



*Your Dreams Our Goal*  
**POORNIMA**  
**UNIVERSITY**

Member of Association of Indian Universities & Approved by UGC (Govt. of India) under 2(f) & 12(B)

# FACULTY OF ENGINEERING & TECHNOLOGY

## DEPARTMENT OF MECHANICAL ENGINEERING



## SCHEME & SYLLABUS BOOKLET

**BATCH 2022-2026**

# **SCHEME & SYLLABUS**

**BATCH: 2022-26**

**B.Tech in Mechanical Engineering  
(Specialization in Hybrid and Electric Vehicles)**

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**Disclaimer:** The scheme, syllabus and other materials published in this booklet may be changed or modified as per the requirement after approval of competent authority. The decision taken by the management of Poornima University will be final and abiding to all.

### Student Details

Name of Student:		
Name of Program:		
Semester:	Year:	Batch:
Faculty of:		



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### ***VISION***

To create knowledge based society with scientific temper, team spirit and dignity of labor to face global competitive challenges.

### ***Mission***

To evolve and develop skill based systems for effective delivery of knowledge so as to equip young professionals with dedication and commitment to excellence in all spheres of life.

### ***Quality Policy***

To provide Quality Education through Faculty development, updating of facilities and continual improvement meeting University norms and keeping stake holders satisfied.

## Knowledge Wheel

At Poornima, the academic atmosphere is a rare blend of modern technical as well as soft skills and traditional systems of learning processes.



## **About Program and Program Outcomes (PO):**

**Title of the Programme:** Bachelor of Technology (B. Tech.)

**Nature of the Programme:** B. Tech. is four year full-time programme.

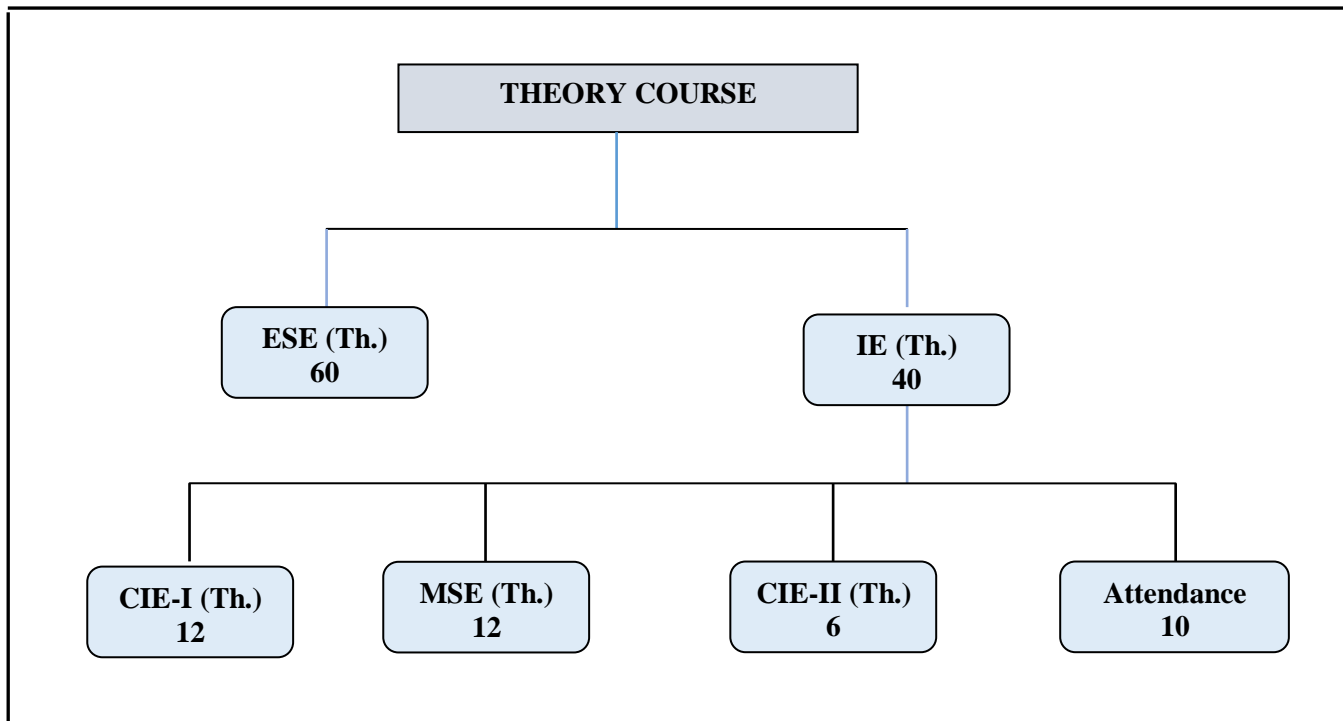
### **Program Outcomes (PO):**

Engineering Graduates will be able to:

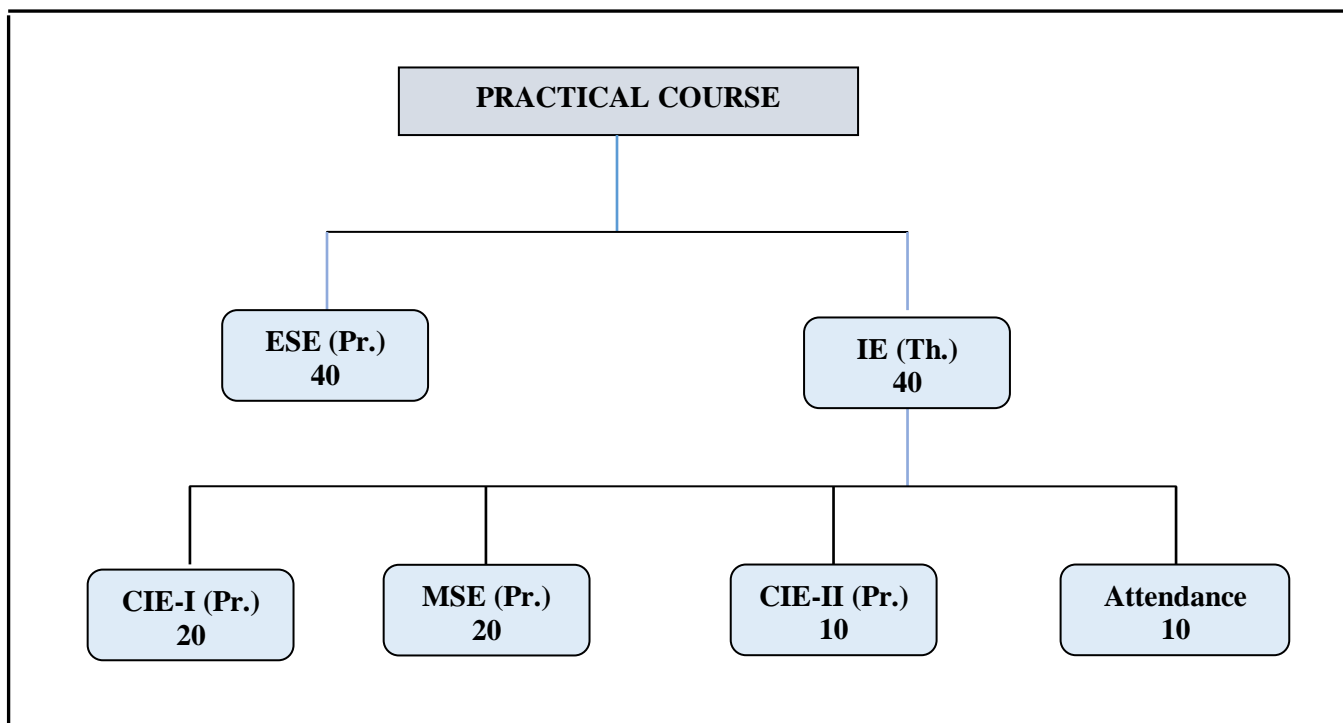
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

## Examination System:

### A. Marks Distribution of Theory Course:



### B. Marks Distribution of Practical Course :



**Th.:** Theory, **Pr.:** Practical, **ESE:** End Semester Examination, **MSE:** Mid Semester Examination, **CIE:** Continuous Internal Evaluation.

<b>Guidelines for Marks Distribution of Attendance Component</b>		
<b>S No.</b>	<b>Total Course Attendance (TCA) range in Percentage</b>	<b>Marks allotted (out of 10)</b>
1	$95\% \leq \text{TCA}$	10
2	$90\% \leq \text{TCA} < 95\%$	9
3	$85\% \leq \text{TCA} < 90\%$	8
4	$80\% \leq \text{TCA} < 85\%$	7
5	$70\% \leq \text{TCA} < 80\%$	6
6	$60\% \leq \text{TCA} < 70\%$	5
7	$50\% \leq \text{TCA} < 60\%$	4
8	$40\% \leq \text{TCA} < 50\%$	3
9	$30\% \leq \text{TCA} < 40\%$	2
10	$20\% \leq \text{TCA} < 30\%$	1
11	$\text{TCA} < 20\%$	0

### **CO Wise Marks Distribution:**

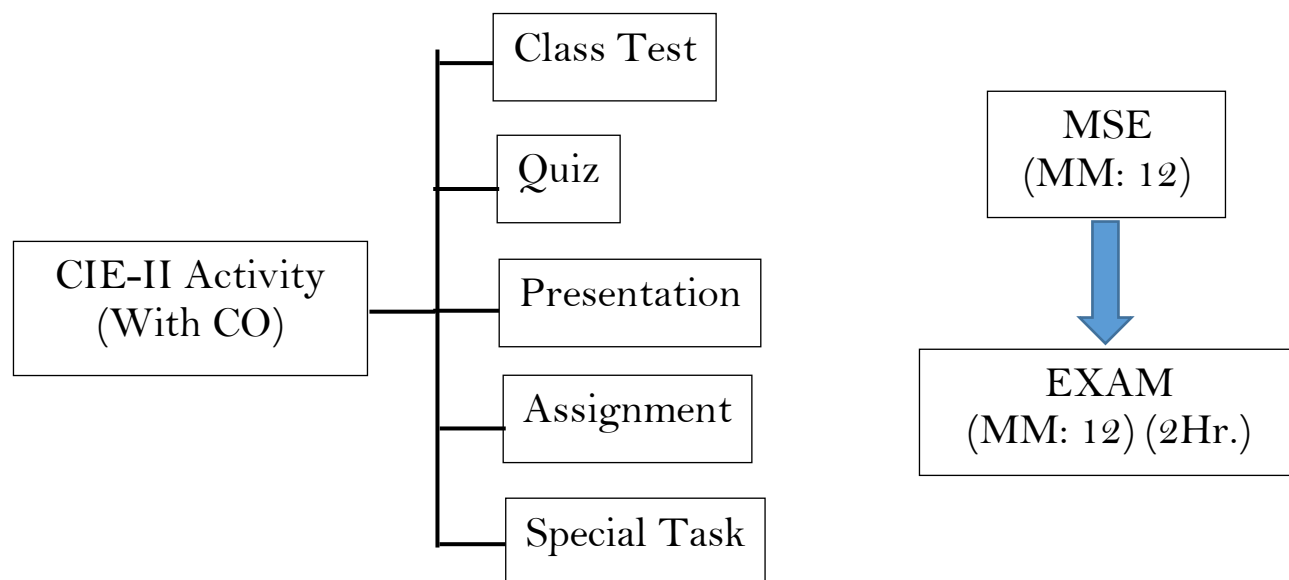
	<b>Theory Subject</b>		<b>Practical/ Studio Subject</b>	
	<b>Maximum Marks</b>	<b>CO to be Covered</b>	<b>CO to be Covered</b>	<b>Maximum Marks</b>
<b>CIE-I (Class Test)</b>	12 ( 6 + 6)	1 & 2	1 & 2	20 (10 + 10)
<b>MSE</b>	12 ( 6 + 6)	3 & 4	3 & 4	20 (10 + 10)
<b>CIE-II (Activity/ Assignment )</b>	6 (6)	5	5	10 (10)
<b>Attendance</b>	10	-	-	10
<b>ESE</b>	60	-	-	40
<b>TOTAL</b>	100	-	-	100



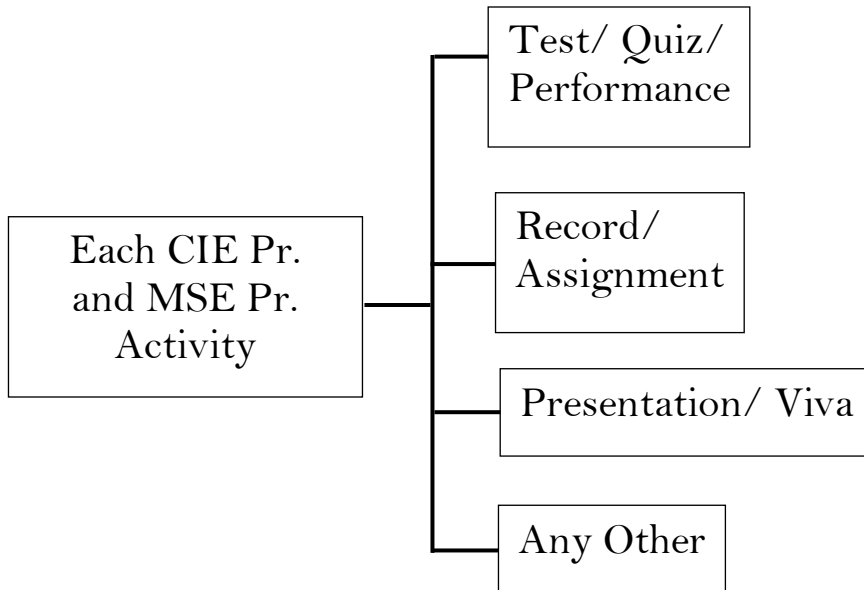
### Minimum Passing Percentage in All Exams:

S. No.	Program	Minimum Passing Percentage in All Exam	
		ESE Component	Total Component
1	Course Work for Ph. D Registration	-----	50 %
2	B. Arch.	45 %	50 %
3	MBA, MHA, MPH, MCA, M. Tech., M. Plan. and M. Des.	40 %	40 %
4	B. Tech., B. Des., BCA, B.Sc., BVA, B. Voc., BBA, B.Com., B.A. and Diploma	35 %	40 %
5	B. Sc. (Hospitality & Hotel Administration)	35 %	40 % (Theory) & 50 % (Practical)

### Break-up of Internal Exam (Theory):



**Break-up of Internal Exam (Practical):**



**Assessment & Grade Point Average: SGPA, CGPA:**

**SGPA Calculation**

$$SGPA = \frac{C_1G_1 + C_2G_2 + \dots + C_nG_n}{C_1 + C_2 + \dots + C_n}$$

$SGPA = \frac{\sum_i C_i \times G_i}{\sum_i C_i}$	<p>Where ( as per teaching Scheme &amp; Syllabus) :</p> <p><math>C_i</math> is the number of Credits of Courses <math>i</math>,</p> <p><math>G_i</math> is the Grade Point for the Course <math>i</math> and <math>i = 1, 2, \dots, n</math></p> <p><math>n</math> = number of courses in a programme in the Semester</p>
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**CGPA Calculation**

$$CGPA = \frac{C_1G_1 + C_2G_2 + \dots + C_nG_n}{C_1 + C_2 + \dots + C_n}$$

$CGPA = \frac{\sum_i C_i \times G_i}{\sum_i C_i}$	<p>Where ( as per teaching Scheme &amp; Syllabus) :</p> <p><math>C_i</math> is the number of Credits of Courses <math>i</math>,</p> <p><math>G_i</math> is the Grade Point for the Course <math>i</math> and <math>i = 1, 2, \dots, n</math></p> <p><math>n</math> = number of courses in a programme of all the Semester up to which CGPA is computed.</p>
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## Grading Table:

**Grading Table-A: For B.Arch. and course work for Ph.D. Registration**

Academic Performance	Grade	Grade Point	Marks Range ( in %)
Outstanding	A+	10	$90 \leq x \leq 100$
Excellent	A	9	$80 \leq x < 90$
Very good	B+	8	$70 \leq x < 80$
Good	B	7	$60 \leq x < 70$
Average	C	6	$50 \leq x < 60$
Fail	F	0	$x < 50$

**Grading Table-B: For all courses except B.Arch. and course work for Ph.D. Registration**

Academic Performance	Grade	Grade Point	Marks Range ( in %)
Outstanding	A+	10	$90 \leq x \leq 100$
Excellent	A	9	$80 \leq x < 90$
Very good	B+	8	$70 \leq x < 80$
Good	B	7	$60 \leq x < 70$
Average	C	6	$50 \leq x < 60$
Satisfactory	D	5	$40 \leq x < 50$
Fail	F	0	$x < 40$

*Calculation of SGPA*

$$SGPA = \frac{\sum C_i \times G_i}{\sum C_i}$$

$$SGPA = \frac{C_1G_1 + C_2G_2 + \dots + C_nG_n}{C_1 + C_2 + \dots + C_n}$$

*Calculation of CGPA*

$$CGPA = \frac{\sum C_i \times G_i}{\sum C_i}$$

$$CGPA = \frac{C_1G_1 + C_2G_2 + \dots + C_nG_n}{C_1 + C_2 + \dots + C_n}$$

where (as per teaching scheme & syllabus):  $C_i$  is the number of credits of subject  $i$ ,  $G_i$  is the Grade Point for the subject  $i$  and  $i = 1$  to  $n$ ,  $n$  = number of subjects in a course in the semester

## Award of Class:

CGPA	Equivalent Division
$7.50 \leq CGPA$	First Division with Distinction
$6.50 \leq CGPA < 7.50$	First Division
$5.50 \leq CGPA < 6.50$	Second Division
$4.50 \leq CGPA < 5.50$	Pass Class

The multiplication factor for conversion of CGPA to percentage is Equivalent % of Marks =  $(CGPA - 0.5) \times 10$ .

