** Electrical services in the building technical terms and symbols for electrical installations and Accessories of wiring, Systems of wiring Plumbing & Air-Conditioning, Air Distribution system, Cleaners,	7
4	**Fire Protection, Acoustic and Sound Insulations:** Introduction, causes of fire and Effects of fire, General Requirements of Fire Resisting building as per IS and NBC 2005, Requirement of good Acoustic, Various sound absorbent, Factors to be followed for noise control in residential building.	8
5	**Water and Sanitation Water quality Purification and treatment**: - water supply systems-distribution systems municipal bye laws and regulations, Rain Water Harvesting Sanitation in buildings, arrangement of sewerage systems in housing.	7
6	**Building Maintenance:** Role of maintenance in durability and serviceability of buildings, Economic aspects of maintenance. Different types of maintenance.	8
	Total	45

Text Books:

1. A text book on Building Services R. Udaykumar Eswar Press, Chennai
2. Building Services S. M. Patil Seema Publication, Mumbai Revised edition
3. National Building Code of India - 2005 Bureau of Indian Standards BIS, New Delhi.

Reference Books:

1. Building Construction Dr. B. C. Punmia Laxmi Publications (P) Ltd., New Delhi
2. Building Construction P. C. Varghese PHI Learning (P) Ltd., New Delhi
3. Building repair and Maintenance Management P. S. Gahlot CBS Publishers & distribution(P) Ltd

E-resource-

https://nptel.ac.in/courses/105102176

Program:	B. Tech. (Mechanical Engineering)					Semester : VI
Course :	Smart Cities & Building Automations (Open Elective-IV)					Code: BCI6604A
Teaching Scheme				Evaluation Scheme		
Lecture	Tutorial	Hours	Credit	FA	SA	Total
3	-	3	3	20	50	100

Prior Knowledge of:

a. Physics

b. Mathematics

c. Programming Language…….are essential

Course Objectives: After Completing this course, student will have adequate background :

1. To understand the concept of smart city and associated challenges
2. To understand latest technologies used in intelligent building
3. To recognize the concepts of Internet of Things and able to build IoT applications
4. To apply the programming and use of Arduino and Raspberry Pi boards for Smart Cities

Course Outcomes: After learning the course, the students will be able:

1. To understand the concept of smart city and associated challenges
2. To understand latest technologies used in intelligent building
3. To program and configure Arduino boards for various designs.
4. To do Python programming and interfacing for Raspberry Pi.
5. To design IoT applications in different domains,

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Introduction to Smart cities:** Introduction to city planning, Concept, Principle stakeholders, key trends in smart cities developments	7
2.	**Smart Cities Regulations:** Understanding smart cities, Global Standards and performance benchmarks, Practice codes for smart city development	7
3.	**Smart Cities Planning and Development:** Smart city planning and development, Dimension of smart cities, Financing smart cities development, Governance of smart cities	7
4.	**IoT in Construction:** Introduction to Internet of Things, Characteristics of IoT, Physical design of IoT, Functional blocks of IoT, Sensing, Actuation, Basics of Networking, Communication Protocols, Sensor Networks.	8
5.	Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino for smart city applications	8
6.	**Introduction to Python and Raspberry pi for Smart Cities** Python programming, Introduction to Raspberry Pi, Interfacing Raspberry Pi with basic peripherals, Implementation of IoT with Raspberry Pi for Smart Cities and Smart Homes	8
	Total	45

Text Books:

1. Jo Beall (1997); "A city for all: valuing differences and working with diversity"; Zed books limited, London (ISBN: 1-85649-477-2).
2. UN-Habitat; "Inclusive and sustainable urban planning: a guide for municipalities"; Volume 3: Urban Development Planning (2007); United Nations Human Settlements Programme (ISBN: 978- 92-1-132024-4).
3. Arup Mitra; "Insights into inclusive growth, employment and wellbeing in India"; Springer (2013), New Delhi (ISBN: 978-81-322-0655-2).
4. "The Internet 'of Things: Enabling Technologies, Platforms, and Use Cases"(2018), by Pethuru Raj and Anupama C. Raman (CRC Press).
5. "Make sensors"(2014) Terokarvinen, Kemo, Karvinen and Villey Valtokari, 1st edition, Maker media.
6. "Internet of Things: A Hands-on Approach"(2018), by Arshdeep Bahga and Vijay Madisetti.

Reference Books

1. "Urban Planning and cultural identity" (2004); William J. V. Neill, Routledge, London (ISBN: 0- 415-19747-3)
2. "Remaking the city: Social science perspective on urban design"(2015) John S. Pipkin, Mark E. La Gory, Judith R. Balu (Editors); State University of New York Press, Albany (ISBN: 0-87395-678-8)
3. "Smart cities – Ranking of European medium-sized cities". Smart Cities. Vienna: Centre of Regional Science (2007) Giffinger, Rudolf; Christian Fertner; Hans Kramar; Robert Kalasek; Nataša Pichler-Milanovic; Evert Meijers
4. "Draft Concept Note on Smart City Scheme". Government of India – Ministry of Urban Development (http://indiansmartcities.in/downloads/CONCEPT_NOTE_-.12.2014__REVISED_AND_LATEST_.pdf)
5. "Internet of Things: A Hands-On Approach"(2018) Vijay Madisetti, Arshdeep Bahga,
6. "Fundamentals of Wireless Sensor Networks: Theory and Practice" (2018), Waltenegus Dargie,Christian Poellabauer, Beginning Sensor networks with Arduino and Raspberry Pi (2013) Charles Bell, A press.

e-References

1. Smart City Mission Guidelines, India, https://smartcities.gov.in/guidelines
2. Smart Cities – Management of Smart Urban Infrastructures by Coursera, https://www.coursera.org/learn/smart-cities
3. e-Learning Course on Smart City by edx, https://www.edx.org/course/smart-city

Program:	B. Tech. (Mechanical Engineering)					Semester : VI
Course :	Mechanical Electrical Plumbing (MEP) Systems (Open Elective-IV)					Code: BCI6604B
Teaching Scheme				Evaluation Scheme		
Lecture	Tutorial	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior Knowledge of:

a. Basics of air conditioning

b. Basics of Electrical Engineering

c. Basics of Mechanical Engineering……..are essential

Course Objectives:

After Completing this course, student will have adequate background :

1. To learn the concept of HVAC
2. To recognize the technologies used in electrical services
3. To understand the concepts of plumbing services
4. To learn the fire protection system

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

1. Analyze and design HVAC system
2. Implement the technologies used in electrical services
3. Apply plumbing services
4. Design fire protection system

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**HVAC** Introduction to HVAC, Basic Components of Air-Conditioning and Refrigeration machines, Classification of Air-Conditioning System , Categories of Air Conditioning , Study of sychometric Charts , Load Calculation, Air Distribution System, Static Pressure Calculation, Hydronic System, VRF/VRV System, Air Conditioning Concepts, Ventilation systems.	7
2.	**Basics of Electrical Implementations** General, Codes & Standards to be followed, Electrical equipment's and its application used in the installation, Means of electrical distribution for installation, Major electrical loads used in the installation, Electrical design calculations, Various design stages & Sequence of electrical design procedure.	8
3.	**Electrical Analysis and Design** Major electrical loads used in the installation, Electrical design calculations, Various design stages & Sequence of electrical design procedure.	7
4.	**Plumbing** Plumbing Systems, Design of Domestic Water Supply and Distribution System, Design of Sanitary Drainage System, Drawings – Plumbing Layouts.	8
5.	**Fire Protection system** Introduction To Fire Fighting, Classification Of Fire (Description), Fire Extinguisher Types- Using Procedure And General Maintenance, Fire Protection Systems-1. Active 2. Passive Refuge Areas – Rules & Regulations.	7

6.	**Fire Alarm System** Designing of fire alarm system, NFPA, NBA & FSAI Code For Fire Fighting System Designing, Fire Fighting, Hydraulic Calculation For High Rise Buildings, Fire norms for new project construction.	**8**
	Total	**45**

Text Books:

1. Design of Mechanical & Electrical Systems. Trost, Pearson Publishing, ISBN 978-0-13097235-4 .
2. MEP Planning Manual: Become a Professional Construction Engineer: 1 (Arabmep H), ISBN-10 : 1677068930, ISBN-13 : 978-1677068937.
3. MEP Databook (Construction Databooks) Hardcover – 16 August 2000 by Sidney Levy, McGraw-Hill Education.
4. Electrical and Mechanical Services in High Rise Building (English, Paperback, Mittal A.K.), CBS Publisher and Distrubutor Pvt.Ltd.