For Example if CGPA = 5.5 then % is  $(5.5 - 0.5) \times 10 = 50\%$ .

## **Guidelines for MOOC COURSES:**

1. Applicable from the session 2020 – 21 onwards, for students aspiring for HONOURS Degree.
2. The UGC has issued UGC (Credit Framework for Online Learning Courses) Regulation, 2016. These shall apply to all universities established or incorporated by or under a Central Act, a Provincial Act, or a State/Union Territory Act and all institutions recognized by or affiliated to such Universities and all institutions deemed to be universities under Section 3 of the UGC Act, 1956.
3. All India Council for Technical Education (AICTE) has introduced Model Curriculum for Bachelor programs of 4 years/ 3 Years, and additional credits will be required to be done for the degree of Bachelor program with Honours. These additional credits will have to be acquired with online courses (MOOCs) as per AICTE.
4. This creates an excellent opportunity for students to acquire the necessary skill set for employability through massive online courses where the rare expertise of world famous experts from academics and industry are available.
5. Students are required to complete additional credits through MOOCs within 4 years/ 3years of time (whatever be applicable time for the completion of registered program) so as to become eligible for Honours degree as per norms.
6. It is necessary to complete minimum MOOCs credit course as mentioned below for becoming eligible for the Honours degree in the registered program.
7. MOOC Course Credits shall be calculated as per details given below:
8. Student are required to give the prior information about MOOCs courses to his respective HOD and COE, in which he/she wants to register for online certification.
9. After getting permission from respective HOD, a student can register for the MOOC certification courses.
10. After successful completion of the said MOOC course, the student shall submit the certificate of completion to the respective department. If he/ she fails to provide the certificates of MOOC courses before last teaching day of the semester then these certificates will not be considered later.

**Required credits for Honours:**

S.No	Program Duration	Required credits for Honours
1.	2- Year	10- Credits
2.	3- Year	15- Credits
3.	4-Year	20- Credits

S. No	NPTEL/ SWAYAM Course duration (in weeks)	Equivalent Credits
1	4	2
2	8	3
3	12	4

**Attached Items:**

Open Elective Booklet	Annexure-1
Soft Skills Booklet	Annexure-2
Value Added Course Booklet	Annexure-3

POORNIMA UNIVERSITY								
Faculty of Engineering & Technology								
Department of First Year								
Batch: 2022-26								
Name of Programs								
B.Tech. (ME/EE/Civil)				B.Tech. (Electrical and Computer Engineering)				
B.Tech. ME/EE (spec. in Hybrid & Electric vehicles)				B.Tech. (Computer Engineering)				
Teaching Scheme for Year I Semester I								
Course Code	Course Name	Teaching Scheme (Hrs per Week)			Marks Distribution			Credits
		Lecture (L)	Tutorials (T)	Practical (P)	IE	ESE	Total	
<b>A.</b>	<b>University Core Courses</b>							
BULCSA1101	Environmental Studies	2	-	-	40	60	100	2
<b>B.</b>	<b>Department Core Courses</b>							
<b>B.1</b>	<b>Theory</b>							
BTXCSEA1101 / BTXCSEA1102	Engineering Mathematics / Engineering Physics	3	1	-	40	60	100	3
BTXCCEE1103 / BTXCCEM1104	Electrical & Electronics Engineering / Engineering Mechanics	3	1	-	40	60	100	3
BTXCCEE1105/ BTXCCEE1106	Programming in C / Introduction to Futuristic Technologies	3	-	-	40	60	100	3
BTXCCEE1107	Fundamental of computing	3	-	-	40	60	100	3
<b>B.2</b>	<b>Practical</b>							
BTXCCEM1201 / BTXCSEA1202	Machine Drawing Lab/ Engineering Physics Lab-I	-	1	2	60	40	100	1
BTXCCEE1203 / BTXCCEM1204	Electrical & Electronics Engineering Lab / Workshop Practice	-	1	2	60	40	100	1
BTXCCEE1205 / BTXCCEM1206	Programming in C Lab / Practical Geometry	-	1	2	60	40	100	1
BTXCHM1207/ BTXCHM1208	Foundation English / Language Lab	-	-	2	60	40	100	1
<b>C.</b>	<b>Department Elective</b>							
	Nil							
<b>D.</b>	<b>Open Elective</b>							
	Nil							
<b>E.</b>	<b>Humanities and Social Sciences including Management courses (AECC)</b>							
	Nil							
<b>F.</b>	<b>Skill Enhancement Courses (SEC) OR Project work, Seminar and Internship in Industry or Elsewhere</b>							
BTXCTX1301	Project	-	-	4	60	40	100	2
<b>G.</b>	<b>Discipline, Value Added Courses &amp; Social Outreach</b>							
BTXCTX1601	Talent Enrichment Programme (TEP)-I	-	-	-	50	-	50	1
	Library / MOOC / Online Certification Courses	1	-	-				
	Non syllabus project/ Industrial Visit / CRT	1	-	-				
	<b>Total</b>	<b>16</b>	<b>05</b>	<b>12</b>				
	<b>Total Teaching Hours</b>	<b>33</b>						<b>21</b>

POORNIMA UNIVERSITY								
Faculty of Engineering & Technology								
Faculty of Computer Science and Engineering								
Department of First Year								
Batch: 2022-26								
Name of Programs				B.Tech. ME/EE (spec. in Hybrid & Electric vehicles)				
B.Tech. (ME/EE/Civil)				B.Tech. (Electrical and Computer Engineering)				
Teaching Scheme for Year I Semester II								
Course Code	Course Name	Teaching Scheme (Hrs per Week)			Marks Distribution			Credits
		Lecture (L)	Tutorials (T)	Practical (P)	IE	ESE	Total	
<b>A.</b>	<b>University Core Courses</b>							
	NIL							
<b>B.</b>	<b>Department Core Courses</b>							
<b>B.1</b>	<b>Theory</b>							
BTXCSA2101	Engineering Chemistry	3	-	-	40	60	100	3
BTXCSA2102 / BTXCSA2103	Engineering Mathematics / Engineering Physics	3	1	-	40	60	100	3
BTXCEE2104 / BTXCME2105	Electrical & Electronics Engineering / Engineering Mechanics	3	1	-	40	60	100	3
BTXCCE2106/ BTXCEE2107	Programming in C / Introduction to Futuristic Technologies	3	-	-	40	60	100	3
<b>B.2</b>	<b>Practical</b>							
BTXCSA2201	Engineering Chemistry Lab		-	2	60	40	100	1
BTXCME2202 / BTXCSA2203	Machine Drawing Lab / Engineering Physics Lab-1	-	1	2	60	40	100	1
BTXCEE2204 / BTXCME2205	Electrical & Electronics Engineering Lab / Workshop Practice	-	1	2	60	40	100	1
BTXCCE2206 / BTXCME2207	Programming in C Lab / Practical Geometry	-	1	2	60	40	100	1
BTXCHM2208/ BTXCHM2209	Foundation English / Language Lab	-	-	2	60	40	100	1
<b>C.</b>	<b>Department Elective</b>							
	Nil							
<b>D.</b>	<b>Open Elective: Anyone</b>							
	<i>As per Annexure-I</i>	2	-	-	40	60	100	2
<b>E.</b>	<b>Humanities and Social Sciences including Management courses</b>							
	Nil							
<b>F.</b>	<b>Skill Enhancement Courses (SEC) OR Project work, Seminar and Internship in Industry or Elsewhere</b>							
	Nil							
<b>G.</b>	<b>Discipline, Value Added Courses &amp; Social Outreach</b>							
BTXCTX2601	Talent Enrichment Programme (TEP)-II	-	-	-	50	-	50	1
	Library / MOOC / Online Certification Courses	2	-	-				
	Non syllabus project/ Industrial Visit / CRT	2	-	-				
	<b>Total</b>	<b>18</b>	<b>05</b>	<b>10</b>				
	<b>Total Teaching Hours</b>	<b>33</b>						<b>20</b>

**POORNIMA UNIVERSITY, JAIPUR**

**School of Engineering & Technology**

**B. Tech. (Mechanical Engineering), Batch: 2022-26**

**Teaching Scheme for Second Year - Third Semester**

Course Code	Course Name	Teaching Scheme (Hrs. per Week)			Marks Distribution			Credits
		Lecture (L)	Tutorials (T)	Practical (P)	IE	ESE	Total	
<b>A.</b>	<b>University Core Courses</b>							
<b>A.1</b>	<b>Theory</b>							
BMECSA3101	Engineering Mathematics - II	3	1	0	40	60	100	3
<b>B.</b>	<b>Department Core Courses</b>							
<b>B.1</b>	<b>Theory</b>							
BMECME3102	Mechanics of Solids	3	1	0	40	60	100	3
BMECME3103	Material Science and Engineering	3	0	0	40	60	100	3
BMECME3104	Engineering Thermodynamics	3	0	0	40	60	100	3
<b>B. 2</b>	<b>Practical</b>							
BMECME3201	Material Testing Lab	0	0	2	60	40	100	1
BMECME3202	Thermal Engineering Lab	0	0	2	60	40	100	1
BMECCE3203	Python Programming Lab	0	0	2	60	40	100	1
BMECME3204	Machine Drawing and AutoCAD Lab	0	0	2	60	40	100	1
<b>C.</b>	<b>Department Elective</b>							
BMEEME3111	Automation and Robotics	3	1	0	40	60	100	3
BMEEME3112	Smart Technologies for Industry 4.0							
BMEEEE3113	Electrical Machines							
<b>D.</b>	<b>Open Elective</b>							
	As Per Annexure-I	2	0	0	40	60	100	2
<b>E.</b>	<b>Humanities and Social Sciences including Management courses (HSSM) OR Ability Enhancement Compulsory Course (AECC)</b>							
BMECHM3209	Human Values & Professional Ethics	0	0	2	60	40	100	1
<b>F.</b>	<b>Skill Enhancement Courses (SEC) OR Project work, Seminar and Internship</b>							
	NA							
<b>G.</b>	<b>Discipline, Value Added Courses &amp; Social Outreach</b>							
BMECME3601	Non Syllabus Project	1	-	-	50	-	50	1
	Online Certification Course	2	-	-				
	<b>Total</b>	<b>20</b>	<b>3</b>	<b>10</b>				
	<b>Total Teaching Hours</b>	<b>33</b>			<b>590</b>	<b>560</b>	<b>1150</b>	<b>23</b>



POORNIMA UNIVERSITY, JAIPUR								
Faculty of Engineering & Technology								
B. Tech. ( Mechanical Engineering), Batch: 2022-26								
Teaching Scheme for Second Year - Fourth Semester								
Course Code	Course Name	Teaching Scheme (Hrs. per Week)			Marks Distribution			Credits
		Lecture (L)	Tutorials (T)	Practical (P)	IE	ESE	Total	
<b>A.</b>	<b>University Core Courses</b>							
	Nil							
<b>B.</b>	<b>Department Core Courses</b>							
<b>B.1</b>	<b>Theory</b>							
BMECME4101	Mechatronics	3	1	0	40	60	100	3
BMECME4102	Theory of Machines	3	1	0	40	60	100	3
BMECME4103	Manufacturing Process	3	0	0	40	60	100	3
BMECME4104	Fluid Mechanics and Fluid Machines	3	1	0	40	60	100	3
<b>B.2</b>	<b>Practical</b>							
BMECME4201	Theory of Machines Lab	0	0	2	60	40	100	1
BMECME4202	Manufacturing Technology Lab – I	0	0	2	60	40	100	1
BMECME4203	Fluid Mechanics and Fluid Machines Lab	0	0	2	60	40	100	1
BMECME4204	Computer Aided Design Lab-I	0	0	2	60	40	100	1
<b>C.</b>	<b>Department Elective</b>							
BMEEME4111	Fundamental of Electric and Hybrid Vehicles	3	0	-	40	60	100	3
BMEEME4112	Additive Manufacturing and Prototyping							
BMEEME4113	Non Destructive Evaluation and Testing							
<b>D.</b>	<b>Open Elective</b>							
	As Per Annexure-I	2	0	0	40	60	100	2
<b>E.</b>	<b>Humanities and Social Sciences including Management courses (HSSM) OR Ability Enhancement Compulsory Course (AECC)</b>							
BMECHM4209	Leadership & Management Skills	0	0	2	60	40	100	1
<b>F.</b>	<b>Skill Enhancement Courses (SEC) OR Project work, Seminar and Internship</b>							
	NA							
<b>G.</b>	<b>Discipline, Value Added Courses &amp; Social Outreach</b>							
BMECME4601	Non Syllabus Project	2	-	-	50	-	50	1
	Online Certification Course	1	-	-				
	<b>Total</b>	<b>20</b>	<b>3</b>	<b>10</b>				
	<b>Total Teaching Hours</b>	<b>33</b>			<b>590</b>	<b>560</b>	<b>1150</b>	<b>23</b>

POORNIMA UNIVERSITY, JAIPUR								
School of Engineering & Technology								
B. Tech. ( Mechanical Engineering), Batch: 2022-26								
Teaching Scheme for Third Year - Fifth Semester								
Course Code	Course Name	Teaching Scheme (Hrs. per Week)			Marks Distribution			Credits
		Lecture (L)	Tutorials (T)	Practical (P)	IE	ESE	Total	
<b>A.</b>	<b>University Core Courses</b>							
	Nil							
<b>B.</b>	<b>Department Core Courses</b>							
<b>B.1</b>	<b>Theory</b>							
BMECME5101	Design of Machine Elements - I	3	0	0	40	60	100	3
BMECME5102	Manufacturing Science and Technology	3	0	0	40	60	100	3
BMECME5103	Operation Research	3	0	0	40	60	100	3
BMECME5104	Automobile and IC Engine	3	0	0	40	60	100	3
BMECME5105	Heat and Mass Transfer	3	0	0	40	60	100	3
<b>B.2</b>	<b>Practical</b>							
BMECME5201	Manufacturing Technology Lab - II	0	0	2	60	40	100	1
BMECME5202	Automobile and IC Engine Lab	0	0	2	60	40	100	1
BMECME5203	Heat Transfer Lab	0	0	2	60	40	100	1
<b>C.</b>	<b>Department Elective</b>							
BMEEME5111	Sensors and Controls	3	0	0	40	60	100	3
BMEEME5112	Operation Management							
BMEEME5113	Product Design and Development							
<b>D.</b>	<b>Open Elective</b>							
	As Per Annexure-I	2	0	0	40	60	100	2
<b>E.</b>	<b>Humanities and Social Sciences including Management courses (HSSM) OR Ability Enhancement Compulsory Course (AECC)</b>							
BMECHM5209	Professional Skills-I	0	0	2	60	40	100	1
BMECHM5210	Communication Skills-I	0	0	2	60	40	100	1
<b>F.</b>	<b>Skill Enhancement Courses (SEC) OR Project work, Seminar and Internship</b>							
BMECME5401	Technical Seminar	-	-	2	60	40	100	1
<b>G.</b>	<b>Discipline, Value Added Courses &amp; Social Outreach</b>							
BMECME5601	Online Certification Courses	-	-	-	50	-	50	1
	Campus Recruitment Training	1	-	-				
	<b>Total</b>	<b>21</b>	<b>0</b>	<b>12</b>				
	<b>Total Teaching Hours</b>	<b>33</b>			<b>630</b>	<b>620</b>	<b>1250</b>	<b>27</b>

POORNIMA UNIVERSITY, JAIPUR								
School of Engineering & Technology								
B. Tech. ( Mechanical Engineering), Batch: 2022-26								
Teaching Scheme for Third Year - Sixth Semester								
Course Code	Course Name	Teaching Scheme (Hrs. per Week)			Marks Distribution			Credits
		Lecture (L)	Tutorials (T)	Practical (P)	IE	ESE	Total	
<b>A.</b>	<b>University Core Courses</b>							
	Nil							
<b>B.</b>	<b>Department Core Courses</b>							
<b>B.1</b>	<b>Theory</b>							
	Nil							
<b>B.2</b>	<b>Practical</b>							
	Nil							
<b>C.</b>	<b>Department Elective</b>							
	Nil							
<b>D.</b>	<b>Open Elective</b>							
	Nil							
<b>E.</b>	<b>Humanities and Social Sciences including Management courses (HSSM) OR Ability Enhancement Compulsory Course (AECC)</b>							
	Nil							
<b>F.</b>	<b>Skill Enhancement Courses (SEC) OR Project work, Seminar and Internship</b>							
BMECME6301	Minor Project	-	-	2	60	40	100	1
BMECME6401	Industrial Training and Seminar-II	-	-	24	60	40	100	12
<b>G.</b>	<b>Discipline, Value Added Courses &amp; Social Outreach</b>							
BMECME6601	Online Certification Course	1	-	-	50	-	50	1
	<b>Total</b>	<b>1</b>	<b>-</b>	<b>26</b>				
	<b>Total Teaching Hours</b>	<b>27</b>			<b>170</b>	<b>80</b>	<b>250</b>	<b>14</b>

Note: all students are required to go to internship for 6 months.