Reference Books

1. MEP Guide for Planning and Scheduling by Planningengineer.net
2. Handbook of Building Construction; Data for Architects, Designing and Construction Engineers, and Contractors by Hool George, Publisher: Nabu Press.

e-Reference

1. Online Mechanical, Electrical and Plumbing Design Training Course by Advance Electrical Design & Engineering Institute (AEDEI) https://www.advanceelectricaldesign.com/
2. Revit MEP Essentials by CADD Centre, India. https://www.cloudkampus.com/clp/revit-mep-essentials
3. MEP Course by MEP Training Institute, India. https://www.mepcentre.com/course/mep
4. Foundation Course on Building MEP Services by MEPA (Mechanical Electrical Plumbing engineers Association) http://www.mepaworld.com/training

Program:	B. Tech. (Mechanical Engineering)					Semester: VI
Course:	Principles of Software Engineering (Open Elective-III)					Code: BCE6604
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Course Objectives:

The course is aiming to impart conceptual clarity among students about.

1. The fundamental phases of the Software Development Life-cycle (SDLC).
2. Selection of an appropriate process model for specific software project development.
3. Comprehension of methods for capturing, specifying, and analyzing software requirements.
4. Applying Design principles to software project development.
5. Comprehension of UML Diagrams for software project development.
6. The fundamental understanding of agile process model.

Course Outcomes:

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

1. Comprehend the fundamental phases of the Software Development Life-cycle (SDLC).
2. Compare and select an appropriate process model for specific software project development.
3. Comprehend methods for capturing, specifying, and analyzing software requirements.
4. Apply Design principles to software project development.
5. Comprehend UML Diagrams for software project development.
6. Relate the basics of agile process model for the development of software projects.

Detailed Syllabus

Unit	Description	Duration (H)
1.	**Introduction To Software Engineering** Definition of Software, Software Application Domains, Software engineering layers, Software engineering practice, The Essence of Practice, General Principles, Software development myths, Management myths, Customer myths, Practitioner's myths, Software Development Life-cycle.	7
2.	**The Software Process** A Generic Process Model, Defining a Framework Activity, Perspective Process Model, Waterfall Model, V Model, Incremental Process Model, Evolutionary Process Models-Prototyping, The Spiral Model, Unified Process, Phases of the Unified Process	8
3.	**Requirements Analysis** Requirement Engineering, Requirements engineering tasks, Establishing the Groundwork-Eliciting Requirements, Collaborative Requirements Gathering, Quality Function Deployment, Usage Scenarios, Elicitation Work Products, Developing use cases.	8
4.	**Design Concepts** The design Process, Abstraction, Architecture, Separation of Concerns, Modularity, Information Hiding, Refinement, The design Model, Data Design Elements, Architectural Design Elements, Interface Design Elements.	8
5.	**Modeling with UML** Modeling Concepts and Diagrams, Introduction to UML, Use Case Diagrams, Class Diagrams, State chart Diagrams, Activity Diagrams, Package Diagram, Component Diagrams, Deployment Diagrams.	7
6.	**Agile development Process** Agile Process- Extreme Programming in agile development, Agile software development process Models, SCRUM – process flow, scrum roles, scrum cycle description, product backlog, sprint planning meeting, sprint backlog, sprint execution, daily scrum meeting.	7
	Total	**45**

Text Books:

1. Roger S Pressman, "Software Engineering – A Practitioner's Approach", Pearson Education, 7th Edition, ISBN 0073655783, 2010.
2. Ian sommerville, "Software Engineering", 9th edition, ISBN-13: 978-0-13-703515-1, 2010.
3. Unified Modeling Language User Guide, The (2nd Edition) (Addison-Wesley Object Technology Series), ISBN:978-0-321-26797-9, May 2005.

Reference Books:

1. Carlo Ghezzi, "Fundamentals of Software Engineering", Prentice Hall India, ISBN 10: 0133056996, 2002.
2. Rajib Mall, "Fundamentals of Software Engineering", Prentice Hall India, ISBN 13: 978-8120348981, 2014.
3. Pankaj Jalote, "An Integrated Approach to Software Engineering", Springer, ISBN 13: 9788173192715, 2010.

Program:	B. Tech. (Mechanical Engineering)			Semester: VI		
Course:	Information Security (Open Elective-III)			Code: BCE6603		
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Course Objectives:

1. To offer an understanding of principle concepts, central topics and basic approaches in information and cyber security.
2. To make students aware about the basics and different algorithms of Cryptography.
3. To acquire knowledge of standard algorithms and protocols employed to provide confidentiality, integrity and authenticity.

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

1. Identify computer and network security threats, classify the threats and develop a security model to prevent, detect and recover from the attacks.
2. Propose the security Services and Mechanisms for preventing the different security attacks.
3. Use Symmetric key Cryptographic Techniques to encrypt and decrypt the massages.
4. Use Asymmetric key Cryptographic Techniques to encrypt and decrypt the massages.
5. Use different Hash Techniques to provide the Authentication and to check the Integrity of messages in transit.
6. Use Message Authentication Code to provide Authentication.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Security Basics** **Computer Security Concepts** - Need, Security Vs Privacy, Confidentiality, Integrity & Availability (CIA), additional Security considerations, The challenges of Security, Threats, Attacks and Assets, Operational Model of Security; **Case Study:** Study of Campus Network and identification of possible Threats, Attacks & Assets	7
2.	**Encryption Techniques** **Basics:** Symmetric & Asymmetric Cipher Model; Cryptography; Cryptanalysis and Brute-Force Attack **Classical Encryption Techniques** - Substitution Techniques: Caesar Cipher, Mono-alphabetic Ciphers, Poly-alphabetic Ciphers, Playfair Cipher; Transposition Techniques: Rail Fense Technique	8
3.	**Symmetric Cipher** **Traditional Cipher Structure:** Stream ciphers and Block Ciphers; Feistel Cipher Structure **Data Encryption Standard (DES):**DES Encryption; DES Decryption; DES Example; Strength of DES; **Block Cipher Modes of Operations:** Electronic Code Book (ECB), Cipher Block, Chaining Mode (CBC), Cipher Feedback Mode (CFB), Output Feedback Mode (OFB), Counter Mode (CTR)	8
4.	**Asymmetric Cipher** **Public-Key Cryptosystems:** Secrecy, authentication, secrecy & authentication; applications, requirements; **The RSA Algorithm:** Algorithm, Example, The security of RSA; **Diffie-Hellman Key Exchange:** The Algorithm, Key Exchange Protocol, Man-in- the-middle attack.	8
5.	**Key Management and Distribution** Symmetric Key Distribution using Symmetric key Encryption, Symmetric Key Distribution using asymmetric key Encryption, Distribution of Public Keys. **Case Study: Introduction to X.509**	7
6.	**Cryptographic Hash Functions & Message Authentication Codes** **Cryptographic Hash Functions:** Applications, Secure Hash Algorithm (SHA)- 512, MD5 **Message Authentication Codes (MAC):** Requirements, Functions, Security of MACs	7
	Total	45

Text Books:

1. William Stallings, "Cryptography and network security principles and practices", Pearson, 6th Edition, ISBN: 978-93-325-1877-3
2. Atul Kahate, "Cryptography and Network Security", Mc Graw Hill Publication, 2nd Edition, 2008, ISBN: 978-0-07-064823-4

Reference Books:

1. Eoghan Casey, "Digital Evidence and Computer Crime Forensic Science, Computers and the Internet", ELSEVIER, 2011, ISBN 978-0-12-374268-1
2. Bernard Menezes, "Network Security and Cryptography", Cengage Learning India, 2014, ISBN No.: 8131513491
3. Forouzan, "Cryptography and Network Security (SIE)", Mc Graw Hill, ISBN, 007070208X, 9780070702080
4. Nina Godbole, SunitBelapure, "Cyber Security", Wiley India, 2014, ISBN No.: 978-81-345-2179-1

Program:	B. Tech. (Mechanical Engineering)					Semester: VI
Course:	Fundamentals of Machine Learning (Open Elective-IV)					Code: BCE6605
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior knowledge of:

a. Engineering Mathematics is essential.

Course Objectives:

1. To introduce different machine learning primitives.
2. To introduce different preprocessing techniques to prepare training and testing data set
3. To solve regression problems using regression techniques.
4. To develop skills to understand nature of the problem and apply machine learning algorithm
5. To use classification algorithms to solve classification problems.
6. To introduce metrics and methods for Evaluating Classifier Performance

Course Outcomes:

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

1. Distinguish different machine learning primitives.
2. Use different data preprocessing techniques to prepare training and testing data set.
3. Apply data similarity and dissimilarity measures for statistical analysis.
4. Apply Association Rule Mining algorithms for market basket analysis.
5. Solve real world problems using regression techniques.
6. Apply classification algorithms to solve real world problems.

Detailed Syllabus:

Note: Case studies mentioned in Unit IV, Unit V and VI are just to get understanding to students, and will not be considered for evaluation.

Unit	Description	Duration (H)
1.	**Introduction to Machine learning** Introduction to Machine learning, Machine Learning Approaches-Supervised Learning, Unsupervised Learning and Reinforcement Learning, Important Elements of Machine Learning- Data formats, Under fitting and Overfitting, Error measures, Creating training and testing datasets	7
2.	**Data Pre-Processing** Data, Information and Knowledge; Attribute Types: Nominal, Binary, Ordinal and Numeric attributes; Data Pre-processing: Data Cleaning, Data integration, Data transformation: Min-max normalization, z-score normalization and decimal scaling; data reduction, Data Discretization, Binning techniques for smoothing noise.	8
3.	**Measuring Data Similarity and Dissimilarity** Measuring Data Similarity and Dissimilarity, Proximity Measures for Nominal Attributes and Binary Attributes, Dissimilarity of Numeric Data: Euclidean distance and Manhattan distance; Cosine Similarity	7
4.	**Unsupervised Learning** **Association Rules Mining-** Market Basket Analysis, Frequent item set, Association Rules, Apriori Algorithm, Generating Association Rules from Frequent Item sets; **Clustering-** K-means: Finding optimal number of clusters **Case study: of ML application:** Shopping mall application for Market Basket Analysis.	7
5.	**Supervised Learning- Regression** **Linear Regression**- Linear models, A bi-dimensional example, Linear Regression and higher dimensionality, Regularization-Ridge, Lasso **Logistic regression**-Linear classification, Logistic regression **Case study of ML applications:** Applications for house price prediction, Share Market	7

6.	**Supervised Learning- Classification** Naïve Bayes Classifier, Decision Tree Classification, K-Nearest Neighbor Classifier, Metrics for Evaluating Classifier Performance, Confusion Matrix, Evaluating the Accuracy of a Classifier: Holdout Method and Cross-Validation, ROC Curve **Case study of ML applications:** Applications in Agriculture sector, Health care domain using analytical tools such as WEKA/KNIME/R/SK-Learn	**9**
	Total	**45**

Text Books:

1. Jiawei Han, Micheline Kamber, “Data mining: concepts and techniques", Morgan Kaufmann Publisher 2012, third edition, ISBN 978-0-12-381479-1.
2. Giuseppe Bonaccorso, “Machine Learning Algorithms”, Packt Publishing Limited 2017, ISBN-10: 1785889621, ISBN-13: 978-1785889622.

Reference Books:

1. EthemAlpaydin, “Introduction to Machine Learning”, PHI 2nd Edition-2013, ISBN 978-0-262-01243-0
2. Peter Flach, “Machine Learning: The Art and Science of Algorithms that Make Sense of Data”, Cambridge University Press, Edition 2012, ISBN-10: 1107422221; ISBN-13: 978-1107422223
3. Tom Mitchell “Machine Learning” McGraw Hill Publication 1997, ISBN: 0070428077 9780070428072
4. AurélienGéron, “Hands-On Machine Learning with Scikit-Learn and TensorFlow”, O'Reilly Media, Inc. publisher 2017, ISBN: 9781491962299.
5. Ian H. Witten and Eibe Frank, “Data Mining: Practical Machine Learning Tools and Techniques”, Second Edition, Morgan Kaufmann Publishers 2005, ISBN: 0-12-088407-0.

Web references:

1. http://myweb.sabanciuniv.edu/rdehkharghani/files/2016/02/The-Morgan-Kaufmann-Series-in-Data-Management-Systems-Jiawei-Han-Micheline-Kamber-Jian-Pei-Data-Mining.-Concepts-and-Techniques-3rd-Edition-Morgan-Kaufmann-2011.pdf
2. https://balasahebtarle.files.wordpress.com/2020/01/machine-learning-algorithms_text-book.pdf
3. http://www.academia.dk/BiologiskAntropologi/Epidemiologi/DataMining/Witten_and_Frank_DataMining_Weka_2nd_Ed_2005.pdf
4. http://scikit-learn.org/stable/datasets/
5. https://scikit-learn.org/stable/modules/model_evaluation.html
6. https://www.kaggle.com/datasets

Program:	B. Tech. (Mechanical Engineering)					Semester: VI
Course:	JAVA Programming (Open Elective-IV)					Code: BCE6606
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior knowledge of:

a. Any programming language

Course Objectives:

1. To understand various data types, conditional and looping constructs in Java.
2. To understand concepts of Java classes, various types of constructors in Java.
3. To use inheritance and polymorphism to solve real life problems.
4. To apply multithreading concepts and collection framework.
5. Exemplify the usage of packages and implement the concepts of Applets and Java FX.

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

1. Comprehend basic Java concepts and JVM.
2. Use object-oriented programming concepts to solve real time problems.
3. Use inheritance and polymorphism in OOP application.
4. Apply exception handling for problem solving in Java.
5. Use multithreading for synchronization in Java.
6. Illustrate UI components for designing windows-based applications.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Introduction to Java :** Introduction to JAVA, history of JAVA, Java virtual machine, difference between JDK, JRE ,variables and data types, control structure, looping structures. Case study: Implement the C++ program to demonstrate class, variables, member function & control structure.	9
2.	**JAVA programming concepts** Features of JAVA, classes, methods, constructor, types of constructor, use of static and this, aggregation. Case study: Implement the student class in JAVA using member functions, constructor, static & this keyword.	8
3.	**Polymorphism and Inheritance :** **Polymorphism**-Introduction, types of polymorphism with syntax, method overloading. **Inheritance**-Introduction, syntax, types of inheritance, extends keyword, method overriding, use of super keyword, use of final keyword, abstract class. **Interface**-Introduction, syntax, extends one interface from another, implement classes through interface. Case study: Implement class employee using polymorphism, inheritance and interface.	9
4.	**Exception Handling**: Introduction, syntax, types of exception, components of exception handling, use of throws keyword, flow control in try catch, exception class, inbuilt exception classes, user defined exception classes, use of finally block.	7
5.	**Java Multithreading:** Introduction to multithreading, life cycle of thread, thread scheduler techniques, synchronization, enumerations fundamentals and example, wrappers class.	6
6.	**Applet**: Introduction to applet, applet architecture, life cycle and components of applet. **JavaFX**: Introduction to JAVAFX, JavaFX architecture, components of JAVAFX, scene graph	6
	Total	45

Text Books:

1. Herbert Schildt,"Java - The Complete Reference", The McGraw-Hill Education,11th Edition,2018, 978-1260440232.
2. E. Balagurusamy, "Programming with Java" McGraw Hill Education India, 6th Edition, 2019, 9789353162.