POORNIMA UNIVERSITY, JAIPUR								
School of Engineering & Technology								
B. Tech. ( Mechanical Engineering), Batch: 2022-26								
Teaching Scheme for Fourth Year - Seventh Semester								
Course Code	Course Name	Teaching Scheme (Hrs. per Week)			Marks Distribution			Credits
		Lecture (L)	Tutorials (T)	Practical (P)	IE	ESE	Total	
<b>A.</b>	<b>University Core Courses</b>							
	Nil							
<b>B.</b>	<b>Department Core Courses</b>							
<b>B.1</b>	<b>Theory</b>							
BMECME7101	Design of Machine Element - II	3	-	-	40	60	100	3
BMECME7102	Industrial Engineering	3	-	-	40	60	100	3
BMECME7103	Unconventional Machining Processes	3	-	-	40	60	100	3
BMECME7104	Vibration Engineering	3	-	-	40	60	100	3
BMECME7105	Refrigeration and Air Conditioning	3	-	-	40	60	100	3
<b>B.2</b>	<b>Practical</b>							
BMECME7201	Industrial Engineering and Robotics Lab	-	-	2	60	40	100	1
BMECME7202	Vibration Engineering Lab	-	-	2	60	40	100	1
BMECME7203	Refrigeration and Air Conditioning Lab	-	-	2	60	40	100	1
<b>C.</b>	<b>Department Elective</b>							
BMEEEE7111	Energy Storage in Electric Vehicles	3	-	-	40	60	100	3
BMEEME7112	Reliability and Maintenance Engineering							
BMEEME7113	Finite Element Analysis							
<b>D.</b>	<b>Open Elective</b>							
	As Per Annexure-I	2	-	-	40	60	100	2
<b>E.</b>	<b>Humanities and Social Sciences including Management courses (HSSM) OR Ability Enhancement Compulsory Course (AECC)</b>							
BMECHM7209	Professional Skills-II	-	-	2	60	40	100	1
BMECHM7210	Use of Social Media	-	-	2	60	40	100	1
<b>F.</b>	<b>Skill Enhancement Courses (SEC) OR Project work, Seminar and Internship</b>							
	Nil							
<b>G.</b>	<b>Discipline, Value Added Courses &amp; Social Outreach</b>							
BMECME7601	Online Certification Courses	1	-	-	50	-	50	1
	Campus Recruitment Training	2	-	-				
	<b>Total</b>	<b>23</b>	<b>0</b>	<b>10</b>				
	<b>Total Teaching Hours</b>	<b>33</b>			<b>630</b>	<b>620</b>	<b>1250</b>	<b>26</b>

POORNIMA UNIVERSITY, JAIPUR								
School of Engineering & Technology								
B. Tech. ( Mechanical Engineering), Batch: 2022-26								
Teaching Scheme for Fourth Year - Eighth Semester								
Course Code	Course Name	Teaching Scheme (Hrs. per Week)			Marks Distribution			Credits
		Lecture (L)	Tutorials (T)	Practical (P)	IE	ESE	Total	
<b>A.</b>	<b>University Core Courses</b>							
	Nil							
<b>B.</b>	<b>Department Core Courses</b>							
<b>B.1</b>	<b>Theory</b>							
BMECME8101	Six Sigma	3	-	-	40	60	100	3
BMECME8102	Computer Integrated Manufacturing	3	-	-	40	60	100	3
<b>B.2</b>	<b>Practical</b>							
BMECME8201	CNC Programming Lab	-	-	2	60	40	100	1
BMECME8202	Computer Aided Design Lab-II	-	-	2	60	40	100	1
<b>C.</b>	<b>Department Elective</b>							
BMEEME8111	Design and Development of Electric & Hybrid Vehicles	3	0	0	40	60	100	3
BMEEME8112	Industrial Internet of Things							
BMEEME8113	Emerging Automotive Technology							
<b>D.</b>	<b>Open Elective</b>							
	Nil							
<b>E.</b>	<b>Humanities and Social Sciences including Management courses (HSSM) OR Ability Enhancement Compulsory Course (AECC)</b>							
BMECHM8209	Communication Skills-II	-	-	2	60	40	100	1
<b>F.</b>	<b>Skill Enhancement Courses (SEC) OR Project work, Seminar and Internship</b>							
BMECME8301	Major Project/Dissertation	-	-	16	60	40	100	8
<b>G.</b>	<b>Discipline, Value Added Courses &amp; Social Outreach</b>							
BMECME8601	Online Certification Course	2	-	-	50	-	50	1
	<b>Total</b>	<b>11</b>	<b>0</b>	<b>22</b>				
	<b>Total Teaching Hours</b>	<b>33</b>			<b>410</b>	<b>340</b>	<b>750</b>	<b>21</b>

# FIRST SEMESTER

## CORE THEORY SUBJECTS

**Code: BULCSA1101**

**ENVIRONMENTAL STUDIES**

**2.0 Credits [LTP: 2-0-0]**

### COURSE OUTCOME

Students will be able to:

CO1: Understand the scope of environmental studies and explain the concept of ecology, ecosystem and biodiversity.

CO2: Implement innovative ideas of controlling different categories of Environmental Pollution.

CO3: Explain different environmental issues together with various Environmental Acts, regulations and International Agreements.

CO4: Summarize social issues related to population, resettlement and rehabilitation of project affected persons and demonstrate disaster management with special reference to floods, earthquakes, cyclones, landslides.

CO5: Determine the local environmental assets with simple ecosystems and identify local flora and fauna.

### A. OUTLINE OF THE COURSE

Unit No.	Title of the unit	Time required for the Unit (Hours)
1.	Introduction to environmental studies	6
2.	Environmental Pollution and its control	5
3.	Environmental Policies & Practices	5
4.	Human Communities and the Environment	5
5.	Field work	5

### B. DETAILED SYLLABUS

Unit	Unit Details
1.	<b>Introduction to environmental studies</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Multidisciplinary nature of environmental studies</li> <li>• Concept of sustainability and sustainable development.</li> <li>• Ecosystem: Structure and function of ecosystem</li> <li>• Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies\</li> <li>• Case studies of the following ecosystems: Forest ecosystem, Grassland ecosystem, Desert ecosystem Aquatic ecosystems</li> <li>• Biodiversity and Conservation</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
2.	<b>Environmental Pollution and its control</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution</li> <li>• Nuclear hazards and human health risks</li> <li>• Solid waste management: Control measures of urban and industrial waste.</li> <li>• Pollution case studies</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
3.	<b>Environmental Policies &amp; Practices</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture</li> <li>• Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.</li> <li>• Environment Laws: Environment Protection Act; Air (Prevention &amp; Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act.</li> <li>• International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD)</li> </ul>

	<ul style="list-style-type: none"> <li>• Conclusion of Unit including Real Life Application</li> </ul>
<b>4.</b>	<b>Human Communities and the Environment</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Human population growth: Impacts on environment, human health and welfare.</li> <li>• Resettlement and rehabilitation of project affected persons; case studies.</li> <li>• Disaster management: floods, earthquake, cyclones and landslides.</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
<b>5.</b>	<b>Field work</b>
	<ul style="list-style-type: none"> <li>• Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc.</li> <li>• Visit to a local polluted site-Urban/Rural/Industrial/Agricultural.</li> <li>• Study of common plants, insects, birds and basic principles of identification.</li> <li>• Study of simple ecosystems-pond, river, Delhi Ridge, etc.</li> </ul>

**C. RECOMMENDED STUDY MATERIAL:**

Sr. No	Reference Book	Author	Edition	Publication
1	Environmental Studies	Erach Barucha	Latest	UGC
2	Environmental Studies	Benny Joseph	Latest	Tata McgrawHill
3	Environmental Studies	R. Rajagopalan	Latest	Oxford University Press
4	Principles of Environmental Science and Engineering	P. Venugoplan Rao	Latest	Prentice Hall of India.
5	Environmental Science and Engineering	P. Meenakshi	Latest	Prentice Hall India.
<b>Important Web Links</b>				
1	<a href="http://www.energy.gov">http://www.energy.gov</a>			
2	<a href="https://nptel.ac.in/courses/122102006/">https://nptel.ac.in/courses/122102006/</a>			

**COURSE OUTCOME**

The student would be able to:

- CO1 Analyze and prove relationships between matrices, rank of matrix and systems of equations, Inverses.
- CO2 Analyze the basic structure of differential equations, and order and degree of the first order and its simple applications.
- CO3 Utilize methods of integration to evaluate volumes and surface of objects and lengths of curves.
- CO4 Apply vector differentiation, and integration in the scalar and vector fields
- CO5 Apply line, surface and volume integral with the help of green's theorem, Gauss's theorem and Stokes theorem.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the Unit	Time required for the Unit (Hours)
1	Matrices	7
2	Integral Calculus	8
3	Ordinary Differential Equations	8
4	Introduction Vector Calculus	8
5	Application of Vector Calculus	8

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1.</b>	<b>Matrices</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Rank of a Matrix, Normal form of a Matrix</li> <li>• Consistency of systems of linear equations</li> <li>• Eigen Values and Eigen Vectors</li> <li>• Cayley-Hamilton Theorem (without proof)</li> <li>• Conclusion of Unit</li> </ul>
<b>2.</b>	<b>Ordinary Differential Equations</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• First order and first-degree differential equations-Separable Variables,</li> <li>• Linear Equation and reducible to linear form, Exact Equation</li> <li>• Linear differential equations with constant coefficients</li> <li>• Conclusion of Unit</li> </ul>
<b>3.</b>	<b>Integral Calculus</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Beta and Gamma functions and their properties</li> <li>• Surfaces and Volumes of Solids of Revolutions</li> <li>• Double integrals, Double integral by changing into polar form, Areas by Double Integration</li> <li>• Change of order of integration</li> <li>• Conclusion of Unit</li> </ul>
<b>4.</b>	<b>Vector Calculus</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Scalar and Vector field</li> <li>• Differentiation and Integration of Vector functions</li> <li>• Gradient, Divergence and Curl, Directional derivatives</li> <li>• Conclusion of Unit</li> </ul>
<b>5.</b>	<b>Application of Vector Calculus</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Line, Surface and Volume integral</li> <li>• Gauss, Stocks and Green theorem (without proof) and its applications</li> <li>• Conclusion of Unit</li> </ul>



**C. RECOMMENDED STUDY MATERIAL:**

<b>Sr.No</b>	<b>Reference Book</b>	<b>Author</b>	<b>Edition</b>	<b>Publication</b>
1.	Higher Engineering Mathematics	B S Grewal	Latest	Khanna Publications, Delhi,
2.	Higher Engineering Mathematics	Ramana, B.V	Latest	Tata McGraw-Hill.
3	Engineering Mathematics: A Tutorial Approach	Ravish R Singh and M Bhatt	Latest	Tata McGraw-Hill
4	Calculus and Analytical Geometry	Thomas and Finney,	Latest	Narosa Publishing, New Delhi
5	Advanced Engineering Mathematics	Erwin Kreyszig	Latest	John Wiley and Sons
<b>Important Web Links:</b>				
1	<a href="https://nptel.ac.in/courses/111105134/">https://nptel.ac.in/courses/111105134/</a>			
2	<a href="https://nptel.ac.in/courses/122/101/122101001/">https://nptel.ac.in/courses/122/101/122101001/</a>			
3	<a href="https://www.classcentral.com/course/swayam-engineering-mathematics-i-13000">https://www.classcentral.com/course/swayam-engineering-mathematics-i-13000</a>			

**COURSE OUTCOME**

The student will be able to:

CO1 Produce coherent sources and phenomenon of interference and diffraction

CO2 Compare quantum mechanical history with experimental facts and its applications.

CO3 Debates in laser and fibre optics and apply it for suitable applications.

CO4 Point out the basic principles of relativity, twin paradox and energy-mass relations.

CO5 Categorize different bonding in materials, band theory and semiconductor material.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1	Wave Optics	8
2	Quantum Mechanics	8
3	Laser & Optical Fibre	8
4	Special Theory of Relativity	7
5	Elements of Material Science	8

**B. DETAILED SYLLABUS**

Unit No.	Unit Details
<b>1.</b>	<b>Wave Optics</b>
	<ul style="list-style-type: none"> <li>• <b>Introduction of Unit</b></li> <li>• <b>Interference of light:</b> Types of interference, Coherent source, methods to produce coherent sources with examples.</li> <li>• Newton's Rings: Principle, Construction, working &amp; Applications</li> <li>• <b>Diffraction of light:</b> Fraunhofer Diffraction from a Single Slit</li> <li>• <b>Diffraction grating:</b> Introduction and its construction</li> <li>• Resolving power and Rayleigh criterion for limit of resolution</li> <li>• Conclusion of Unit</li> </ul>
<b>2.</b>	<b>Quantum Mechanics</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Black body radiation and Planck's hypothesis</li> <li>• Compton Effect, Compton shift</li> <li>• Wave function and its basic postulates</li> <li>• Physical interpretation of wave function and its properties</li> <li>• Time dependent and time independent Schrodinger's Wave Equation,</li> <li>• Applications of the Schrodinger's Equation: Particle in one dimensional box</li> <li>• Conclusion of Unit</li> </ul>
<b>3.</b>	<b>Laser &amp; Optical Fibre</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Theory of laser action: Einstein's Coefficients, Components of laser, Threshold conditions for laser action</li> <li>• Theory, Design and Applications of He-Ne Laser</li> <li>• Optical Fibre: Construction and working principle of Optical fiber</li> <li>• Types of optical fibre (on the basis of modes and the refractive index of the medium)</li> <li>• Applications of optical fibre</li> <li>• Conclusion of Unit</li> </ul>
<b>4.</b>	<b>Special Theory of Relativity</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Inertial and non-inertial frames of Reference.</li> <li>• Postulates of special theory relativity</li> <li>• Galilean and Lorentz Transformations, Length contraction, Mass Variation and Time Dilation.</li> <li>• Relativistic Mass-Energy relation</li> <li>• Relativistic Energy and Momentum</li> </ul>

	<ul style="list-style-type: none"> <li>• Conclusion of Unit</li> </ul>
<b>5</b>	<b>Elements of Material Science</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit: Bonding in solids, Covalent bonding and Metallic bonding</li> <li>• Classification of Solids as Insulator, Semi-Conductor and Conductor</li> <li>• Semiconductors: Conductivity in Semiconductors</li> <li>• Determination of band gap of a semiconductor</li> <li>• Hall Effect: Theory, Hall Coefficients and application to determine the sign of charge carrier</li> <li>• Conclusion of Unit</li> </ul>

### C. RECOMMENDED STUDY MATERIAL

Sr.No	Reference Books	Author	Edition	Publication
1.	Fundamental of Optics	Jenkins and While	4 <sup>th</sup>	Tata McGraw-Hill
2.	Optics	Ajoy Ghatak	3 <sup>rd</sup>	Tata McGraw-Hill
3.	A Text Book of optics	Brijlal & Subramaniam	Latest	S.Chand and co. Ltd
4.	Quantum Mechanics	Schiff	3 <sup>rd</sup>	Tata Mc Graw-Hill
5.	Concept of Modern Physics	Beiser	Latest	Tata McGraw-Hill
6.	Introduction to special Theory of Relativity	R. Resnick	Latest	Johan Willy Singapore
7.	Elements of Properties of Matter	D.S.Mathur	Latest	S.Chand& Co.
8.	Solid State Physics	S.O.Pillai	Latest	Wiley Eastern Ltd.
<b>Important Web Links</b>				
1.	<a href="https://nptel.ac.in/courses/122107035/">https://nptel.ac.in/courses/122107035/</a>			
2.	<a href="https://nptel.ac.in/courses/122103011/">https://nptel.ac.in/courses/122103011/</a>			
3.	<a href="https://www.khanacademy.org/science/physics">https://www.khanacademy.org/science/physics</a>			
4.	<a href="https://ocw.mit.edu/courses/physics/">https://ocw.mit.edu/courses/physics/</a>			

**COURSE OUTCOME**

The student will be able to:

CO1 Apply basic electrical concepts, including various circuit analysis techniques and fundamentals of theorem, in practical applications.

CO2 Analyze the fundamentals of AC circuits such as the R.M.S value, average value, active power, reactive power, power factor, form factor, peak factor and their applications.

CO3 Analyze the energy conversion process and fundamentals of rotating and stationary electrical machines with their application in real life.

CO4 Analyze the working of semiconductor devices such as Diode, BJT, UJT, photovoltaic cells, filters and fundamentals of digital electronics.