Reference Books:

1. D.T. Editorial Services, "Java 8 Programming Black Book", Dreamtech Press India Pvt. Ltd., Paperback, 2015, 9789351197584.
2. Ken Arnold, James Gosling and David Holmes, "The Java Programming Language", Addison-Wesley, 4th Edition, 2005, 0321349806

Web references:

1. https://www.w3schools.com/java
2. https://www.javatpoint.com/java-tutorial
3. www.spoken-tutorial.com : Free Online course of JAVA

Program:	B. Tech. (Mechanical Engineering)			Semester: VI		
Course:	Designing with Raspberry Pi (Open Elective-III)			Code: BET6601		
Teaching Scheme				Evaluation Scheme		
Lecture	Tutorial	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior Knowledge of:

a. Basics of Programming is essential

Course Objectives:

1. To explain fundamentals of Raspberry pi (Rpi) and installation of OS in Rpi
2. To demonstrate the Python programming and interfacing of sensors and actuators with Rpi
3. To describe the Node-RED tool used in Rpi and its applications.

Course Outcomes:

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

1. **Describe** the basic specifications and operating systems of Raspberry Pi.
2. **Illustrate** the usage of Node-RED tool for Raspberry Pi programming.
3. **Understand** the Python programming concepts.
4. **Apply** the concepts of programming for sensor interfacing with RPi.
5. **Apply** the concepts of programming for actuator interfacing with RPi.
6. **Design** IoT based applications with Python programming and Raspberry Pi.

Detailed Syllabus:

Unit	Description	Duration (H)
1	**Getting started with Raspberry Pi** Basic functionality of Raspberry Pi board, Physical design and specifications, GPIO Pin description of Rpi, Reading the datasheet of RPi, comparison of various Rpi models, Rpi as mini- computer. Introduction of various operating systems of Rpi, Installation of Raspbian/Noobs/OSMC operating system on Rpi, first boot and basic configuration of Rpi, Introduction to Linux commands required to configure Rpi, Overview of Graphic User Interface (GUI).	8
2	**Getting started with Node-RED tool on Rpi** Prerequisite for Node-RED, Installing and upgrading Node-RED, Running Node-RED app locally and as a service on network, auto-start on boot, opening the editor, installation of various libraries for Node-RED, adding node, add debug node, wire the nodes, deploy the flow.	6
3	**Programming the Raspberry Pi** Introduction to Python programming language: Python Programming Environment, Python Expressions, Strings, Functions, Data types in python, importing libraries, flow control, conditional statement, Loops.	10
4	**Sensor interfacing with Rpi** Basics of sensors: What are sensors? Types of sensors Sensor interfacing: Temperature and Humidity sensor (DHT11), PIR Motion sensor, obstacle detection using Ultrasonic sensor, soil moisture sensor	6
5	**Actuator interfacing with Rpi** Basics of actuators: What are actuators?, Their need in making a closed loop system Actuator interfacing: Electronic Relays, LED's, Buzzers/Fan, DC Motor, Stepper motor, LCD.	7
6	**Case Study based following topics** Home Automation, Smart City, Smart Farming, Smart Transportation, Health and Lifestyle, Pollution Monitoring system	8
	Total	45

Text Books:

1. Gary Mitnick,"Raspberry Pi 3: An Introduction to using Python Scratch, javascript and more", 1st edition Createspace Independent publishing Platform 2017.
2. Tim Cox, "Raspberry Pi for python program cookbook" Packt Publishing Limited, 2nd edition, 2016
3. John C. Shovic,"Raspberry Pi IoT Projects: Prototyping Experiments for Makers", 1st edition Apress Berkeley CA, 2016

Reference Books:

1. Sean McManus, Mike Cook, "Raspberry Pi for Dummies", Wiley Publishers, 4th edition, 2021
2. Maik Schmidt, "Raspberry Pi: A Quick-Start Guide", The pragmatic programmers, 1st edition LLC, 2012
3. Simon Monk,"Programming the Raspberry Pi", 2nd Edition, McGraw Hill publications, 2012
4. Matt Richardson,"Getting started with Raspberry pi", 3rd Edition, Make community, LLC 2016
5. Derek Molloy,"Exploring Raspberry pi", 1st Edition, Wiley, 2016

MOOCs Courses:

1. https://onlinecourses.nptel.ac.in/noc20_cs66/preview
2. https://onlinecourses.nptel.ac.in/noc22_cs74/preview

Program:	B. Tech. (Mechanical Engineering)				Semester: VI	
Course:	Basics of Automotive Electronics (Open Elective-III)				Code: BET6602	
Teaching Scheme				Evaluation Scheme		
Lecture	Tutorial	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior knowledge of:

a. Electrical and Electronics is essential.

Course Objectives:

1. To introduce Electronics Control Unit (ECU) used in Automotive applications.
2. To apply operating principles of sensors and actuators used in automotive.
3. To explore the role of electronic systems in Active and passive safety systems.

Course Outcomes:

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

1. To apply the concept of electronics systems in automotive applications.
2. To explore different sensors and actuators.
3. Illustrate vehicle motion control systems.
4. Understand algorithms used in Engine Control System.
5. Describe the role of electronics in Active and passive safety systems.
6. Make use of automotive components, subsystems, and basics of Electronic Engine Control in the automotive industry

Detailed Syllabus:

Unit	Description	Duration (H)
1	**Automotive Systems Overview:** Automotive vehicle technology, Present trends in automobiles with emphasis on increasing role of electronics and software, Overview of typical automotive subsystems and components, Body, Chassis, and Powertrain Electronics	7
2	**Sensors :** Basic sensor arrangement, Types of sensors such as oxygen sensors, Crankshaft angle position sensors, Fuel metering/ vehicle speed sensors, Flow sensor, Temperature, Exhaust Gas Oxygen (O2/EGO), Air mass flow sensors, Throttle position sensor, Strain Gauge MAP sensor, Magnetic Reluctance Position Sensor, Hall effect Position Sensor, Engine Coolant Temperature (ECT) Sensor, Piezoelectric Knock Sensor. Actuators : Solenoids, Stepper Motors, Relays, Fuel Injector, EGR Actuator, Ignition System	9
3	**Vehicle Motion Control:** Typical Cruise Control System, Digital Cruise Control System, Digital Speed Sensor, Throttle Actuator, Digital Cruise Control configuration, Cruise Control Electronics (Digital only), Antilock Brake System (ABS)	7
4	**Engine Control System:** Algorithms for engine control including open loop and closed loop control system, Electronic ignition, EGR for exhaust emission control.	7
5	**Active and passive safety systems:** Body electronics including lighting control, Remote keyless entry, Immobilizers, Electronic instrument clusters and dashboard electronics, Antilock braking system, Computer vision based ADAS	7
6	**Future Automotive Electronic Systems:** Alternative Fuel Engines, Electric and Hybrid vehicles, Fuel cell powered cars, Collision Avoidance Radar warning Systems, Low tire pressure warning system, Voice Recognition Cell Phone dialing, Advanced Cruise Control, Stability Augmentation, Automatic driving Control	8
	Total	45

Text Books:

1. William B. Ribbens, “Understanding Automotive Electronics- An Engineering Perspective”, 7th edition, Butterworth-Heinemann Publications, 2017.
2. Ronald K. Jurgen, “Automotive Electronics Handbook”, Mc-Graw Hill, 1999
3. oliverscheid , “Autosar Compendium, Part 1: Application & RTE”, Create Space Independent Publishing Platform,2015

Reference Books:

1. Robert Bosch, “Automotive Hand Book”, 10th edition, Wiley Publications, 2018
2. Kiencke, Uwe, Nielsen & Lars, “Automotive Control Systems for Engine, Driveline and Vehicle”, Second edition, Springer Publication, 2005.
3. John F. Kershaw, James D. Halderman,“Automotive Electrical and Electronic Systems”, 5thEdition, Pearson Prentice Hall, 2007
4. https://autosartutorials.com/
5. https://www.udemy.com/course/learn-autosar-from-scratch/

Program:	B. Tech. (Mechanical Engineering)	Semester: VI
Course:	Designing with Arduino platform (Open Elective -IV)	Code: BET6603

Teaching Scheme				Evaluation Scheme		
Lecture	Tutorial	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior knowledge of:

a. Basic of Programming is essential

Course Objectives:

1. To make the students aware of the Arduino platform in terms of the physical board, Arduino IDE and libraries.
2. To make the students aware of circuit prototyping, and interfacing of peripherals with Arduino.