CO5 Illustrate the concepts of Communication systems and Instrumentation engineering in practical applications.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the Unit	Time required for the Unit (Hours)
1.	Basic Concepts of Electrical Engineering	8
2.	Alternating Quantities and Electrical Installations	8
3.	Energy Conversion and Electrical Machines	7
4.	Basic Electronics	8
5.	Communication Systems and IoT	8

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1.</b>	<b>Basic Concepts of Electrical Engineering</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Basic Concepts: Electric Current, Electromotive Force, Electric Power, Ohm's Law, Basic Circuit Components, Faraday's Law of Electromagnetic Induction.</li> <li>• DC Network Analysis &amp; Theorems: Kirchhoff's Laws, Network Sources, Resistive Networks, Series-Parallel Circuits, Star-Delta Transformation, Node Voltage Method, Mesh Current Method, Super- Position, Thevenin's, Norton's and Maximum Power Transfer Theorems.</li> <li>• Conclusion of Unit</li> </ul>
<b>2.</b>	<b>Alternating Quantities and Electrical Installations</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Single Phase AC system: Introduction, Generation of AC Voltages, Root Mean Square and Average Value of Alternating Currents and Voltages, Form Factor, Peak Factor, Power Factor and Quality Factor, Phasor Diagram</li> <li>• Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Importance of earthing. Types of Batteries, Important characteristics for Batteries. Elementary calculations for energy consumption and savings, battery backup.</li> <li>• Conclusion of Unit</li> </ul>
<b>3.</b>	<b>Energy Conversion and Electrical Machines</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Introduction to Energy: Types of Energy, Introduction to Energy Conversion, Sources of Energy (Conventional &amp; Non-Conventional), Energy Scenario in India &amp; Rajasthan.</li> <li>• Rotating Machines: DC Machines: Principle of Operation of DC Machine as Motor and Generator, EMF Equation, Applications of DC Machines. AC Machines: Principle of Operation of 3-Phase Induction Motor, 3-Phase Synchronous Motor and 3- Phase Synchronous Generator (Alternator), Applications of AC Machines. Electric Vehicle: Introduction to Electric Vehicles: Types of EVs, Applications of EV, Charging of EV. Stationary Machines: Introduction, Construction and Principle of Working of Transformer, EMF Equation,</li> <li>• Conclusion of Unit</li> </ul>

<b>4.</b>	<b>Basic Electronics</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Semiconductor Devices: Conduction in Semiconductors, Conduction Properties of Semiconductor Diodes, Behavior of the PN Junction, PN Junction Diode, Zener Diode, LED, Photovoltaic Cell, Rectifiers, L, C, &amp; L-C filters, BJT, UJT, Transistor as an Amplifier.</li> <li>• Digital Electronics: Boolean algebra, Binary System, Logic Gates and Their Truth Tables.</li> <li>• Conclusion of Unit</li> </ul>
<b>5.</b>	<b>Communication Systems and IoT</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Basics of Communication: Introduction, IEEE Spectrum for Communication Systems, Types of Communication, Amplitude and Frequency Modulation.</li> <li>• Basics of Instrumentation: Introduction to Transducers, Thermocouple, RTD, Strain Gauges, Load Cell and Bimetallic Strip.</li> <li>• An overview of Internet of Things-Building blocks of IoT, IoT enabling technologies, Characteristics of IoT systems and IoT levels, Evolution of the Internet paradigm, Device-to-Device/ Machine-to-Machine Integration</li> <li>• Conclusion of Unit</li> </ul>

### C. RECOMMENDED STUDY MATERIAL

Sr.No	Reference Book	Author	Edition	Publication
1	Electrical and Electronic Technology	Edward Hughes et al,	Latest	Pearson Publication
2	Basic Electrical & Electronics Engineering	V. Jagathesan, K. Vinod Kumar & R. Saravan Kumar	Latest	Wiley India
3	Basic Electrical & Electronics Engineering	Van Valkenburge	Latest	Cengage learning
4	Basic Electrical and Electronics Engineering by,	Muthusubramaniam	Latest	TMH
5	Basic Electrical & Electronics Engineering	Ravish Singh	Latest	TMH
<b>Important Web Links</b>				
1.	<a href="https://nptel.ac.in/courses/108108076/">https://nptel.ac.in/courses/108108076/</a>			
2.	<a href="https://nptel.ac.in/courses/117103063/">https://nptel.ac.in/courses/117103063/</a>			
3.	<a href="https://nptel.ac.in/courses/108/101/108101091/">https://nptel.ac.in/courses/108/101/108101091/</a>			

**COURSE OUTCOME**

The student would be able to:

CO1 Analyze the forces act on a component and method of resolution.

CO2 Evaluate centroid and center of gravity of an object and also analyze how to minimize the effort for lifting a load.

CO3 Evaluate the effect of friction and also evaluate forces with the effect of friction.

CO4 Analyze the conversion of linear motion into angular motion and vice versa.

CO5 Analyze the effect of impact on elastic and non-elastic body.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the Unit	Time required for the Unit (Hours)
1.	<b>Fundamentals of Mechanics</b>	8
2.	<b>Machine &amp; Moment of Inertia</b>	8
3.	<b>Friction &amp; Belt Drive</b>	7
4.	<b>Dynamics of Particles</b>	8
5.	<b>Work, Power &amp; Impact</b>	8

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1.</b>	<b>Fundamentals of Mechanics</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Fundamental laws of mechanics, Principle of transmissibility.</li> <li>• System of forces, Resultant force, Resolution of force.</li> <li>• Moment and Couples, Varignon's Theorem,</li> <li>• Equilibrium, Conditions for equilibrium, Lami's theorem.</li> <li>• Conclusion of Unit</li> </ul>
<b>2.</b>	<b>Machine &amp; Moment of Inertia</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Lifting Machines: Mechanical advantage, Velocity Ratio, Efficiency of machine, Ideal machine, Ideal effort and ideal load, Reversibility of machine, Law of machine, Lifting machines.</li> <li>• Centroid &amp; Moment of Inertia: Location of centroid and center of gravity, Moment of inertia, Parallel axis and perpendicular axis theorem, Radius of gyration, M.I of composite section.</li> <li>• Conclusion of Unit</li> </ul>
<b>3.</b>	<b>Friction &amp; Belt Drive</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Friction: Types of Friction, Laws of friction, Angle of friction, Angle of repose, Ladder.</li> <li>• Belt Drive: Types of belts, Types of belt drives, Velocity ratio, Effect of slip on Velocity ratio, Length of belt, Ratio of tensions and power transmission by flat belt drives.</li> <li>• Conclusion of Unit</li> </ul>
<b>4.</b>	<b>Dynamics of Particles</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Kinematics of Particles and Rigid Bodies: Velocity, Acceleration, Types of Motion, Equations of Motion, Rectangular components of velocity and acceleration, Angular velocity and Angular acceleration.</li> <li>• Kinetics of Particles and Rigid Bodies: Newton's laws, Linear Momentum, Equation of motion in rectangular coordinate, Equation of motion in plane for a rigid body, D' Alembert principle.</li> <li>• Conclusion of Unit</li> </ul>
<b>5.</b>	<b>Work, Power &amp; Impact</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Work, Energy and Power: Work of a force, weight, Power, Efficiency, Energy, Kinetic energy of rigid body, Principle of work and energy.</li> <li>• Impact: Collision of elastic bodies, types of impact, conservation of momentum, Newton's law of collision.</li> <li>• Conclusion of Unit</li> </ul>

### C. RECOMMENDED STUDY MATERIAL

Sr.No	Reference Book	Author	Edition	Publication
1.	Vector Mechanics for Engineers	Beer and Johnston	Latest	Tata McGraw Hill
2.	Engineering Mechanics	D S Kumar	Latest	S K Kataria & Sons
3.	Engineering Mechanics Statics	Meriam, J. L. & Kraige, L. G	Latest	John Wiley & Son
4.	Engineering Mechanics	S. Ramamruthan	Latest	Dhanpat Rai Pub.
5.	Engineering Mechanics	Shames	Latest	Pearson Education
Important Web Links				
1.	<a href="https://nptel.ac.in/courses/112103109/">https://nptel.ac.in/courses/112103109/</a>			
2.	<a href="https://nptel.ac.in/courses/112106286/">https://nptel.ac.in/courses/112106286/</a>			
3.	<a href="https://freevideolectures.com/course/2264/engineering-mechanics">https://freevideolectures.com/course/2264/engineering-mechanics</a>			

**Course Outcomes: -**

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

CO1 Identify parts of computer hardware

CO2 Evaluate data representation techniques like binary, hexadecimal and octal

CO3 Design algorithms to solve small computer problems related to daily life

CO4 Apply arithmetic operations and sequential programming using C Language

CO5 Discriminate among while, for and do-while iterative statements

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1.	Introduction to C	8
2.	Data Representation and Looping Statement	8
3.	Functions	7
4.	Memory Allocation	8
5.	Concept of I/O File Allocation	8

**B. DETAILED SYLLABUS**

Unit	Unit Details
1.	<b>Introduction to C</b>
	<ul style="list-style-type: none"> <li>• Introduction to the C Language – Algorithm, Pseudo code,</li> <li>• Flow chart, Background, C Programs, Identifiers,</li> <li>• Data Types, Variables, Constants, Input / Output, Operators (Arithmetic, relational, logical, bitwise etc.),</li> <li>• Expressions, Precedence and Associativity, Expression Evaluation, Type conversions.</li> </ul>
2.	<b>Data Representation and Looping Statement</b>
	<ul style="list-style-type: none"> <li>• Statements- Selection Statements (making decisions) – if and switch statements,</li> <li>• Repetition statements (loops)-while, for, do-while statements,</li> <li>• other statements related to looping – break, continue, go to</li> </ul>
3.	<b>Functions</b>
	<ul style="list-style-type: none"> <li>• Functions- Introduction to Structured Programming,</li> <li>• Functions- basics, user defined functions, inter function communication (call by value, call by reference),</li> <li>• Standard functions. Storage classes-auto, register, static, extern,</li> <li>• scope rules, arrays to functions, recursive functions,</li> </ul>
4.	<b>Memory Allocation</b>
	<ul style="list-style-type: none"> <li>• Arrays– Basic concepts, one-dimensional arrays, two – dimensional arrays, multidimensional arrays,</li> <li>• Pointers – Introduction (Basic Concepts), pointers to pointers, compatibility, Pointer Applications, Arrays and Pointers, Pointer Arithmetic,</li> <li>• Memory allocation functions, array of pointers, pointers to void</li> <li>• pointers to functions, command –line arguments, Introduction to structures and unions.</li> </ul>
5.	<b>Concept of I/O File Allocation</b>
	<ul style="list-style-type: none"> <li>• Strings – Concepts, C Strings, String Input / Output functions, string manipulation functions,</li> <li>• string /data conversion. Input and Output – Concept of a file, streams, text files and binary files,</li> <li>• Differences between text and binary files, State of a file,</li> <li>• Opening and Closing files, file input / output functions (standard library input / output functions for files),</li> <li>• file status functions (error handling), Positioning functions.</li> </ul>



### C. RECOMMENDED STUDY MATERIAL

Sr.No	Reference Book	Author	Edition	Publication
1.	Fundamentals of Computers	V.Rajaraman	Sixth	PHI
2.	Computer Fundamentals and Programming in C	ReemaThareja	Second	Oxford
3.	Fundamentals of Computers	E Balagurusamy	First	Tata McGraw Hill
4.	Programming in ANSI C	E Balagurusamy	Eight	Tata McGraw Hill
5.	Let US C	YashavantKanetkar	Fifteenth	BPB Publications
6.	The C Programming language	Ritchie Kernighan	Third	PHI
<b>Important Web Links</b>				
1.	<a href="https://www.learn-c.org/">https://www.learn-c.org/</a>			
2.	<a href="https://www.sanfoundry.com/">https://www.sanfoundry.com/</a>			
3.	<a href="https://nptel.ac.in/courses/106/104/106104128/">https://nptel.ac.in/courses/106/104/106104128/</a>			
4.	<a href="http://www.tutorials4u.com/c/">http://www.tutorials4u.com/c/</a>			
5.	<a href="http://www.howstuffworks.com/c.htm">www.howstuffworks.com/c.htm</a>			

**COURSE OUTCOME**

The student would be able to:

CO1 Analyze the design and working of Hybrid and Electric Vehicle.

CO2 Understand the importance of Additive Manufacturing (AM) and Rapid Prototyping (RP).

CO3 Create smart devices using Internet of Things (IoT).

CO4 Analyze the future with AI, and AI in Action

CO5 Analyze the Opportunities and Challenges in adoption of Industry 4.0.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time Required for the Unit (Hours)
1.	<b>Introduction to Hybrid and Electric Vehicle</b>	8
2.	<b>Introduction to Additive Manufacturing (AM) and Rapid Prototyping (RP)</b>	8
3.	<b>Introduction to Internet of Things (IoT)</b>	7
4.	<b>Introduction to Artificial Intelligence (AI) and Blockchain</b>	8
5.	<b>Introduction to Industry 4.0 and 5.0</b>	8

**B. DETAILED SYLLABUS**

Unit	Contents
<b>1.</b>	<b>Introduction to Hybrid and Electric Vehicle</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Hybrid and Electric Vehicles (HEV): History Overview and Modern Applications</li> <li>• Power Flow and Power Management in HEV</li> <li>• Introduction to Electric Drives: Shunt Drives, Series Drives, Compound Drives</li> <li>• Types of Batteries and Energy Storages</li> <li>• Introduction to Power Electronics in Hybrid Electric Vehicles</li> <li>• Case Studies: Toyota Camry Hybrid, MG Hector Hybrid, Tata Nexon EV</li> <li>• Conclusion of Unit</li> </ul>
<b>2.</b>	<b>Introduction to Additive Manufacturing (AM) and Rapid Prototyping (RP)</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Introduction to reverse engineering Traditional manufacturing v/s AM</li> <li>• Computer aided design (CAD) and manufacturing (CAM) and AM</li> <li>• Different AM processes and relevant process physics AM process chain</li> <li>• Growth of RP industry, and classification of RP systems</li> <li>• Application level: Stereo Lithography Systems, Selective Laser Sintering Fusion, Deposition Modelling, Solid Ground Curing, 3-D Printing processes</li> <li>• Conclusion of Unit</li> </ul>
<b>3.</b>	<b>Introduction to Internet of Things (IoT)</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Introduction to IoT</li> <li>• Sensing, Actuation, Basics of Networking</li> <li>• Interoperability in IoT,</li> <li>• Introduction to Arduino Programming: Sensors and Actuators with Arduino</li> <li>• Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi</li> <li>• Case Studies: Smart Cities and Smart Homes, Connected Vehicles, Healthcare,</li> <li>• Conclusion of Unit</li> </ul>
<b>4.</b>	<b>Introduction to Artificial Intelligence (AI) and Blockchain</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• What is AI? Applications and Examples of AI</li> <li>• AI Concepts, Terminology, and Application Areas</li> <li>• AI: Issues, Concerns and Ethical Considerations</li> </ul>

	<ul style="list-style-type: none"> <li>• The Future with AI, and AI in Action</li> <li>• Case Studies: Travel &amp; Navigation, Social Media Feeds, Google Lens and OCR, Smart Cars, Security &amp; surveillance</li> <li>• Introduction to Blockchain Technology</li> <li>• Conclusion of Unit</li> </ul>
<b>5.</b>	<b>Introduction to Industry 4.0 and 5.0</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Introduction to Industry 4.0</li> <li>• Road to Industry 4.0: Smart Manufacturing, Smart Devices and Products, Smart Logistics, Smart Cities, Predictive Analytics</li> <li>• Technologies for enabling Industry 4.0</li> <li>• Opportunities and Challenges</li> <li>• Future of Works and Skills for Workers in the Industry 4.0 Era</li> <li>• Industry 4.0 vs Industry 5.0</li> <li>• Conclusion of Unit</li> </ul>

### C. RECOMMENDED STUDY MATERIAL:

Sr. No	ReferenceBook	Author	Edition	Publication
1	Electric and Hybrid Vehicles	A.K. Babu	Second Edition, 2022	Khanna Publishing
2	Artificial Intelligence: Concepts and Applications	Lavika Goel	2021	Wiley
3	Industry 4.0: Challenges, Trends, and Solutions in Management and Engineering	Carolina Machado	2021	CRC Press
4	Additive Manufacturing	C. P. Paul	2021	McGraw Hill
<b>Important Web Links</b>				
1	<a href="https://nptel.ac.in/courses/106105195">https://nptel.ac.in/courses/106105195</a>			
2	<a href="https://www.linkedin.com/learning/foundations-of-the-fourth-industrial-revolution-industry-4-0">https://www.linkedin.com/learning/foundations-of-the-fourth-industrial-revolution-industry-4-0</a>			
3	<a href="https://nptel.ac.in/courses/108103009">https://nptel.ac.in/courses/108103009</a>			
4	<a href="https://onlinecourses.nptel.ac.in/noc22_cs56/preview">https://onlinecourses.nptel.ac.in/noc22_cs56/preview</a>			

# PRACTICAL

Code: BTXCME2201

MACHINE DRAWING LAB

1 Credit [LTP: 1-0-2]

## COURSE OUTCOME

The student would be able to:

CO1 analyze the concepts sectioning, true section and apparent section and create the sectional views of the engineering components.

CO2 analyze the development of surface and analyze the sheet metal requirement for fabricating a surface.

CO3 analyze the curves produced due to intersections of different surfaces.

CO4 create isometric views of various engineering components.

CO5 create multi view drawings of simple and complex engineering components

## A. LIST OF EXPERIMENT

1.	Introduction to machine drawing
2.	Dimensioning, locations and placing
3.	<b>Orthographic projections:</b> First & third angle methods Drawing Sheet 1: Orthographic Projections (3 Problems) Drawing Sheet 2: Sectional Views (3 Problems) Drawing Sheet 3: Riveted joints, lap joints, butt joints, chain riveting, zig-zag riveting Drawing Sheet 4: Screw fasteners, different threads, Nuts & bolts locking devices, set screws, foundation Drawing Sheet 5: Bearing, Plumber block
4.	Instructions on free hand sketches List of free hand sketches <ul style="list-style-type: none"><li>• Different type of lines</li><li>• Conventional representation of materials</li><li>• Screw fasteners</li><li>• Bearing: Ball, roller, needle, foot step bearing</li><li>• Coupling: Protected type, flange, and pin type flexible coupling</li><li>• Welded joints</li></ul>
Virtual Labs	
1	<a href="http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/egraphics_lab/labs/index.php">http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/egraphics_lab/labs/index.php</a>

**COURSE OUTCOME:-**

Students will be able to:

CO1 Analyze the concept of interference with the help of Newton's ring and dispersive power through prism.

CO2 Evaluate the resolving power through diffraction grating and double slit arrangement.

CO3 Apply the numerical aperture of optical fiber and Coherent length and time using He-Ne laser.

CO4 Evaluate the height of the unknown object by Sextant.

CO5 Analyze the mechanism of Ballistic Galvanometer and evaluate the specific resistance of wire through Carey's foster bridge.