Course Outcomes:

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

1. Summarize the features of the Arduino board.
2. Apply the programming concepts to the Arduino board.
3. Make use of analog and digital pins of Arduino.
4. Develop a system to monitor the real-time parameters using Arduino.
5. Illustrate the Object detection using Arduino.
6. Realize the Sound sensing and distance measurement using Arduino.

Detailed Syllabus:

Unit	Description	Duration (H)
1	**Knowing Your Arduino:** Introduction of Arduino Uno, Atmega328P,Arduino Shields, getting to know the Arduino Uno Pins, power, clock, Using the digital input and output pins, analog input and output pins, Introduction to Serial (UART) communications, I²C (TWI) communications, SPI communications	7
2	**Arduino Ide And Programming Concepts.** An introduction to the Arduino IDE: Getting and installing the Arduino IDE and uploading a sketch to your Arduino. An introduction to Arduino programming, Understand the basic parts of an Arduino sketch, custom functions Creating custom functions and the return keyword, Using variables, constants, Introduction to control structures: The "if”,” while", "For”,” Switch" statement	8
3	**Arduino Programming Hands On** Digital input/output - how to read the state of a button control an LED, Analog input/ output - how to read the state of a potentiometer and create a fading LED, Introduction to the RGB (color) LED, Wiring the RGB LED, RGB LED: creating colors, using a library to control an RGB LED with PWM.	8
4	**Monitoring Real Time Parameters Using Arduino** Interfacing of Ultra -violet light sensor, RGB color sensor, DHT22 sensor, LM 35 to Arduino for monitoring the parameters like temperature, humidity, etc.	7
5	**Interfacing With Arduino - I.** Introduction to detecting acceleration with the ADXL335, Plugging the ADXL335 directly in the Arduino, and detect its orientation, A demonstration of using the IR and PIR sensor with the Arduino	7
6	**Interfacing With Arduino - II.** Introduction to the ultrasonic distance sensor, Wiring and understanding Trigger and Echo, and calculating distance. Introduction to the analog sound sensor, A demonstration and sketch of the analog sound sensor and the digital sound sensor. Case study elaborating the use of Arduino in various applications.	8
	Total	45

Text Books:

1. Arduino-Based Embedded Systems: By Rajesh Singh, Anita Gehlot, Bhupendra Singh, and Sushabhan Choudhury, CRC Press, Taylor & Francis Group, 1st edition 2017.
2. Arduino Made Simple by Ashwin Pajankar, BPB Publication, 1st edition 2018.

Reference Books:

1. Exploring Arduino: Tools and Techniques for Engineering Wizardry,by Jeremy Blum ,Wiley Publication, 2013, 1st Edition, ISBN- 13: 978-1118549360,ISBN-10: 1118549368.

Online Links :

1. https ://www.arduino.cc/en/Tutorial/HomePage
2. https://spoken-tutorial.org/tutorial-search/?search_foss=Arduino&search_language=English

Program:	B. Tech. (Mechanical Engineering)					Semester: VI
Course:	Communication Protocols for e-Vehicle (Open Elective -IV)					Code: BET6604
Teaching Scheme				Evaluation Scheme		
Lecture	Tutorial	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior knowledge of:

a. Fundamentals of computer networks
b. Electric machines…….are essential

Course Objectives:

1. To make student understand basics of EVs, including EV Components, architecture, and energy management.
2. To make student able to compare various topologies of EV communication systems.
3. To introduce student about connectors and chargers in EV's
4. To make student to evaluate the impact of EVs in Connected Mobility and Autonomous Mobility

Course Outcomes: On completion of the course, learner will be able to–

1. Understand the basics of e-vehicles
2. Illustrate the EV Components and controlling units.
3. Compare various EV Communication protocols & their need in the e-Mobility business
4. Understand the fundamentals of EVSE Communication
5. Analyze connectors and chargers in EVs
6. Apply the Knowledge of e-Mobility through Indian Roadmap Perspective

Detailed Syllabus:

Unit	Description	Duration (H)
1	**EV Basics:** Overview of EVs and challenges, the architecture of EVs, EV market and promotion, infrastructure needs, energy sources used in EVs & HEVs, medium of power transfer (conductive and wireless), and wireless power transfer.	7
2	**EV Components:** Battery Management System (BMS), BLDC Motors, Inverter Unit, Powertrain Unit and Couplers with Chassis, PDU (Power Distribution Unit), BCM (Body Control Module, ECU, and Tuning Parameters.	7
3	**EV Communication protocols:** Communication Systems in EV (CAN and LIN), V2V, V2G and its applications in power systems, power saving & coordinated charging, the layout of power converters, electrification challenges	8
4	**Electric vehicle supply equipment (EVSE):** Basics of EVSE, EVSE Power Module selection and technical specification, Selection of EVSE Communication Protocol (PLC / Ethernet / Modbus/ CAN Module), Communication gateway	8
5	**Connectors and Chargers:** Types of EV charging connectors, EV Plug Standards, Selection and Sizing of Common Types of Connectors and Applications, Selection of AC and DC charger types.	7
6	**Charging communication & e-Mobility:** Communication Interface between the charger and CMS, CCS (Combined Charging System), CHAdeMO, Tesla, Specification of open charge point protocol, Connected Mobility and Autonomous Mobility, e-Mobility: Indian Roadmap Perspective, EV integration in smart grid, social dimensions of EVs.	8
	Total	45

Text Books:

1. William Ribbens, Understanding Automotive. Electronics. An Engineering Perspective. 7th edition, 2017.
2. Jack Erjavec and Nathan Smith, Hybrid, Electric and Fuel-Cell Vehicles, 3rd Edition, 2022.
3. Tom Denton, Electric and Hybrid Vehicles, 2nd Edition, 2016.

Reference Books:

1. Wireless Communications Principles and Practice; by Theodore S Rappaport, Pearson Education, 2nd edition 2018
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2010.
3. Wei Liu (General Motors, USA), Hybrid Electric Vehicle System Modelling and Control, John Wiley & Sons, Inc., 2nd edition, 2017.
4. Teresa Donateo, Hybrid Electric Vehicles, , Published by ExLi4EvA,1st edition , 2017

NPTEL Links :

1. NPTEL course on Fundamentals of Electric vehicles: Technology & Economics, IIT Madras, Prof. Ashok Jhunjhunwala, Prof. Prabhjot Kaur, Prof. Kaushal Kumar Jha, Prof. L Kannan, https://nptel.ac.in/courses/108106170
2. NPTEL course on electric Vehicles - Part 1, IIT Delhi, Prof. Amit Jain, https://nptel.ac.in/courses/108102121
3. NPTEL Archives on E-vehicles and renewable energy, IIT Madras, https://archive.nptel.ac.in/courses/108/106/108106182
4. E-Vehicles Comprehensive Course, Udemy.com, https://www.udemy.com/course/electric-vehicles-comprehensive-course/

Program:	B. Tech. (Mechanical Engineering)			Semester : VI		
Course :	Web Technology (Open Elective -III)			Code: BIT6601		
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior knowledge of:

a. Computer Fundamentals
b. Any one computer Language …….are essential.

Course Objectives:

1. To write a valid standards-conformant HTML document involving a variety of element types, including hyperlinks, images, lists, tables, and forms
2. To use CSS to implement a variety of presentation effects in HTML and XML documents, including explicit positioning of elements
3. To demonstrate techniques for improving the accessibility of an HTML document
4. To learn the concepts commonly used in dynamic language programming, such as introspection, higher-order functions, and closures.