**A. LIST OF EXPERIMENTS:**

1.	To determine the wave length of Sodium light by Newton's Ring
2.	To determine the dispersive power of material of a prism for violet, red and yellow color of mercury light with the help of spectrometer.
3.	To determine the wave length of prominent lines of mercury by plane diffraction grating with the help of spectrometer
4.	To verify the expression for the resolving power of Telescope
5.	To measure the numerical Aperture of an optical fibre by He-Ne laser
6.	To determine the coherent length and coherent time by using He-Ne laser
7.	To study the variation of a semiconductor resistance with temperature and hence determine the Band Gap of the semiconductor in the form of reverse biased P-N junction diode.
8.	To study the characteristics of semiconductor diode and determine forward and reverse bias resistance
9.	To Determine the height of a given line drawn on the wall by sextant
10.	To study the charging and discharging of a condenser and hence determine time constant (both current and voltage graphs are to be plotted)
11.	To determine the high resistance by method of leakage, using a ballistic galvanometer.
12.	To specify the specific resistance of a material of a wire by carey foster's bridge.
Virtual Labs	
1	<a href="http://vlab.amrita.edu/?sub=1&amp;brch=282">http://vlab.amrita.edu/?sub=1&amp;brch=282</a>
2	<a href="http://vlabs.iitb.ac.in/vlab/labsps.html">http://vlabs.iitb.ac.in/vlab/labsps.html</a>
3	<a href="https://praxilabs.com/en/virtual-labs.aspx?TAB=1#LOL">https://praxilabs.com/en/virtual-labs.aspx?TAB=1#LOL</a>

**COURSE OUTCOMES:-**

Students will be able to:

CO1 Analyze the house wiring connections of various equipments such as energy meter, ceiling fan, tubelight etc.

CO2 Create the connections of single phase and three phase induction motors.

CO3 Create circuits and connects of various electrical components such as Resistors, Inductors, Capacitors, PN-Diode. Zenger Diode, LED, LCD, etc.

CO4 Analyze the effect of L, C and L-C filters in single phase half wave and full wave bridge rectifier

CO5 Analyze the effect of LC and LC filters in current and power rectifiers

**A. LIST OF EXPERIMENTS:**

1	Assemble house wiring including earthing for 1-phase energy meter, MCB, ceiling fan, tube light, three pin socket and a lamp operated from two different positions. Basic functional study of components used in house wiring.
2	Prepare the connection of ceiling fan along with the regulator and vary the speed.
3	Prepare the connection of single phase induction motor through 1-Phase Auto-transformer and vary the speed.
4	Prepare the connection of three phase squirrel cage induction motor through 3-Phase Autotransformer and vary the speed.
5	Prepare the connection of Fluorescent Lamp, Sodium Vapour and Halogen Lamp and measure voltage, current and power in the circuit.
6	Identification, testing and application of Resistors, Inductors, Capacitors, PN-Diode. Zenger Diode, LED, LCD, BJT, Photo Diode, Photo Transistor, Analog/Digital Multi- Metres and Function/Signal Generator.
7	Measure the frequency, voltage, current with the help of CRO.
8	Assemble the single phase half wave and full wave bridge rectifier & the analyse effect of L, C and L-C filters in rectifiers.
9	Study the BJT amplifier in common emitter configuration. Measure voltage gain plot gain frequency response and calculate its bandwidth.
10	Verify the truth table of AND, OR, NOT, NOR and NAND gates
11	Prepare the connection of sodium lamp and measure voltage
12	Analyze the effect of LC and LC filters in current and power rectifiers
Virtual Lab	
1	<a href="http://vlabs.iitkgp.ernet.in/be/">http://vlabs.iitkgp.ernet.in/be/</a>
2	<a href="http://em-coep.vlabs.ac.in/List%20of%20experiments.html?domain=Electrical%20Engineering">http://em-coep.vlabs.ac.in/List%20of%20experiments.html?domain=Electrical%20Engineering</a>

**COURSE OUTCOMES:-**

Students will be able to:

CO1 Create a model of T Lap and T- Bridle Joint through carpentry shop

CO2 Analyze the making of prototype model through foundry shop

CO3 Analyze the difference between gas welding and arc welding and their applications

CO4 Create a model on fitting shop through filing, slotting, drilling and tapping operation

CO5 Analyze the difference between forging, moulding and casting

**A. LIST OF EXPERIMENTS**

1.	<b>Carpentry Shop</b> <ul style="list-style-type: none"> <li>• Timber, definition, engineering applications, seasoning and preservation</li> <li>• Plywood and ply boards</li> </ul>
2.	<b>Foundry Shop</b> <ul style="list-style-type: none"> <li>• Moulding Sands, constituents and characteristics</li> <li>• Pattern, definition, materials types, core prints</li> <li>• Role of gate, runner, riser, core and chaplets</li> <li>• Causes and remedies of some common casting defects like blow holes, cavities, inclusions</li> </ul>
3.	<b>Welding Shop</b> <ul style="list-style-type: none"> <li>• Definition of welding, brazing and soldering processes and their applications</li> <li>• Oxyacetylene gas welding process, equipment and techniques, types of flames and their applications</li> <li>• Manual metal arc welding technique and equipment, AC and DC welding</li> <li>• Electrodes: Constituents and functions of electrode coating, welding positions</li> <li>• Types of welded joints, common welding defects such as cracks, undercutting, slag inclusion and boring</li> </ul>
4.	<b>Fitting Shop</b> <ul style="list-style-type: none"> <li>• Files, materials and classification.</li> </ul>
5.	<b>Smithy Shop</b> <ul style="list-style-type: none"> <li>• Forging, forging principle, materials</li> <li>• Operations like drawing, upsetting, bending and forge welding</li> <li>• Use of forged parts</li> </ul>

**List of Jobs to be made in the Workshop Practice**

1.	<b>Carpentry Shop</b> <ol style="list-style-type: none"> <li>1. T – Lap joint</li> <li>2. Bridle joint</li> </ol>
2.	<b>Foundry Shop</b> <ol style="list-style-type: none"> <li>3. Mould of any pattern</li> </ol>
3.	<b>Welding Shop</b> <ol style="list-style-type: none"> <li>4. Square butt joint by MMA welding</li> <li>5. Lap joint by MMA welding</li> </ol>
4.	<b>Machine Shop Practice</b> <ol style="list-style-type: none"> <li>6. Job on lathe with facing operation</li> <li>7. Job on lathe with one step turning and chamfering operations</li> <li>8. Job on shaper for finishing two sides of a job</li> </ol>
5.	<b>Fitting Shop</b> <ol style="list-style-type: none"> <li>9. Finishing of two sides of a square piece by filing</li> <li>10. Drilling operation on fitted job (two holes)</li> <li>11. Slotting operation on fitted job</li> <li>12. Tapping operation on fitted job</li> </ol>

**COURSE OUTCOME: -**

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

CO1 Prepare documents, worksheets and presentations using MS Word, Excel and PowerPoint.

CO2 Perform arithmetic and conditional operations using C Language.

CO3 Design program based on iterative statements using C Language.

CO4 Perform array operations to solve computer problems.

CO5 Demonstrate the use of pointers and structures.

**A. LIST OF EXPERIMENTS:**

MS Office	
1.	Implement basic features of MS Office, Prepare a document using MS-Word
2.	Prepare a Sheet using MS Excel and Slides using MS PowerPoint
Programming In C	
3.	Programs to demonstrate the use of input and output in C Language including data types and format specifiers.
4.	Program to evaluate arithmetic operations in C Language
5.	Program to apply conditional operators. (if-else, switch-case)
6.	Program to design program using iterative statements. (while, for and do-while)
7.	Program to implement input, output and manipulation operations on Array.
8.	Program to perform matrix addition and multiplication.
9.	Program to demonstrate declaration, definition, initialization and access operations on pointers.
10.	Program to solve problems of collection of different data types using structures.
Virtual Lab	
1	<a href="http://cse02-iiith.vlabs.ac.in/">http://cse02-iiith.vlabs.ac.in/</a>



**COURSE OUTCOME: -**

Students will be able to:

CO1 Apply the concept of scale and their applications

CO2 Analyze the different applications of conic section and engineering curves and also how to draw on sheet

CO3 Analyze the use of projection and also analyze the difference between first and third angle projection method

CO4 Apply the concept of sectioning and draw sheet on section of solid

CO5 Analyze the use of development and their application

**(Theory Concepts)****A. List of Experiments**

1.	<ul style="list-style-type: none"> <li>• Lines, Lettering and Dimension (Sketch Book)</li> <li>• Scales: Representative Fraction, plain scales, diagonal scales, (In drawing sheet)</li> </ul>
2.	<ul style="list-style-type: none"> <li>• Conic Sections: Construction of ellipse, parabola and hyperbola by different methods( in drawing sheet)</li> <li>Engineering Curves: Construction of Cycloid, Epicycloids, Hypo-cycloid( in drawing sheet)</li> </ul>
3.	<ul style="list-style-type: none"> <li>• Type of Projection, Orthographic projection: first angle and third angle projection (in drawing sheet)</li> <li>• Projection of Points</li> <li>• Projection of Straight lines</li> <li>• Projection of planes: Different positions of plane lamina like: regular polygon, circle of three planes (four problems in drawing sheet)</li> <li>• Projection of Solids: Projection of right and regular polyhedron, cone (four problem in drawing sheet)</li> </ul>
4.	<ul style="list-style-type: none"> <li>• Sections of Solids: Projection of Frustum of a cone and pyramid (in drawing sheet)</li> </ul>
5.	<ul style="list-style-type: none"> <li>• Development of Surfaces: Parallel line and radial line method for right solids, Regular Solids (in drawing sheet)</li> <li>• Isometric Projections: Isometric Scale, Isometric axes, Isometric View of geometrical shapes (in drawing sheet)</li> </ul>

**(Practical Concepts)**

6.	<ul style="list-style-type: none"> <li>• Introduction</li> <li>• Line (coordinate Methods)</li> <li>• Dimension</li> <li>• Scale</li> </ul>
7.	<ul style="list-style-type: none"> <li>• Rectangle</li> <li>• Conic Section</li> <li>• Construction of ellipse, Parabola &amp; Hyperbola, Polygon</li> <li>• Circle</li> </ul>
8.	<ul style="list-style-type: none"> <li>• AutoCAD commands (copy, Mirror, Move, Array, Block, Group, Join, Hatch etc.)</li> </ul>
9.	<ul style="list-style-type: none"> <li>• Type of Projection , Orthographic projection: First Angle and Third Angle projection</li> <li>• Projection of Points</li> <li>• Projection of Straight lines, different positions of straight lines</li> <li>• Projection of planes</li> <li>• Projection of Solids: projection of right and regular polyhedron and cone</li> </ul>
10.	<ul style="list-style-type: none"> <li>• Section of solids: projection of frustum of a cone and pyramid</li> <li>• Isometric projections</li> </ul>
<b>Virtual Labs</b>	
1	<a href="http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/egraphics_lab/labs/index.php">http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/egraphics_lab/labs/index.php</a>

**COURSE OUTCOME:**

On successful completion of the course, the learners will be able to:

CO	Cognitive Abilities	Course Outcomes
CO-01	Understanding/ Applying/Creating	Demonstrate the grammar skills involved in writing sentences and short paragraphs.
CO-02	Understanding/ Applying	Build up a good command over English grammar and vocabulary to be able to ace error spotting.
CO-03	Understanding/ Applying/Creating	Define unknown words in sentence level context using a picture dictionary or by creating a memory link for support.
CO-04	Understanding / Applying	Understand, analyze and effectively use the conventions of the English language.
CO-05	Understanding/Applying	Develop their interest in reading and enhance their oral and silent reading skills along with sharpen their critical and analytical thinking.

UNIT NO.	UNIT NAME	HOURS
1	Basics of Grammar	8
2	Spotting the grammatical errors and rectification	2
3	Vocabulary Building	4
4	Basics of Writing Skills	2
5	Reading Comprehension	8

LIST OF ACTIVITIES	
1.	Parts of Speech: Theory & Practice through various Exercises
2.	Sentence Structures: Theory & Practice through various Exercises
3.	Tenses: Theory & Practice through various Exercises
4.	Spotting the Errors: Applying the rules and Practice Questions
5.	Vocabulary Building-I: Practice by sentence formation
6.	Vocabulary Building-II: Practice by sentence formation
7.	Paragraph Writing
8.	Article Writing
9.	Précis Writing
10.	Formal & Informal Letter Writing
11.	Reading Comprehension- I: Beginner's level reading and Answering the Questions (Competitive Exams)
12.	Reading Comprehension- II: Intermediate's level reading and Answering the Questions (Competitive Exams)

**COURSE OUTCOME:**

On successful completion of the course the learners will be able to

CO	Cognitive Abilities	Course Outcomes
CO-01	Understanding/ Applying/Creating	Understand the nuances of language through audio-visual experience and group activities.
CO-02	Understanding/ Applying	Neutralize the accent for intelligibility and develop confidence in speaking with clarity enhancing their employability skills.
CO-03	Understanding/ Applying/Creating	Demonstrate an understanding of grammatical structures in conversations and discussions.
CO-04	Understanding / Applying	Utilize the knowledge of confidence building strategies to manage one's own thoughts and emotions.
CO-05	Understanding/Applying	Identify the requirements of skills development and apply their learning to sharpen the same.

UNIT NO.	UNIT NAME	HOURS
1	Introduction to Communication Skills on Learning Software	6
2	Concepts of Phonetics	4
3	Grammar Practice	2
4	Confidence Enhancement Activities	4
5	Skills Enhancement Activities	8

LIST OF LABS	
1.	Listening Skills
2.	Reading Comprehension
3.	Writing Skills
4.	Phonetics I
5.	Phonetics II
6.	Grammar and Common Errors Usage
7.	Conversation
8.	Role Plays
9.	Presentation Skills I
10.	Presentation Skills II
11.	Group Discussion
12.	Interview Skills

**Software used in Language Lab: EL-Client**

S.No.	Topics	Exercises
I	Listening Skills: Fourteen Lessons each containing five exercises	
II	Fundamental Language Skills: Introductory Lessons Basic Lessons (a) Reading Basic Lessons (a) Grammar Basic Lessons (a) Vocabulary Basic Lessons (a) Writing Basic Lessons (b)-(c) Reading Basic Lessons (b)-(c) Grammar Basic Lessons (b) Vocabulary Basic Lessons (b) Writing	5exercises 6exercises 3exercises 6exercises 5exercises 9exercises 9exercises 5exercises 3exercises
III	Communication Skills:	

	Reading Comprehension Vocabulary Grammar Writing Exercises on Reading, Vocabulary, Grammar and Writing	
IV	Vocabulary: Word mentor: Various games based on the formation of words.	
V	Phonetics: Consonants Vowels Diphthongs Intonation Correct Pronunciation	
VI	English as Second Language	45exercises
VII	Conversations: Nine topics for conversations.	

- Neutralization of accent for intelligibility
- Speaking with clarity and confidence thereby enhancing employability skills of the students

**COURSE OUTCOME**

The student would be able to:

CO1 Develop innovative methods to produce soft water for industrial use and potable water at cheaper cost.

CO2 Use their knowledge of polymers and glass and its use in industries and daily life.

CO3 Identify practices for the prevention and remediation of corrosion.

CO4 Characterize the fuels and analyze the combustion mechanisms of various fuels.

CO5 Understand the manufacturing of cement and the chemistry involved in setting and hardening of it and also learn about the suitable use of lubricants.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1.	Water Technology	8
2.	Polymer and Glass	7
3.	Corrosion and its control	6
4.	Fuel and Fuel Analysis	8
5.	Binding Materials and Lubricants	7

**B. DETAILED SYLLABUS**

Unit	Unit Details
1.	<p><b>Water Technology</b></p> <ul style="list-style-type: none"> <li>• Introduction of Unit</li> </ul> <p><b>Water</b></p> <ul style="list-style-type: none"> <li>• Sources of water, Impurities in water and effect of impurities</li> <li>• Municipal water supply: Requisites of drinking water, Steps involved in purification of water, Sedimentation, Coagulation, Filtration and Disinfection, Break Point Chlorination</li> </ul> <p><b>Water Analysis</b></p> <ul style="list-style-type: none"> <li>• Hardness of water; Type of hardness, Degree of hardness, Units of hardness, Disadvantages of hard water, Determination of hardness by Complexometric (EDTA) method, Numericals based on hardness by EDTA method</li> <li>• Boiler Troubles: Formation of solids (scale and sludge), Carry over (Priming and Foaming), Caustic Embrittlement, Disadvantages and Prevention</li> <li>• Treatment of hard water: Lime-soda method, Permutit (zeolite) method and Deionization or Demineralization method, Numerical problems based on Lime-soda and Zeolite softening methods</li> <li>• Desalination: Reverse osmosis, Electro dialysis</li> <li>• Conclusion of Unit</li> </ul>
2.	<p><b>Polymer and Glass</b></p> <ul style="list-style-type: none"> <li>• Introduction of Unit</li> </ul> <p><b>Polymers</b></p> <ul style="list-style-type: none"> <li>• Introduction to Polymer chemistry:, Classification of Polymers and Types of polymerization</li> <li>• Plastics: Constituents of plastics, Thermosets and Thermoplastics, Preparation, Properties and Uses of Polyethylene, Bakelite, Teflon, Terylene and Nylon</li> <li>• Elastomers: Natural rubber, Vulcanization, Synthetic rubber- Preparation, Properties and Applications of SBR, Buna-N, Butyl and Neoprene rubber.</li> </ul> <p><b>Glass</b></p> <ul style="list-style-type: none"> <li>• Introduction</li> <li>• Definition of glass, its Properties, Manufacturing of glass, Importance of annealing in glass making, Types of silicate glasses and their commercial uses.</li> <li>• Conclusion of Unit</li> </ul>

<b>3.</b>	<b>Corrosion and its control</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> </ul> <p><b>Corrosion and its control</b></p> <ul style="list-style-type: none"> <li>• Definition of corrosion and its Significance</li> <li>• Mechanisms of Corrosion: Chemical (Dry) corrosion and Electrochemical (Wet) corrosion</li> <li>• Types of corrosion: Galvanic corrosion, Concentration cell corrosion, Stress corrosion, Pitting corrosion</li> <li>• Factors affecting the rate of corrosion</li> <li>• Protection from corrosion : Material selection and design, Improvement of Environment , Coating of metallic surface, Cathodic protection, Anodic protection, Electroplating, Tinning, Galvanization and Modification in designs . Some practical examples of corrosion.</li> <li>• Conclusion of Unit</li> </ul>
<b>4.</b>	<b>Fuel and Fuel Analysis</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Classification and general aspects of fuel.</li> <li>• Solid fuel: Coal, Types of coal, Carbonization of coal</li> <li>• Liquid fuel: Processing of crude petroleum, Cracking, Thermal Cracking and Catalytic Cracking, Synthetic petrol (Coal to Liquid (CTL) Technology): Bergius and Fischer Tropsch process. Knocking, Octane number and Cetane number, Anti-knocking and Anti-knocking agents</li> <li>• Gaseous fuel: Advantages of gaseous fuel, Biogas, LPG, CNG</li> <li>• Analysis of Coal: Ultimate and Proximate analysis of coal</li> <li>• Calorific Value: Definition, Higher calorific value, Lower calorific value, Determination of higher &amp; lower calorific value by Bomb Calorimeter</li> <li>• Fuel gas analysis by Orsat's apparatus and its significance</li> <li>• Numericals based on Bomb</li> <li>• Numericals based on combustion and requirement of oxygen/ air in combustion process</li> <li>• Conclusion of Unit</li> </ul>
<b>5.</b>	<b>Binding Materials and Lubricant</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> </ul> <p><b>Binding Materials</b></p> <ul style="list-style-type: none"> <li>• Cement: Composition and Significance of cement</li> <li>• Manufacturing of Portland cement by Rotary Kiln Technology</li> <li>• Chemistry of setting and hardening of cement and role of gypsum</li> </ul> <p><b>Lubricants</b></p> <ul style="list-style-type: none"> <li>• Introduction of lubricants, Classification, Properties and Uses of lubricants</li> <li>• Mechanism of lubrication, Selection of lubricants</li> <li>• Properties of lubricants: Viscosity &amp; Viscosity Index, Flash and Fire Point, Cloud and Pour Point, Carbon Residue, Oiliness, Aniline Point, Steam Emulsification Number, Precipitation Number and Neutralization Number</li> <li>• Conclusion of Unit</li> </ul>

### C. RECOMMENDED STUDY MATERIAL

Sr.No	Reference Book	Author	Edition	Publication
1.	Engineering Chemistry	P.C. Jain	Latest	Dhanpat Rai&Sons
2.	Engineering Chemistry.	S. S. Dara	Latest	S. Chand & Co.
3.	Chemistry in Engineering & Tech.	Rajaram, Kuriacose	Latest	Tata McgrawHill
4.	Physical Chemistry	P.W. Atkins	Latest	Oxford University Press.
<b>Important Web Links:</b>				
1.	<a href="https://civilengineersforum.com/cement-manufacturing-process/">https://civilengineersforum.com/cement-manufacturing-process/</a>			
2.	<a href="https://www.explainthatstuff.com/lubricants.html">https://www.explainthatstuff.com/lubricants.html</a>			
3.	<a href="https://nptel.ac.in/courses/122/101/122101001/">https://nptel.ac.in/courses/122/101/122101001/</a>			

**COURSE OUTCOME**

The student would be able to:

CO1 Analyze hardness and fluoride content of water.

CO2 Analyze the strength of NaOH and Na<sub>2</sub>CO<sub>3</sub> solutions.

CO3 Analyze hardness strength of Ferrous Ammonium sulphate solution and CuSO<sub>4</sub> solution

CO4 Analyze the different properties of lubricating oil.

CO5 Use different instruments & analytical techniques.

**A. LIST OF EXPERIMENTS**

EXPERIMENTS	
1.	To determine the hardness of water by EDTA method.
2.	To determine the amount of fluoride in drinking water
3.	To determine the strength of NaOH and Na <sub>2</sub> CO <sub>3</sub> in a given alkali mixture.
4.	To determine the strength of Ferrous Ammonium sulphate solution with the help of K <sub>2</sub> Cr <sub>2</sub> O <sub>7</sub> solution using diphenyl amine as internal indicator.
5.	To determine the strength of CuSO <sub>4</sub> solution with the help of hypo solution.
6.	To determine the acid value of a given oil.
7.	To determine the viscosity of a given lubricating oil by Redwood viscometer.
8.	To determine the flash and fire point of a given lubricating oil.
9.	To determine the cloud and pour point of a given oil.
10.	Synthesis of Bakelite
11.	To determine the calorific value of a fuel by Bomb Calorimeter.
12.	To determine the Saponification No. of a given oil.
Virtual Labs	
1.	<a href="https://www.youtube.com/watch?v=RzAPQPWOINI">https://www.youtube.com/watch?v=RzAPQPWOINI</a>
2.	<a href="https://vlab.amrita.edu/?sub=3&amp;brch=63&amp;sim=688&amp;cnt=1">https://vlab.amrita.edu/?sub=3&amp;brch=63&amp;sim=688&amp;cnt=1</a>

**COURSE OUTCOMES**

The student will be able to:

CO1 Analyze exact linear differential equation of non-linear with other form of differential equations.

CO2 Analyze the techniques of transform in various form of Laplace rules.

CO3 Analyze the techniques of Fourier transform for solutions PDE.

CO4 Analyze the various form of special function in the differentiation equation.

CO5 Apply the concept of probability and data analyses techniques for statistics.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the Unit	Time required for the Unit (Hours)
1.	Ordinary Differential Equations	10
2.	Laplace Transform	9
3.	Fourier Transform	9
4.	Special Functions	10
5.	Statistics and Probability	10

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1.</b>	<b>Ordinary Differential Equations</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit.</li> <li>• Exact Linear Differential Equations of 2nd order</li> <li>• Non linear differential equation of particular form: Equation of the form <math>d^n y/dx^n = f(x)</math> (Introduction Only)</li> <li>• Equation that do not contain x directly.</li> <li>• Equation that do not contain y directly.</li> <li>• Conclusion and Summary of Unit.</li> </ul>
<b>2.</b>	<b>Laplace Transform</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit.</li> <li>• Laplace Transform: Advantage and sufficient conditions for existence of Laplace Transform, General Properties of Laplace Transform.</li> <li>• Inverse Laplace Transform, General Properties of Inverse Laplace Transform, Use of partial fractions to find Inverse Laplace Transform.</li> <li>• Solution of Ordinary differential equation with constant coefficients.</li> <li>• Conclusion and Summary of Unit.</li> </ul>
<b>3.</b>	<b>Fourier Transform</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Fourier Integral theorem, Fourier Sine &amp; Cosine Integrals.</li> <li>• Fourier Transforms, Fourier Cosine Transforms, Fourier Sine Transform and their inverse.</li> <li>• Application of Fourier Transform in solving Partial Differential Equations</li> <li>• Conclusion and Summary of Unit.</li> </ul>
<b>4.</b>	<b>Special Functions</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit.</li> <li>• Bessel's function of first kind and second kind, simple recurrence relations, orthogonal property.</li> <li>• Legendre's function of first kind (definition only)</li> <li>• Conclusion and Summary of Unit.</li> </ul>



<b>5.</b>	<b>Statistics and Probability</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Statistics, Introduction to Mean, Median, Mode, Standard deviation, Variance, Coefficient of variation</li> <li>• Probability, Probability distribution functions, Binomial, Poisson, Normal Distribution</li> <li>• Conclusion and Summary of Unit.</li> </ul>

**C. RECOMMENDED STUDY MATERIAL:**

S. No	Book	Author	Edition	Publication
<b>Reference Books</b>				
1.	Higher Engineering Mathematics	B S Grewal	Latest	Khanna Publications, Delhi,
2.	Higher Engineering Mathematics	Ramana, B.V	Latest	TMH
3.	Engineering Mathematics: A Tutorial Approach	Ravish R Singh and M Bhatt	Latest	TMH
4.	Calculus and Analytical Geometry	Thomas and Finney,	Latest	Narosa Publishing, Delhi
5.	Advanced Engineering Mathematics	Erwin Kreyszig	Latest	John Wiley and Sons
<b>Important Web Links:</b>				
1.	<a href="https://nptel.ac.in/courses/111105035/">https://nptel.ac.in/courses/111105035/</a>			
2.	<a href="https://nptel.ac.in/courses/111105121/">https://nptel.ac.in/courses/111105121/</a>			

**COURSE OUTCOMES**

The student will be able to:

CO1 Analyze the theory of elasticity, concepts of stress and strain, strength and stiffness, deformations and displacements, strain energy

CO2 Analyze the principle stresses and strains and theory of failure

CO3 Solve the problems related to SFD and BMD

CO4 Analyze the twisting moment of shaft and buckling of column

CO5 Analyze the deflection of beam and concept of strain energy

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1	Simple Stresses & Strains	7
2	Principle Stresses & Theory of Failure	8
3	Shear Force and Bending Moment Diagram	7
4	Torsion in Circular Shafts	7
5	Deflection of Beams and Strain Energy	7

**B. DETAILED SYLLABUS**

Unit	Unit Details
1	<b>Simple Stresses &amp; Strains</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Concept of stress and strain (linear, lateral, shear and volumetric), Hook's law, Poisson's ratio, modulus of elasticity, modulus of rigidity, stress-strain diagram for ductile and brittle materials, factor of safety and working stress, bulk modulus, inter relation between elastic modulus. Various strengths of material- Yield strength, Ultimate permissible stress.</li> <li>• Axial force diagram, stress-strain, deformations in determinate homogeneous and composite bars of Following types. 1) Prismatic 2) Linearly varying 3) Stepped section under concentrated loads and self-weights. Axial stresses and strain in determinate members –axial homogeneous and composite bars concentrated loads, self-weights and temperature changes.</li> <li>• Conclusion and Summary of Unit</li> </ul>
2	<b>Principle Stresses &amp; Theory of Failure</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Principal planes, stresses &amp; strains; Normal and shear stress on any oblique plane, concept of principle plane, derivation of expression for principle stresses and planes and plane of maximum Shear stress, position of principle plane and plane of maximum Shear, graphical solution using Mohr's circle of stresses, combined effect of shear and bending in beams. bending moment &amp; torsional moment on circular shafts.</li> <li>• Theories of Elastic Failures: The necessity for a theory, Strain Energy, different theories- Maximum principal stress theory, maximum shear stress theory, maximum distortion energy theory, maximum strain theory – their limitations, significance and comparison &amp; applications.</li> <li>• Conclusion and Summary of Unit</li> </ul>
3.	<b>Shear Force and Bending Moment Diagram</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Bending stresses : Theory of simple bending, assumptions, derivation of flexural formula, second moment of area of common cross sections( rectangular, I,T,C ) with respective centroidal &amp; parallel axes, bending stress distribution diagrams, moment of resistance &amp; section modulus calculations.</li> <li>• Shear stresses: Concept, derivation of shear stress distribution formula, maximum and average shears stresses.</li> <li>• Shear Force &amp; Bending Moments: Definitions, SF &amp; BM diagrams for cantilevers, simply supported beams with or without over-hang and calculation of maximum BM &amp; SF and the point of contra-flexure under</li> </ul>

	<p>concentrated loads, uniformly distributed loads over whole span or a part of it, combination of concentrated loads and uniformly distributed loads, Problems.</p> <ul style="list-style-type: none"> <li>• Conclusion and Summary of Unit</li> </ul>
<b>4.</b>	<b>Torsion in Circular Shafts</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Torsion of shafts: Introduction, Basic assumptions, Derivation of shear stress produced in a circular shaft subjected to torsion, Max. torque transmitted by a circular and hollow circular shaft. Polar modulus, strength of a shaft and tensional rigidity.</li> <li>• Buckling of columns: Concept of buckling of columns, Stability of equilibrium: Instability &amp; elastic stability. Long &amp; short columns, ideal strut, derivation of Euler's formula for long column, – assumptions and limitations. Euler's formula for crippling load for columns of different ends. Rankine's formula for intermediate columns, safe load on columns, Eccentric loading of columns.</li> <li>• Conclusion and Summary of Unit</li> </ul>
<b>5.</b>	<b>Deflection of Beams and Strain Energy</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Transverse deflection of beams: Relation between deflection, bending moment, shear force and load, Transverse deflection of beams and shaft under static loading, area moment method, direct integration method: method of superposition and conjugate beam method.</li> <li>• Elastic strain energy: Strain energy due to axial, bending and Torsional loads; stresses due to suddenly applied loads; use of energy theorems to determine deflections of beams and twist of shafts.</li> <li>• Conclusion and Summary of Unit</li> </ul>

### C. RECOMMENDED STUDY MATERIAL:

Sr.No	Reference Book	Author	Edition	Publication
1.	Strength of Materials	Khurmi, R.S.	Latest	Khanna Publishers.
2.	Strength of Materials	Ramamurtham, S.	Latest	Dhanpat Rai & Sons
3.	Strength of Materials	Beer F. P. & Johnston S J	Latest	TMH, New Delhi,
4.	Strength of Materials	Bhavikatti S S	Latest	Vikas Publication House , New Delhi,
5.	Strength of material	S.S. Rattan	Latest	TMH
6.	Strength of material	Dr. R. K. Bansal	Latest	Laxmi publication Pvt. Ltd., New Delhi
<b>Important Web Links:</b>				
1.	<a href="https://nptel.ac.in/courses/112107146/">https://nptel.ac.in/courses/112107146/</a>			
2.	<a href="https://nptel.ac.in/courses/112107147/">https://nptel.ac.in/courses/112107147/</a>			

**COURSE OUTCOMES**

The student will able:

CO1: To analyze the features, classification, applications of engineering materials.

CO2: To analyze the Structure of materials at different levels, basic concepts of crystalline materials like unit cell, FCC, BCC, HCP, APF (Atomic Packing Factor), Co-ordination Number etc.

CO3: To apply the concept of phase & phase diagram & analyze the basic terminologies associated with metallurgy.

CO4: To apply and suggest the heat treatment process & its types.

CO5: To analyze and suggest the mechanical test

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1.	Classification of Engineering materials	7
2.	Structure of Materials	7
3.	Equilibrium Diagrams	7
4.	Heat Treatments	8
5.	Mechanical Properties and Testing's	7

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1.</b>	<b>Engineering Materials</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Engineering materials, classification of engineering materials, metals and alloys, polymers, ceramics, composites. General properties of engineering materials, stress-strain diagram. Selection of engineering materials as per the properties and application areas</li> <li>• Metallic alloys: Ferrous alloys, plain carbon and alloy steels classification, stainless steel, spring steel, tool steels, corrosion resistant steels, high speed steels etc. Cast iron and types. Nonferrous metals and alloys and their applications.</li> <li>• Classification of nonmetallic materials: Plastics, ceramics, composites types, their properties, applications and case studies.</li> <li>• Advanced Materials: Materials for modern vehicles, components and their case studies. smart materials, advanced composites and their applications, waste materials and their utilization</li> <li>• Conclusion and Summary of Unit</li> </ul>
<b>2.</b>	<b>Structure of Materials</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Structure of engineering materials. Crystalline structure of solids; development of grain structure, unit cell, atomic and nucleus arrangement. Space lattice, lattice parameters, coordination number, atomic packing factor.</li> <li>• Crystal lattice of simple cubic, body centered cubic, face centered cubic, hexagonal crystal structures. Miller Indices and crystal structure determination methods.</li> <li>• Crystal imperfection: Point defects- vacancy, Schottky's defect, Frankel defect, linear defects or dislocations, surface and volume defects.</li> <li>• Plastic deformation- Role of dislocation, slip, twinning, strain hardening, Bauschinger's effect. Recovery, recrystallization and grain growth</li> <li>• Conclusion of Unit</li> </ul>
<b>3.</b>	<b>Equilibrium Diagrams</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit.</li> <li>• Solidification of metals and of some typical alloys: Mechanism of crystallization (i) nuclear formation (ii) crystal growth. General principles of phase transformation in alloys, phase rule, phase diagram and equilibrium diagrams,</li> <li>• Binary isomorphous alloy system, Hume-Rothery rule, Binary system with limited solid solubility of terminal phase and in which solubility decreases with temperature and also alloy with peritectic transformation.</li> </ul>

	<ul style="list-style-type: none"> <li>Equilibrium diagram of a system whose components are subject to allotropic change. Iron carbon equilibrium diagram, phase transformation in the iron carbon diagram, eutectic, peritectic, eutectoid and peritectoid reactions and microstructures.</li> <li>Conclusion of Unit including real life applications</li> </ul>
<b>4.</b>	<b>Heat Treatments</b>
	<ul style="list-style-type: none"> <li>Introduction of Unit</li> <li>TTT curve- Cooling curves superimposed on Isothermal Transformation diagram, critical cooling rate. Formation of Martensite, Bainite</li> <li>Principles of heat treatment, types and applications. Annealing, normalizing, hardening, tempering types, diagram, objectives and applications.</li> <li>Chemical Heat treatment of steels: Case hardening, carburising, nitriding, cyaniding, carbonitriding. Flame and Induction hardening</li> <li>Hardenability and methods for determination of hardenability. Over-heated and burnt steel, temper brittleness -its causes and remedies</li> <li>Conclusion of Unit including real life application.</li> </ul>
<b>5.</b>	<b>Mechanical Properties and Testing's</b>
	<ul style="list-style-type: none"> <li>Introduction of Unit</li> <li>Mechanical Properties: Static property, tensile test, engineering and true stress, true strain curves, evaluation of properties and significance of test, typical engineering stress-strain diagrams</li> <li>Destructive Testing; Mechanical Properties and Testing: Types of fracture, testing of materials under tension, compression and shear loads – hardness tests (Brinell, Vickers and Rockwell) Impact test Izod and charpy, fatigue and creep test</li> <li>Non-destructive testing: Advantages and limitations of destructive and non-destructive testing, liquid penetrant magnetic particle inspection, and ultrasonic test, radiography and eddy current test.</li> <li>Effect of alloying elements in steels. Steels designation system.</li> <li>Conclusion of Unit including real life applications</li> </ul>

### C. RECOMMENDED STUDY MATERIAL:

Sr.No	Reference Book	Author	Edition	Publication
1.	Material science and metallurgy for Engineers	Dr V.D.Kodgire	Latest	Vrinda Publications
2.	Material Science.	Narula and Gupta	Latest	New Age Publishers
3.	A Text Book of Material Science & Metallurgy	K. M. Gupta	Latest	Umesh Publications
4.	Material Science and Engineering-An Introduction	Callister W.D.	Latest	John Wiley & Sons. Delhi.
5.	Engineering Materials	Kenneth G. Budinski	Latest	Prentice Hall of India, New Delhi
6.	Material Science & Engineering	V. Raghvan	Latest	Prentice Hall of India, New Delhi
Important Web Links:				
1	<a href="https://nptel.ac.in/courses/112108150/">https://nptel.ac.in/courses/112108150/</a>			
2	<a href="https://nptel.ac.in/courses/113106032/">https://nptel.ac.in/courses/113106032/</a>			

**COURSE OUTCOMES**

The student will be able to:

CO1 Analyze the basic concept of thermodynamics.