Course Outcomes:

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

1. Illustrate static website development using HTML and CSS.
2. Demonstrate static and dynamic website development using Bootstrap.
3. Discuss the basics of JavaScript in Web Development.
4. Make use of AJAX and JQuery in mobile website development
5. Describe MVC architecture as Front end framework.
6. Build responsive web application using ReactJS

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**HTML** Getting started with HTML, Why HTML, Tags and Elements, Attributes, Properties, Headings list, Links, Tables, Images, HTML Form, Media (Audio, Video), Semantic HTML5 Elements. **CSS:** Types of CSS, How to use CSS, Properties, Classes, Child-Class (Nested CSS), Colors, Text, Background, Border, Margin, Padding, Positioning (flex, grid, inline, block), Animation, Transition.	6
2.	**BOOTSTRAP** CSS over Bootstrap, How to Use Bootstrap, Bootstrap Grid System, Bootstrap Responsive, Bootstrap Classes, Bootstrap Components (i.e., Button, Table, List, etc.),Bootstrap as a Cross Platform. W3C: What is W3C , How W3C handles/Supports Web Technologies.	6
3.	**JavaScript** Introduction to Scripting languages, Introduction to JavaScript (JS), JS Variables and Constants, JS Variable Scopes, JS Data Types, JS Functions, JS Array, JS Object, JS Events. Advanced JavaScript: JSON - JSON Create, Key-Value Pair, JSON Access, JSON Array, JS Arrow Functions, JS Callback Functions, JS Promises, JS Async-Await Functions, JS Error Handling	7
4.	**AJAX** Why AJAX, Call HTTP Methods Using AJAX, Data Sending, Data Receiving, AJAX Error Handling. JQUERY :Why JQuery, How to Use, DOM Manipulation with JQuery, Dynamic Content Change with JQuery, UI Design Using JQuery.	10
5.	**Front-End Frameworks** Web Framework Types. MVC: What is MVC, MVC Architecture, MVC in Practical, MVC in Web Frameworks. TypeScript: Introduction to TypeScript (TS), Variables and Constants, Modules in TS.	6
6.	**ReactJS** Introduction to ReactJS, React Components, Inter Components Communication, Components Styling, Routing, Redux- Architecture, Hooks- Basic hooks, useState() hook, useEffect() hook, useContext() hook	10
	Total	45

Text Books:

1. Ralph Moseley & M. T. Savaliya, “Developing Web Applications”, Wiley publications, ISBN 13: 978812653867
2. Jeremy McPeak& Paul Wilton,” Beginning JavaScript”, Wrox Publication, ISBN-13: 978-0470525937

Reference Books:

1. Steven Holzner,”HTML Black Book”, Dremtech press.
2. Web Technologies, Black Book, Dreamtech Press
3. Web Applications: Concepts and Real World Design, Knuckles, Wiley-India
4. Internet and World Wide Web How to program, P.J. Deitel & H.M. Deitel Pearson.

Program:	B. Tech. (Mechanical Engineering)			Semester : VI		
Course :	Mobile Application Development (Open Elective -IV)			Code : BIT6602		
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
3	-	3	3	40	60	100

Prior knowledge of :

a. Java programming language is essential.

Course Objectives:

1. To learn a new mobile application development environment.
2. To develop problem solving skills with mobile applications.
3. To develop competency for the design, coding and debugging for mobile app development.
4. To build the programming skills using 'Android Programming Language.

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

1. Explore the android environment for mobile application development.
2. Design android user interface for Mobile application.
3. Explore different notification interfaces to facilitate communication between components.
4. Apply different persistent storage techniques used to store and retrieve data in android applications.
5. Make use of SQLite in android application development,
6. Explore android services in android application development.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Introduction to Android Operating System** Android OS design and Features – Android development framework, SDK features, Installing and running applications on Android Studio, Creating AVDs, Types of Android applications, Best practices in Android programming, Android tools. Android application components – Android Manifest file, Externalizing resources like values, themes, layouts, Menus etc, Resources for different devices and languages, Runtime Configuration Changes Android Application, Activities, Activity lifecycle,	8
2.	**Android User Interface** Measurements – Device and pixel density independent measuring units, Layouts – Linear, Relative, Grid and Table Layouts etc. User Interface (UI) Components – Editable and non-editable TextViews, Buttons, Radio and Toggle Buttons, Checkboxes, Spinners, Dialog and pickers etc. Event Handling – Handling clicks or changes of various UI components. Fragments – Creating fragments, Lifecycle of fragments, Fragment states, Adding fragments to Activity, adding, removing and replacing fragments with fragment transactions, interfacing between fragments and Activities, Multi-screen Activities.	8
3.	**Intents and Broadcasts** Intent – Using intents to launch Activities, Explicitly starting new Activity, Implicit Intents, Passing data to Intents, Getting results from Activities, Native Actions, using Intent to dial a number or to send SMS Broadcast Receivers – Using Intent filters to service implicit Intents, Resolving Intent filters, finding and using Intents received within an Activity Notifications – Creating and Displaying notifications, Displaying Toasts	8
4.	**Persistent Storage** Files – Using application specific folders and files, creating files, reading data from files, listing contents of a directory Shared Preferences – Creating shared preferences, saving and retrieving data using Shared Preference	5
5.	**Database** Introduction to SQLite database, creating and opening a database, creating tables, inserting retrieving and deleting data, Registering Content Providers, Using content Providers (insert, delete, retrieve and update)	8
6.	**Android Services** Introduction of android services and its lifecycle. Location Services,Types of Services, Best practices-Performance, Testing,Privacy, Security etc. Deployment of Application.	8
	Total	45

Text Books:

1. Professional Android 4 Application Development, Reto Meier, Wiley India, (Wrox), 2012
2. Android Application Development for Java Programmers, James C Sheusi, Cengage Learning, 2013

Reference Books:

1. Beginning Android 4 Application Development, Wei-Meng Lee, Wiley India (Wrox), 2013
2. Android Application Development Black Book Pradeep Kothari, KLSI,Dreamtech Press.

Reference URL:

1. https://www.javatpoint.com/android-service-tutorial
2. https://developer.android.com/guide/components/services

Program:	B. Tech. (Mechanical Engineering)			Semester: VI		
Course :	Project Management (HSMC-VI)			Code: BHM6114		
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
2	-	2	2	30	20	50

Course Objectives:

This course aims at enabling students,

1. To help the students gain understanding regarding the concept of projects and Project Management
2. To enable the students to know the key components of project management including project time, cost & Risk management
3. Recognize issues in a realistic project scenario.

Course Outcomes:

After learning the course, the students will be able to

1. **Understand** how to initiate, define and organize a project.
2. **Optimize** results while managing the triple constraints.
3. **Apply** appropriate approaches to plan a new project and develop project schedule
4. **Analyze** the risk associated with various project

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Introduction to Project Management** Concept and Definition of Project, Characteristics of Project, Concept and definition of Project Management, Functions of Project Management, Importance of Project Management, Who is a Project Manager, Roles & Responsibilities of Project Manager. Understanding the Phases in the Lifecycle of Projects and their Significance, Different types of Projects: Industrial, Telecommunication, Research and more, Project Selection Methods : Agile method & Waterfall methods	7
2.	**The Triple Constraint in Project Management :** The concept of the Triple Constraint in Project Management : Scope, Cost and Time, Project Cost Management : Concept, Consideration, Five types of Costs involved in a project, Cost Management process, Project Time Management and methods of Time estimation, Communications Management in Project , Work Breakdown Structure (WBS). Case studies based on Mega Projects of the World.	7
3.	**Planning and Execution of Project**: Developing a Mission, Vision, Goals of the project. Concept and definition of Project Planning. Importance of Project Planning. Concept and definition of Network Scheduling ,Critical Path Method, Concept of Project Execution, Phases of Project Execution, Project Evaluation; The Review Technique – Planning and Scheduling of Activity Networks - Concept of PERT/CPM, Assumptions in PERT Modeling – Time-cost, Trade-offs, HRM issues in Project Management & How they can be tackled, Quality Circle, Reasons for Failures of Project , Case Study with respect to different Domains	8
4.	**Project Monitoring and Risk Management** : Concept of Project Monitoring, How to Building a Suitable Monitoring; Control System, Concept of Conflict Management, Concept & Definition of Risk and Risk Management, Concept of Risk Matrix Analysis, Strategies to Manage Risks, An Overview of Useful Techniques and Tools Used in Project Management. Case Studies	8
	Total	30