CO2 Analyze the concept of entropy and availability.

CO3 Analyze the properties of steam and vapour processes.

CO4 Apply the concept of gas power cycle and derive the efficiency of Rankine cycle.

CO5 Analyze the design aspects of various types of steam generator and air compressors..

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1.	Basic concepts of Thermodynamics	7
2.	Entropy and Availability	7
3.	Properties of Steam and Vapour Processes	8
4.	Steam Cycles And Fuel Combustion	7
5.	Steam Generators and Air compressors	7

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1.</b>	<b>Basic concepts of Thermodynamics</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Basic Concepts: Macroscopic and Microscopic Approaches, Thermodynamic Systems, Surrounding and Boundary, Thermodynamic Property – Intensive and Extensive, Thermodynamic Equilibrium, State, Path, Process and Cycle, Quasi-static, Reversible and Irreversible Processes, Working Substance. Concept of Thermodynamic Work and Heat, Zeroth Law of Thermodynamic and its utility, Problems.</li> <li>• Law of Thermodynamics; First Law of Thermodynamics, Second Law of Thermodynamics: Limitations of First Law, Heat Engine, Refrigerator and Heat Pump, Kelvin- Planck and Clausius Statements and their Equivalence, PMMSK. Carnot Cycle, Carnot Heat Engine and Carnot Heat Pump, Carnot Theorem and its Corollaries.</li> <li>• Conclusion of Unit including real life applications</li> </ul>
<b>2.</b>	<b>Entropy and Availability</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Entropy, Clausius Inequality, Principle of Entropy Increase, Temperature Entropy Plot, Entropy Change in Different Processes, Introduction to Third Law of Thermodynamics.</li> <li>• Availability and Irreversibility: High and Low Grade Energy, Availability and Unavailable Energy, Loss of Available Energy Due to Heat Transfer Through a Finite Temperature Difference, Availability of a Steady Flow System, Helmholtz and Gibb's Functions, Second law efficiencies of processes &amp; cycles.</li> <li>• Conclusion of Unit including real life applications</li> </ul>
<b>3.</b>	<b>Properties of Steam and Vapor Processes</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Steam; Pure Substance: Pure Substance and its Properties, Phase and Phase Transformation, Saturated and Superheat Steam, Solid – Liquid – Vapour Equilibrium, T-V, P-V and P-T Plots During Steam Formation, Properties of Dry, Wet and Superheated Steam, Temperature – Entropy (T-S) and Enthalpy – Entropy (H-S) Diagrams.</li> <li>• Ideal Gas Properties and Processes; Concept of an Ideal Gas, Basic Gas Laws, Characteristic Gas Equation Avogadro's law and Universal Gas Constant, Ideal gas processes- on P-V and T-S diagrams, Constant Pressure, Constant Volume, Isothermal, Adiabatic, Polytropic.</li> <li>• Conclusion of Unit including real life applications</li> </ul>

<b>4.</b>	<b>Steam Cycles And Fuel Combustion</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit.</li> <li>• Gas power Cycles: Otto Cycle, Diesel Cycle, Dual Cycle, Stirling Cycle, Ericson cycle and Brayton cycle. Comparison of Carnot cycle and Rankine cycle, Efficiency of Rankine cycle, work ratio, specific steam consumption. Effect of operating variables on Rankine cycle, Reheat and regenerative Rankine.</li> <li>• Types of fuels, Physical law of combustion, composition of dry air, Actual air fuel ratio, excess air, determination of actual quantity of air from combustion analysis, Fuel gas analysis; Orsat apparatus, Enthalpy of formation, Enthalpy of combustion, calorific values and their determination.</li> <li>• Conclusion of Unit including real life applications</li> </ul>
<b>5.</b>	<b>Steam Generators and Air compressors</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Steam Generators; Classification, Constructional details of low pressure boilers, Features of high pressure boilers, Construction and working principle of boiler, Boiler mountings and accessories, Boiler efficiency by direct and indirect method Energy balance, Boiler draught</li> <li>• Air Compressor; 1) Reciprocating Air Compressor and 2) Multistage compressors, isothermal efficiency, volumetric efficiency, 3) Rotary Air Compressors: - Classification, Difference between compressors and blowers.</li> <li>• Conclusion of Unit including real life application.</li> </ul>

### C. RECOMMENDED STUDY MATERIAL:

Sr.No	Reference Book	Author	Edition	Publication
1.	Thermal Engineering	R. K. Rajput	Latest	Laxmi Publication, New Delhi.
2.	Engineering Thermodynamics	P.K. Nag	Latest	Tata McGraw-Hill , New Delhi
3.	Thermal Engineering	S.C. Gupta	Latest	Pearson Education Pvt. Ltd. New Delhi.
4.	Thermal Engineering	P.L. Ballany	Latest	Khanna Publication, New Delhi.
5.	An introduction to Thermodynamics	YVC Rao	Latest	New Age publishers, New Delhi.
6.	Fundamental of Engg. Thermodynamics	R.Yadav	Latest	Central Publishing House, Allahabad
<b>Important Web Links</b>				
1	<a href="https://nptel.ac.in/courses/101104063/">https://nptel.ac.in/courses/101104063/</a>			
2	<a href="https://nptel.ac.in/courses/11210512/">https://nptel.ac.in/courses/11210512/</a>			

**COURSE OUTCOMES**

The student will be able to:

CO1 Analyze the metallographic samples and determine the phases present in them

CO2 Determine the tensile and compressive properties of material using UTM.

CO3 Differentiate between the Rockwell and Brinell test and determine the hardness of material.

CO4 Calculate the unit cell parameters in atomic arrangements like simple cubic, bcc, fcc etc.

CO5 Perform the torsion, fatigue and impact testing and analyze the parameters associated with them.

**A. LIST OF EXPERIMENTS**

1.	To determine the hardenability by Jominy end quench test.
2.	To determine machine defects by dye-penetrant & magnetic flow detection NDT technique
3.	To calculate the effective number of atoms, co-ordination number, packing factors, Miller indices (plane and Directions)
4.	To prepare metallic samples for metallographic examination and to study the principle and construction of the Metallurgical Microscope
5.	To determine flows by ultrasonic technique.
6.	To determine tensile and compressive properties of ductile and Non Ductile material with the help of Universal testing machine (UTM).
7.	To determine the impact strength of materials with the help of Charpy- Izod Impact Test
8.	To determine hardness of material with the help of Rockwell Hardness tester
9.	To determine hardness of material with the help of Brinell Hardness tester
10.	Fatigue testing on fatigue testing machine.
11.	Creep testing on creep testing machine.
12.	Torsion testing of a rod on torsion testing machine.
13.	Deflection of beam experiment, comparison of actual measurement of deflection with dial gauge to the calculated one, and or evaluation of young's modulus of beam
<b>Virtual Labs</b>	
<ul style="list-style-type: none"> <li>• <a href="http://sm-nitk.vlabs.ac.in/#">http://sm-nitk.vlabs.ac.in/#</a></li> </ul>	



**COURSE OUTCOMES**

The student will be able to:

CO1 Analyze the types of boiler, boiler draught and its applications.

CO2 Analyze the calorific value of fuel and carry out flue gas analysis.

CO3 Analyze the concept of steam condensers and cooling towers.

CO4 Analyze the basic components of air-conditioning system.

CO5 Analyze the performance of domestic refrigerator.

**A. LIST OF EXPERIMENTS**

1	To study various types of Boilers (Steam generators) and to study Boiler mounting and accessories
2	Study of boiler draughts.
3	Determination of calorific value using gas calorimeter or Bomb calorimeter.
4	Flue gas analysis using Orsat apparatus or Gas analyzer.
5	Determination of dryness fraction of steam using Throttling Calorimeter or Separating and Throttling Calorimeter.
6	Determination of Isothermal and Volumetric efficiency of reciprocating air compressor.
7	Study of steam condensers and cooling towers.
8	Study of various elements of a mechanical refrigerator system through cut sections models / actual apparatus.
9	To study basic components of air-conditioning system.
10	Experiment on air conditioning test rig and calculation of various performance
11	Study and performance of domestic refrigerator

**Virtual Labs**

1	<a href="http://www.khanacademy.com">www.khanacademy.com</a>
2	<a href="https://realism.io/simulations/bombcalorimeterlab">https://realism.io/simulations/bombcalorimeterlab</a>
3	<a href="http://web.mst.edu/~gbert/cal/bomb/Acal.html">http://web.mst.edu/~gbert/cal/bomb/Acal.html</a>

**COURSE OUTCOMES**

The student will be able to:

CO1 Understand why Python is a useful scripting language for developers.

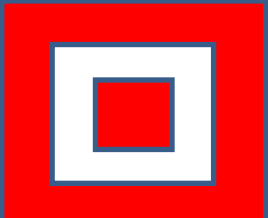
CO2 Identify the key issues in Python code, develop and experiment with python programming.

CO3 Develop problem solving and critical thinking skills in fundamental enable techniques like conditionals and loops.

CO4 Construct and explain with structure and concept of different data type like, List and Dictionary.

CO5 Implement read and write data from/to files in Python Develop Python programs step-wise by defining functions with tinker.

**A. List of Programs:**

<b>Part A</b>	
	<p>1. Write and run a Python program that outputs the value of each of the following expressions:</p> <p style="text-align: center;">5.0/9.0 5.0/9 5/9.0 5/9 9.0/5.0 9.0/5 9/5.0 9/5</p> <p>Based on your results, what is the rule for arithmetic operators when integers and floating point numbers are used?</p> <p>2. Write and run a Python program that asks the user for a temperature in Celsius and converts and outputs the temperature in Fahrenheit. (Use the formula given in the example above and solve for tempFin terms of tempC.)</p> <p>3. Here is an algorithm to print out n! (n factorial) from 0! to 19!:</p> <ol style="list-style-type: none"> <li>1. Set f = 1</li> <li>2. Set n = 0</li> <li>3. Repeat the following 20 times:               <ol style="list-style-type: none"> <li>a. Output n, "! = ", f</li> <li>b. Add 1 to n</li> <li>c. Multiply f by n</li> </ol> </li> </ol> <p>Using a for loop, write and run a Python program for this algorithm.</p> <p>4. Modify the program above using a while loop so it prints out all of the factorial values that are less than 1 billion.</p> <p>5. Modify the first program so it finds the minimum in the array instead of the maximum.</p> <p>6. (Harder) Modify the first program so that it finds the <b>index</b> of the maximum in the array rather than the maximum itself.</p>
<b>Part B</b>	
	<p>7. Modify the bubble sort program so it implements the improvements discussed in class. (HINT: To exit the main loop if the array is already sorted, simply change the loop variable to equal the last value so the loop ends early.)</p> <p>8. Draw the Target symbol (a set of concentric Squares, alternating red and white) in a graphics window that is 200 pixels wide by 200 pixels high. Hint: Draw the largest circle first in red, then draw the next smaller circle in white, then draw the next smaller circle in red. Graphical objects drawn later appear "on top of"</p> <div style="text-align: center;">  </div> <p style="text-align: right;">smaller circle in red. Graphical objects drawn earlier.</p>

9. Try entering the following literal values at the prompt. (Hit ENTER after each)

**-5**

**-4.2**

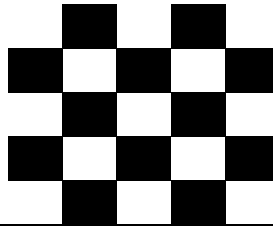
**4.5**

**4.14**

**0.90**

Something odd should occur. *Describe it on paper.*

10. Create a 5 X 5 rectangle whose top left corner is at (*row\*5, col\*5*). (Where is the bottom right corner?) If the sum of the *row* and *col* numbers is even, set the fill color of the rectangle to white, otherwise set it to black. Then draw the rectangle.



#### Virtual Labs

1	<a href="http://vlabs.iitb.ac.in/vlabs-dev/labs/oops/labs/exp1/index.php">http://vlabs.iitb.ac.in/vlabs-dev/labs/oops/labs/exp1/index.php</a>
2	<a href="http://vlabs.iitb.ac.in/vlabs-dev/labs/oops/labs/exp3/index.php">http://vlabs.iitb.ac.in/vlabs-dev/labs/oops/labs/exp3/index.php</a>
3	<a href="http://vlabs.iitb.ac.in/vlabs-dev/labs/oops/labs/exp2/index.php">http://vlabs.iitb.ac.in/vlabs-dev/labs/oops/labs/exp2/index.php</a>
4	<a href="http://vlabs.iitb.ac.in/vlabs-dev/labs/oops/labs/exp5/index.php">http://vlabs.iitb.ac.in/vlabs-dev/labs/oops/labs/exp5/index.php</a>

**COURSE OUTCOMES**

The student will be able to:

- CO1 Analyze the Industrial drawing.
- CO2 Analyze the difference between part and detailed drawing.
- CO3 Analyze the various parts of Lathe Tailstock.
- CO4 Apply the basic commands of AutoCAD.
- CO5 Create 3D model in AutoCAD.

**A. LIST OF EXPERIMENTS:**

1	Assembly Drawings – C Clamp
2	Assembly Drawings – IC Engine- Connecting Rod
3	Assembly Drawings- Lathe Tailstock
4	Orthographic Views : Drawing Tools: Arc, Ellipse, Polygon, Rectangle, Multiline, Pline, Xline, Modify Tools: Erase, oops, Undo, Redo, Explode,
5	Drawing Tools: Move, Copy, Rotate, Mirror, Array, Scale, Trim, Extend, Chamfer, Fillet, Mline, Mlstyle
6	Display Control: Zoom, Pan, Redraw, Regen, Object Properties: Color, Linetype, Ltscale, Lineweight, Properties, Matchprop
7	Dimension - Linear, Aligned, Radius, Diameter, Center Mark, Angle, Arc length, Continues, Baseline, Dimension Style, Leader, Qleader
8	Layer Management- Adding / Removing Layers, Layer Status, New Property Filter, New Group Filter, Layer Status Manager, Plot Control
9	Block Creation, Insert, Attribute
10	Introduction to plotting, Layout, Mview, Page setup, Plot
<b>Virtual Labs</b>	
1	<a href="http://www.vlab.co.in/participating-institute-iit-kharagpur">http://www.vlab.co.in/participating-institute-iit-kharagpur</a>
2	<a href="https://www.autodesk.com">https://www.autodesk.com</a>

**COURSE OUTCOMES**

The student will be able to:

CO1 Analyze potential areas for automation and justify need for automation.

CO2 Analyze the automated production lines, transfer lines and inspection methods.

CO3 Analyze the law of robotics and classification of robots.

CO4 Analyze the various types of sensors and end effectors used in robots

CO5 Apply the control of robots for some specific applications.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1.	Introduction to automation	7
2.	Automated production Lines	8
3.	Robotics	7
4.	Robot sensor and end efforts	7
5.	Robot Control and Applications	7

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1.</b>	<b>Introduction to Automation</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Basic elements of an automated system, advanced automation functions, levels of automation, process industries versus discrete manufacturing industries, FMS. Hardware components for automation and process control, sensors, actuators. Social issues of automation, types of automation, reasons of automation.</li> <li>• Basic elements of fluid power system, advantages and disadvantages of fluid power, application of fluid power. Pneumatic vs. hydraulics, Advantages and disadvantages of pneumatics and hydraulics.</li> <li>• Conclusion and Summary of Unit</li> </ul>
<b>2.</b>	<b>Automated production Lines</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Fundamentals of automated production lines, application of automated production lines, analysis of transfer lines, types of assembly lines, reasons for using automated assembly lines, fundamentals of automated assembly systems, barcode technology, RFID etc.</li> <li>• Automated Inspection Principles and Methods, Sensor Technologies for Automated Inspection, Coordinate Measuring Machines, Other Contact Inspection Methods, Machine Vision, other optical Inspection Methods.</li> <li>• Conclusion of Unit including real life applications</li> </ul>
<b>3.</b>	<b>Robotics</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit.</li> <li>• History of robots. Definition of robots. Industrial robots, law of robotics. Advantages and disadvantages of robots. Characteristics of an industrial robot, components of an industrial robot. Classification of robots- Robot classification on the basis of co-ordinate system, basics of power supply, basis of method of control, basis of programming method. Robotic safety, maintenance.</li> <li>• Conclusion of Unit including real life applications</li> </ul>
<b>4.</b>	<b>Robot sensor and end efforts</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit.</li> <li>• Types of sensors in robots. Tactile sensor, Proximity sensor (Position sensor), Range sensor, Machine vision sensor, Velocity sensor.</li> <li>• Robot end effectors- End effectors, classification of end effector, gripper, selection of gripper, Types of grippers, Finger gripper, Mechanical grippers.</li> <li>• Conclusion of Unit including real life applications</li> </ul>
<b>5.</b>	<b>Robot Control and Application</b>

- Introduction of Unit
- Basics of control: open loop- closed loop, Transfer functions. Types and components of a robot, Embedded systems: Microcontroller Architecture, Kinematic Modeling: Translation and Rotation Representation, Coordinate transformation.
- Robot capabilities, application of robots, manufacturing applications, material handling applications.
- Conclusion of Unit including real life application.