Text Books:

1. Joseph Heagney, Fundamentals of Project Management, American Management Association, 2012

Reference Books:

1. Erik W Larson, Clifford Gray, Rohit Joshi; Project Management-The managerial process, MacGraw Hill Publication, 2021
2. Punmia, Project Management with CPM /PERT, Laxmi Publications, 2001
3. Robert L Kimmons, Project Management Basics, Taylor & Francis Ltd, 2018
4. N. D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

e-sources:

1. https://www.youtube.com/watch?v=RjOA7AxOVj8&list=PLLy_2iUCG87AUusGVo2wsXvRZ4zlbbKUu
2. https://www.youtube.com/watch?v=W2EdffbwgcM&list=PL3MO67NH2XxIRneBXA3yA1RacZQIuX7Yl
3. https://www.youtube.com/watch?v=RQNZWCl6eXI&list=PLBd76GK9sWTwVXm9FlVHOTXXbGY2vZR8z

Program:	B Tech (Mechanical Engineering)			Semester: VI		
Course:	Financial Management (HSMC-VI)			Code: BHM6115		
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Tutorial	Credit	FA	SA	Total
2	-	-	2	30	20	50

Prior knowledge of

a. Basic Financial Literacy is essential

Course Objectives:

This course aims at enabling students

1. To develop an understanding of day-to-day working capital decisions; and also longer-term dealing, involving major capital investment decisions and raising long-term finance.
2. To improve students' understanding of the time value of money concept and the role of finance in the current competitive business scenario.

Course Outcomes:

After learning the course, the students will be able to

1. **Understand** the basics of financial management and its terms and concepts
2. **Understand** financial markets and the role of financial institutions
3. **Apply** knowledge of capital budgeting; its allocation, management and funding.
4. **Analyse** financial statements and read documents and books of accounts.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Introduction to Financial Management**- Concept of Business Finance, Objective function in Finance, Traditional and Modern Approaches to Financial Management, Financial Planning - Principles and Steps in Financial Planning and its practical approach.	7
2.	**Financial Markets, Institutions and instruments:** Introductions to Financial Markets – Nature – Functions and Types of Financial markets, Different Financial Instruments, Sources of financing - Shares, Debentures, Term Loans, Lease & Hire Purchase, Retained Earnings, Public Deposits, Bonds, Trade Credit, Introduction to Bank Finance.	8
3.	**Time Value of Money and capital budgeting:** Timelines for cash flow, Annuities, Perpetuities, Need and Importance of Capital Budgeting, Different Techniques of Evaluating the Project on the Basis of Payback Period, ARR, NPV, IRR, PPP	7
4.	**Financial Statement Analysis:** Concept of Financial Statements: Balance Sheet, Profit and Loss Statement, Cash Flow Statement, Tools of Analysis of Financial Statements: Comparative Statements, and Ratio analysis.	8
	Total	30

Text Books:

1. Prasanna Chandra, Financial Management, Tata McGraw Hill, 2011

Reference Books:

1. Agrawal M R, Financial Management, Garima Publications, Jaipur, 2021
2. Khan and Jain, Financial Management, Tata McGraw Hill, 2008
3. Paramasivan C, Subramanian T, Financial Management, New Age International (L) Publishers, 2017
4. R. M.Srivastava, Financial Management, Himalaya Publishers, 2005
5. Vanhorne J, Financial Management & Policy, Pearson Education, Delh,2015
6. Gupta Pratik, Arora Amit, Financial Management, Vayu Education of India, 2020

e-sources:

1. https://www.youtube.com/watch?v=TgF2XvjquUU&list=PLLy_2iUCG87CXY2B6fPex1SOIqxzzD5Wj
2. https://www.youtube.com/watch?v=CCQwz_Gwo6o
3. https://www.youtube.com/watch?v=OT5RdoJAkhY&list=PLPjSqITyvDeUTeAOGhip_ubjN3y8oqT13

Program:	B. Tech. (Mechanical Engineering)			Semester: VI		
Course:	Entrepreneurship Development (HSMC-VI)			Code: BHM6116		
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
2	-	3	2	30	20	50

Course Objectives:

This course aims at enabling students,

1. To understand the role and importance of entrepreneurship for economic development
2. To seek necessary knowledge and develop skills required for organizing and carrying out entrepreneurial activities.
3. To develop the ability to analyze and understand business situations in which entrepreneurs act..

Course Outcomes:

After learning the course, the students will be able to

1. Understand the entrepreneurship as an opportunity
2. Optimize the business opportunities that suit aspirant entrepreneurs
3. Appraise the financial schemes and support systems for Entrepreneurship Development.
4. Design a comprehensive business plans.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Introduction to the Entrepreneurship Development** : Concept and definition of Entrepreneurship, The concept of Opportunity Window, Challenges and Misconceptions Related to Entrepreneurship with Indian Context, McClelland's Need Achievement Theory, Concept of Entrepreneur, Entrepreneurship as a Career, Traits of Successful Entrepreneur, Types of Entrepreneur (proprietary, partnership, collaboration etc), Entrepreneur v/s Intrapreneur, Woman Entrepreneur – A Paradigm Shift , Factors Affecting Entrepreneurship, Types of Enterprises and their Features: Manufacturing, Service and Trading Case Study: Indian Entrepreneurs Pre and Post Covid World, Success stories for few Entrepreneurs.	7
2.	**Entrepreneurial Opportunities and Process Selection:** Concept of Business Opportunity, How to Generate Business Ideas? Identification of Ideal and Viable Business Opportunities, Elements of a good business idea. the entrepreneurial process, Challenges in the Selection of Business Opportunities, Business Opportunities Identification Process, Required Licenses, Approvals and Expertise, Business Value Chain, Different Sections of the Business Value Chain for Potential Opportunities, Understanding Product Costs and Operations Costs; Legal Aspects.	7
3.	**Finance and Support Systems**: Raising Capital, Venture Capital, Angel Investors, Seed Funding, Role of Government in Promoting Entrepreneurship in India, Start-up India, Atmanirbhar Bharat, Make in India, Assistance to an Entrepreneur, Industrial park, Special Economic Zone, MSME Act, MSME Policy in India, Financial Assistance to MSME, Various Government Schemes - PMEGP, CGTMSE, PMKVY, Mudra Loan, Incubation, Role of Incubation Centers, Support from Incubation Centers	8
4.	**Business Plan:** Concept and definition of Business Plan, Contents of Business Plan: Executive Summary, Business Concept, Business Strategy, Management Summary, Marketing Plan, Operations Plan, Financial Plan, Presenting Business Plan, Procedure for setting up an Enterprise, Why Do Some Business Plans Fail?	8
	Total	**30**

Text Books:

1. C. B. Gupta and N. P. Srinivasan, Entrepreneurial Development, Sultan Chand & Sons, New Delhi, 2008

Reference Books:

1. Dr. Radha, Entrepreneurial Development, Prasana Publishers, Chennai, 2007.
2. S.S.Khanka, Entrepreneurial Development, Sultan Chand & Co., Ltd., New Delhi 2005
3. Stevenson, H. Perspective on entrepreneurship. Boston: Harvard Business Press, 2007

e-sources:

1. https://www.entrepreneur.com/
2. http://dst.gov.in/scientific-programme/t-d-tdb.htm
3. https://www.youtube.com/

Program:	B. Tech. (Mechanical Engineering)					Semester : VI
Course :	Computational Fluid Dynamics (PFC–IV)					Code : BME6914
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Hours	Credit	FA	SA	Total
--	2	2	--	--	--	--

Prior knowledge of:

a. Fundamental of Thermal Engineering, Fluid Mechanics and Heat Transfer and Mathematics.
b. Hands on experience on commercial design software like CAMD, CATIA, etc. is recommended…….are essential

Course Objectives:

1. To create an awareness of CFD among students
2. Students should be able to model fluid / heat transfer problems and apply fundamental conservation principles
3. To prepare the students for further graduate studies involving CFD analysis and its applications
4. To prepare the students for career in industry in CAE using software tools.

Course Outcomes:

The students should be able to:

1. **Use** suitable modern tools to formulate the problem
2. **Create** high quality grids and interprete the correctness of numerical results with physics.
3. **Analyze** the model fluid flow and heat transfer problems and **apply** relevant boundary conditions.
4. **Apply** the various numerical techniques for approximate results.
5. **Evaluate** and **Solve** flow problems and heat transfer by analyzing the results obtained from computational method.

Detailed Syllabus:

Unit	Description	Duration (H)
1	**Introduction to Computational fluid dynamics:** ● What is Computational Fluid Dynamics (CFD)? Significance of CFD in the industry. CFD analysis process: Preprocessing, Solver and Post processing. ● Introduction to any suitable software tool for CFD analysis. ● Introduction to Boundary conditions and Initial value conditions. ● Brief overview of Navier-Stokes equation ● Concept of Finite Difference Method (FDM) and Finite Volume Method (FVM)	4
2	● Overview of the ANSYS software tool a) Introduction Ansys Workbench, Geometry, Meshing, Fluent solver, Problem Set up, Post-processing module. b) Modeling: Turbulence modeling, Heat Transfer Modeling, Transient Flow Modeling	4
3	● Discretization: 1D, 2D and 3D element Meshing, Use of Symmetry, Mesh quality, Mesh independent test. **Case Study:** a) Internal flow: Flow through pipe, Forward facing step or Backward facing step b) External flow: Flow over Circular Cylinder	4
4	Aerodynamic analysis of an 2-Dimensional Ahmed Body	4
5	Solving a 2-Dimensional Conjugate Heat Transfer Problem using suitable commercial software	4
6	Melting and Solidification behavior of phase change material (PCM) in single shell and tube heat exchanger using ANSYS FLUENT.	4
	Total	24

Text Books:

1. A. Sharma, Introduction to Computational Fluid Dynamics, Athena Academic and John Wiley & Sons, UK, 2017
2. J. D. Anderson, Computational Fluid Dynamics, McGraw Hill, 1995
3. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2010.

Program:	B. Tech. (Mechanical Engineering)				Semester : VI	
Course :	Professional Development Training- II (MC-II)				Code : BHM6918	
Teaching Scheme				Evaluation Scheme		
Lecture	Practical	Tutorial	Credit	FA	SA	Total
3	-	-	-	-	-	-

Course Objectives:
This course aims at enabling the students
1. To enhance the logical reasoning skills of the students and improve the problem-solving abilities.
2. To improve the overall professional development of students

Course Outcomes: Students will be able to
After learning the course, the students will be:
1. Having adaptive thinking and adaptability through various Quantitative ability concepts.
2. Having critical thinking and innovative skills.
3. Having interest in lifelong learning & developing verbal competencies in the students.

Detailed Syllabus:

Unit	Description	Duration (H)
1.	**Modern Maths** Profit loss, Ratio & Proportion, LCM & HCF, Time speed and Distance, Average, Mean, mode, median, permutation & combination, Probability, Pipe & systems, Mixture validation, Allegations and Mixtures, Simple Interest and Compound Interest.	6
2.	**Algebra** Linear equations, Quadratic equations, Triplets. **Geometry** Triangles, Polygons (questions on Area Perimeter).	6
3.	**Mensuration** Cube cuboids cone cylinder sphere (questions on volume surface Area) **Trigonometry** **Number System** **Statistics.**	6
4.	**Logical Reasoning** Clocks and Calendar, Direction sense, Family tree, Syllogism, Seating arrangement, Team formation, Coding and Decoding, Number Series and Letter Series, Ranking and Arrangements, Game-Based Aptitude.	6
5.	**Data Interpretation** Data charts, Data tables, Bar, Pie, Line graphs, Venn diagram.	6
6.	**Verbal Ability & Reading Comprehension** Subject-Verb Agreement, Articles and Other Determiners, Prepositions, Tenses, Parts of Speech, Active and Passive Voice, Direct and Indirect Speech, Error Spotting and Sentence Correction, Sentence Completion, Synonyms and Antonyms, Reading Comprehension, Para Jumbles.	6
	Total	**36**

Reference Books:

1. Arun Sharma, Quantitative Aptitude, 2016, 7th Edition, McGraw Hill Education Pvt. Ltd.
2. ETHNUS, Aptimithra, 2013, 1stEdition, McGraw-Hill Education Pvt.Ltd.
3. R S Aggarwal, Quantitative Aptitude For Competitive Examinations, 2017, 3rd Edition, S. Chand Publishing, Delhi.
4. M. Tyra, Quicker Maths, 2018, 5th edition, 2018, BSC publishing company Pvt. Lt.

**** Students should get a passing grade if they will clear at least two online aptitude tests and achieve minimum criteria of attendance**

Program:	B. Tech. (Mechanical Engineering)			Semester: VI		
Course :	Constitution of India (AUDIT-III)			Code: BHM9962		
Teaching Scheme				Evaluation Scheme		
Lecture	Tutorial	Hours	Credit	FA	SA	Total
1	-	1	-	-	-	-

Course Objectives:

1. To enable the student to understand the importance of constitution
2. To identify individual role and ethical responsibility towards nation.
3. To understand human rights and its implications
4. To know about central and state government functionalities in India.

Course Outcomes:

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

1. Understand the functions of the Indian government and get acquainted with knowledge of Constitutional Amendments.
2. Identify and explore the basic features, modalities about Indian constitution and assessment of the Parliamentary System in India.
3. Differentiate and relate the functioning of Indian Political system at the Central and State level.
4. Comprehend the fundamental rights and abide the rules of the Indian constitution.

Detailed Syllabus:

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

Text Books:

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

Reference Books:

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

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

To be the department of sustainable academic excellence, fostering innovation, skill development, and work ethics leading to globally competent mechanical engineers.

जागतिक स्तरावर सक्षम यांत्रिक अभियंत्यांना मार्गदर्शन करणारा नावीन्य, कौशल्य विकास आणि कामाच्या नैतिकतेला चालना देणारा शाश्वत शैक्षणिक उत्कृष्टतेचा विभाग बनणे.

MISSION

1. **Nurture cohesive learning environment and develop matching ecosystem.**

   एकसंध शिक्षण वातावरण जोपासणे आणि जुळणारी परिसंस्था विकसित करणे.

2. **Cultivate excellent work ethics and right attitude among students by imparting essential skills and knowledge.**

   आवश्यक कौशल्ये आणि ज्ञान देऊन विद्यार्थ्यांमध्ये उत्कृष्ट कार्य नैतिकता आणि योग्य दृष्टिकोन विकसित करणे.

3. **Instill a sense of creativity, social responsibility and environmental awareness among students.**

   विद्यार्थ्यांमध्ये सर्जनशीलता, सामाजिक जबाबदारी, आणि पर्यावरण विषयक जागरुकता निर्माण करणे.

DEPARTMENT OF MECHANICAL ENGINEERING

Program Educational Objectives

1. To cultivate knowledge and skills in formulating, analyzing, and solving interdisciplinary engineering problems among the mechanical engineering graduates.
2. To inculcate right attitude and awareness about codes of professional practice, social commitment, and life-long learning among the mechanical engineering graduates.
3. To enhance professional competence for catering to the needs and expectations of society as a profound Mechanical Engineer.

Program Specific Outcomes

1. Conceptualize, design, model, simulate, and analyze mechanical components, systems and processes in complex interdisciplinary applications.
2. Develop sustainable solutions to real-life mechanical engineering problems in products and process industries.
3. To practice professional codes and conducts, safety norms, industrial engineering and management principles while working in the industry or as an entrepreneur.