### C. RECOMMENDED STUDY MATERIAL

Sr.No	Reference Book	Author	Edition	Publication
1.	Robotics and Control	Nagrath and Mittal	Latest	Tata McGraw-Hill
2.	Robot Dynamics and Control	Spong and Vidhyasagar	Latest	John Wiley and sons
3.	Introduction to Robotics – Analysis, Systems and Application	Saeed B. Niku	Latest	PHI
4.	Robotics for Engineers	YoramKoren	Latest	McGraw Hill International
5.	Robotic Engineering – An Integrated approach	Klafter, Chmielewski and Negin	Latest	PHI
<b>Important Web links:</b>				
1	<a href="https://nptel.ac.in/courses/112101098/">https://nptel.ac.in/courses/112101098/</a>			
2	<a href="https://nptel.ac.in/courses/112105249/">https://nptel.ac.in/courses/112105249/</a>			

**COURSE OUTCOMES**

The student will be able to:

CO1 Analyze the drivers and enablers of Industry 4.0.

CO2 Analyze the application of IoT in Smart Factories, Smart cities, smart products and smart services.

CO3 Illustrate the systems used in a manufacturing plant and their role in an Industry 4.0 world.

CO4 Recommend the support system for Industry 4.0 and mobile computing.

CO5 Analyze the opportunities, challenges brought about by Industry 4.0 and how organizations and individuals should prepare to reap the benefits.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the Unit	Time required for the Unit (Hours)
1	Introduction to Industry 4.0	05
2	Road to Industry 4.0	04
3	Related Disciplines, System, Technologies for enabling Industry 4.0	05
4	Role of data, information, knowledge and collaboration in future organizations	05
5	Other Applications and Case Studies	05

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1.</b>	<b>Introduction to Industry 4.0</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• The Various Industrial Revolutions, Digitalisation and the Networked Economy, Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0 , The Journey so far: Developments in USA, Europe, China and other countries, Comparison of Industry 4.0 Factory and Today's Factory, Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation</li> <li>• Conclusion and Summary of Unit</li> </ul>
<b>2.</b>	<b>Road to Industry 4.0</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Internet of Things (IoT) &amp; Industrial Internet of Things (IIoT) &amp; Internet of Services, Smart Manufacturing , Smart Devices and Products, Smart Logistics, Smart Cities, Predictive Analytics</li> <li>• Conclusion and Summary of Unit</li> </ul>
<b>3.</b>	<b>Related Disciplines, System, Technologies for enabling Industry 4.0</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Cyber physical Systems, Robotic Automation and Collaborative Robots , Support System for Industry 4.0 , Mobile Computing, Related Disciplines, Cyber Security</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
<b>4.</b>	<b>Role of data, information, knowledge and collaboration in future organizations</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Resource-based view of a firm, Data as a new resource for organizations, Harnessing and sharing knowledge in organizations, Cloud Computing Basics, Cloud Computing and Industry 4.0</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
<b>5.</b>	<b>Other Applications and Case Studies</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Industry 4.0 laboratories, IIoT case studies, Case studies from HKPolyU students, opportunities and Challenges, Future of Works and Skills for Workers in the Industry 4.0 Era, Strategies for competing in an Industry 4.0 world</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>

### C. RECOMMENDED STUDY MATERIAL

S.No.	Reference Book	Author	Edition	Publication
1.	The Fourth Industrial Revolution	Klaus Schwab	Latest	World Economic Forum
2	Industry 4.0: The Industrial Internet of Things	Alasdair Gilchrist	Latest	Press
3.	Industry 4.0 Value Roadmap: Integrating Technology and Market Dynamics for Strategy, Innovation and Operations	Tuğrul U. Daim	Latest	Springer
4	Industry 4.0 and Regional Transformations	Lisa De Propris	Latest	Routledge
<b>Important Web Links:</b>				
1	<a href="https://en.wikipedia.org/wiki/Industry_4.0">https://en.wikipedia.org/wiki/Industry_4.0</a>			
2	<a href="https://www.dqindia.com/role-digital-verification-signature-scaling-industry-4-0/">https://www.dqindia.com/role-digital-verification-signature-scaling-industry-4-0/</a>			



**COURSE OUTCOMES:**

**After Successful completion of the course students will be able to understand-**

CO1: The principles of operations of DC machines as motor and generator

CO2: The principles of operations of Transformers

CO3: The principles of operations of Induction machines

CO4: The principles of operations of Synchronous machines and special machines.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the Unit	Time Required For The Unit (Hours)
1.	D.C. Machines	7
2.	Transformers	9
3.	Synchronous Machines	10
4.	Three Phase Induction Motors	9
5.	Single Phase Induction Motors And Special Machines	9

**B. DETAILED SYLLABUS**

Unit	Unit Details
1.	<b>D.C. MACHINES</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• D.C. Machines – Principle of operation and construction of motor and generator – torque and EMF equation – Various excitation schemes – Characteristics of Motor and Generator – Starting, Speed control and braking of D.C. Motor</li> <li>• Conclusion and Summary of Unit</li> </ul>
2.	<b>TRANSFORMERS</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Principle, Construction and Types of Transformer - EMF equation - Equivalent circuits – Phasor diagrams - Regulation and efficiency of a transformer-three phase transformer Connection</li> <li>• Conclusion and Summary of Unit</li> </ul>
3.	<b>SYNCHRONOUS MACHINES</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Principle of Operation, type - EMF Equation and Phasor diagrams - Synchronous motor- Rotating Magnetic field Starting Methods, Torque V-Curves, inverted – V curves</li> <li>• Conclusion and Summary of Unit</li> </ul>
4.	<b>THREE PHASE INDUCTION MOTORS</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Induction motor-principle of operation,</li> <li>• Types, Torque-slip characteristics - Starting methods and</li> <li>• Speed control of induction motors.</li> <li>• Conclusion and Summary of Unit</li> </ul>
5.	<b>SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Types of single phase induction motors – Double field revolving theory- Capacitor start capacitor run motors – Shaded pole motor – Repulsion type motor – Universal motor – Hysteresis motor - Permanent magnet synchronous motor – Switched reluctance motor – Brushless D.C motor.</li> <li>• Conclusion and Summary of Unit</li> </ul>

**D. RECOMMENDED STUDY MATERIAL:**

<b>Sr.No</b>	<b>Reference Book</b>	<b>Author</b>	<b>Edition</b>	<b>Publication</b>
1.	The Performance and Design of Direct Current Machines	Albert.E.Clayton, N.N. Hancock	Latest	Oxford
2.	Alternating Current Machines	Say. M. G.,	Latest	ELBS &Piman, London
3.	Utilisation of Electrical Power	Rajput, R.K.	Latest	Laxmi publications
4.	Electrical Technology	Theraja, B.L. and Theraja, A.K	Vol. II, 22 <sup>nd</sup> Ed	S.Chand
5.	Electric Machines	Nagrath, I.J	Latest	Tata McGraw hill
<b>Websites</b>				
<input type="checkbox"/>	khanacademy.com			
<input type="checkbox"/>	<a href="https://nptel.ac.in/courses/108/102/10812146/">https://nptel.ac.in/courses/108/102/10812146/</a>			

**Course Outcomes:**

On successful completion of the course the learners will be able to:

CO	Cognitive Abilities	Course Outcomes
CO-01	Understanding/ Applying	Understand the importance of human values and learn from others' experiences to become the conscious practitioners of the same.
CO-02	Understanding/ Applying	Enhance their self-esteem, confidence and assertive behaviour to handle difficult situations with grace, style, and professionalism.
CO-03	Understanding/ Applying	Distinguish among various levels of professional ethics while developing an understanding of them as a process in an organization.
CO-04	Understanding / Applying	Implement emotional intelligence to achieve set targets and excel in interpersonal as well as intrapersonal
CO-05	Understanding/Applying	Demonstrate knowledge of personal beliefs and values and a commitment to continuing personal reflection and reassessment.

UNIT NO.	UNIT NAME	Hours
1	Introduction to Human Values	6
2	Study of Self	4
3	Introduction to Professional Ethics	4
4	Emotional Intelligence	6
5	Life Skills & Value Education	5

LIST OF LABS	
1.	Human Values: Love & Compassion
2.	Truth, Non-Violence, Righteousness
3.	Peace, Service, Renunciation (Sacrifice)
4.	Self-Esteem: Do's and Don'ts to develop positive self-esteem
5.	Self-Assertiveness: Development of Assertive Personality
6.	Ambition & Desire: Self & Body (concepts & differences )
7.	Professional Ethics: Personal & Professional Ethics
8.	Emotional Intelligence: Skill Building for Strengthening the Elements of Self-awareness, Self-regulation, Internal motivation, Empathy, Social skills
9.	Governing Ethics & Ethics Dilemma
10.	Profession, Professionalism & Professional Risks
11.	Professional Accountabilities & Professional Success
12.	Life Skills & Value Education

**COURSE OVERVIEW AND OBJECTIVES:**

The objective of Discipline and TEP is to provide students with the opportunities to enhance job fetching skills and at the same time to cultivate the student's personal interests and hobbies while maintaining the good disciplinary environment in the University. TEP is integrated into the curriculum for holistic development of students through active participation in various activities falling in Technical and non-technical categories.

Discipline and Talent Enrichment Programme (TEP) -IV shall be evaluated irrespective of period/time allocation (as in the case of Extra Curricular activity) in the teaching scheme as a 1 credit course. The record related to discipline and related activities are maintained for each student and they shall be evaluated for the same also. It shall be counted in calculation of SGPA but it is not a backlog subject. However, the attendance of these classes shall be recorded and accounted in the total attendance.

Activities included in this category in the Third Semester are as follows:

Code	Activities	Hours	Credits
BMECME3601	Talent Enrichment Programme (TEP) - III	-	1
	Library/MOOC/Online Certification Courses	2	
	Non Syllabus Project (NSP) / Industrial Visit / Campus Recruitment Training (CRT) - III	1	

# FOURTH SEMESTER

Code: BMECME4101

MECHATRONICS

3 Credits [LTP: 3-1-0]

## COURSE OUTCOMES

The student will be able to:

CO1 Analyze the term mechatronics and its various components.

CO2 Analyze the role of signal conditioning in electronics domain and data presentation system.

CO3 Analyze the different types of actuators used in mechatronics system.

CO4 Analyze the working of microprocessors and microcontrollers and various types of control system and controllers.

CO5 Examine the influence of Industrial Design, Aesthetics and Ergonomics on product design, AGV's and industrial robots

## A. OUTLINE OF THE COURSE

Unit No.	Title of the unit	Time required for the Unit (Hours)
1.	Basics of Mechatronics	7
2.	Data acquisition system	9
3.	Actuators and Mechanisms	9
4.	Microprocessors and Microcontrollers	9
5.	Industrial Design, Aesthetics and Ergonomics	8

## B. DETAILED SYLLABUS

Unit	Unit Details
1.	<b>Basics of Mechatronics</b>
	<ul style="list-style-type: none"> <li>• <b>Introduction to Mechatronics</b> Scope and importance of mechatronics, Key issue, Systems, Measurement systems.</li> <li>• <b>Transducers and Sensors</b> Introduction, Difference between transducer and sensor, Transducer types, Transduction principle, Photoelectric transducers – photoemissive transducers, photoconductive transducers, photovoltaic transducers, Thermistors, Thermo devices, Thermocouple, Inductive transducers, Capacitive transducers.</li> <li>• Conclusion of Unit including real life applications</li> </ul>
2.	<b>Data acquisition system</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Signal Conditioning:</b> Introduction, Voltage divider, Rectification, Diode voltage stabilizer, Clipping and Clamping circuit, more about filter circuits, Isolator, Instrumentation amplifier, Bridge circuit, Comparator, Oscillator, Sample and Hold, Clock, Analog to Digital conversion principle, successive approximation method.</li> <li>• <b>Data Presentation and Data Logging Systems:</b> Introduction, Recorders–Graphic recorders, Strip chart recorders, X-Y recorders, Magnetic tape recorder. Data loggers – block diagram description, Data acquisition system – generalized data acquisition system, computer based data acquisition system.</li> <li>• Conclusion of Unit including real life applications</li> </ul>
3.	<b>Actuators and Mechanisms</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Actuators and Mechanisms:</b> Introduction, Actuator types and application areas, DC Motors – brushed, brushless DC motor, AC Motors – induction motors, synchronous motors, stepper motor,</li> <li>• Fluid power actuators – pneumatic actuators, hydraulic actuators, comparison.</li> <li>• Case studies on recent developments in actuators and their mechanisms.</li> <li>• Conclusion of Unit including real life applications</li> </ul>
4.	<b>Microprocessors and Microcontrollers</b>
	<ul style="list-style-type: none"> <li>• <b>Introduction to Microprocessors and Microcontrollers</b> Microprocessor–Introduction, Basic element of control systems Microcontrollers – Introduction, Difference between Microprocessors and Microcontrollers Programmable logic controllers – Introduction. Case studies on use of micro controllers in modern machines and</li> </ul>

	<p>devices</p> <ul style="list-style-type: none"> <li>• <b>Control Systems and Controllers</b> Introduction, Control system, Open-loop control systems, Closed-loop control systems – notations, reachability, transfer function. The Controllers – on-off controller, proportional controller, integral controller, derivative controller, P-I-D Controller.</li> <li>• Case studies on use of different controllers and control systems in Electric, hybrid vehicle and modern machineries.</li> <li>• Conclusion of Unit including real life applications.</li> </ul>
<b>5.</b>	<b>Industrial Design, Aesthetics and Ergonomics</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Industrial Design, Aesthetics and Ergonomics: Introduction, Element of product design–product physiognomy aesthetics, ergonomics in machine tool design, product safety audit,</li> <li>• Aesthetics and its elements. Aesthetics and ergonomics in product design</li> <li>• Automated guided vehicles: Factory without people, industrial robots, ergonomic problems in new technology.</li> <li>• Conclusion of Unit including real life applications</li> </ul>

### C. RECOMMENDED STUDY MATERIAL

S.No	Book	Author	Edition	Publication
<b>Reference Books</b>				
1.	Mechatronics	J.G. Joshi	Latest	Prentice Hall of India
2.	Mechatronics	HMT Limited	Latest	Tata McGraw-Hill
3.	Mechatronics	R.P. Borole	Latest	Nirali Prakashan, Jalgaon
4.	Mechatronics	N.P. Mahalik	Latest	Tata McGraw-Hill
5.	Mechatronics	W. Bolton	Latest	Pearson Education
6.	Applied Mechatronics	A. Smaili	Latest	Oxford University Press
7.	Introduction to Mechatronics	D.R. Appukuttan	Latest	Oxford University Press
<b>Important Web Links</b>				
•	<a href="https://nptel.ac.in/courses/112103174/">https://nptel.ac.in/courses/112103174/</a>			
•	<a href="https://nptel.ac.in/content/syllabus_pdf/112103174.pdf">https://nptel.ac.in/content/syllabus_pdf/112103174.pdf</a>			

**COURSE OUTCOMES**

The student will be able to:

- CO1 Analyze the various kinematics link and mechanism.  
 CO2 Analyze the concept of friction and cams and followers.  
 CO3 Apply the principle of governor and gyroscope working.  
 CO4 Analyze the gear and gear trains and their applications.  
 CO5 Analyze the methods of balancing single and multi-cylinder engines.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1.	Fundamentals of Kinematics	9
2.	Friction devices and clutches	9
3.	Mechanisms for Control	10
4.	Gears	10
5.	Balancing	10

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1.</b>	<b>Fundamentals of Kinematics</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Introduction to mechanism: Basic concept of machines, link, kinematic pairs, kinematic chain, and mechanism. Inversions of kinematic chains: four bar chain mechanism, quick return mechanisms, inversions of double slider crank mechanisms. Velocity and acceleration in mechanism: velocity and acceleration polygons, relative velocity and instantaneous centre method.</li> <li>• Conclusion and Summary of Unit.</li> </ul>
<b>2.</b>	<b>Friction devices and Cams</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Friction devices: Types and laws of friction, Clutches: single and multi-plate clutches. Brakes: Band, block, band and block brakes. Cams: Types of cams- displacement, velocity and acceleration curves for different cam followers, consideration of pressure angle and wear.</li> <li>• Conclusion and Summary of Unit.</li> </ul>
<b>3.</b>	<b>Mechanisms for Control</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Governor: a) Types of governors – Watts, Porter, Proell, Hartnell governor, and spring controlled governors b) Sensitiveness of governors, c) Hunting, Isochronisms, stability, d) Effect of governor, e) Power of governor, controlling force.</li> <li>• <b>Gyroscope:</b> Principle of gyroscopic couple, effect of gyroscopic couple and centrifugal force on vehicle taking a turn, stabilization of sea vessels.</li> <li>• Conclusion of Unit including Real Life application.</li> </ul>
<b>4.</b>	<b>Gears</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Gear: a) <b>Spur Gears:-</b> Law of gearing &amp; Terminology used in gears, conjugate action, in involute and cycloidal profile, path of contact, arc of contact, contact ratio, interference, undercutting, methods to avoid undercutting and interface, gear standardization, effect of center distance variation on the velocity ratio for involute profile tooth gears. <b>Gear Trains:</b> - Simple, compound and epicyclic gear trains. Analytical and graphical method for velocity ratio.</li> <li>• Conclusion of Unit including Real Life application</li> </ul>
<b>5.</b>	<b>Balancing</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Balancing of rotating masses in one and several planes. Balancing of reciprocating masses in single cylinder</li> </ul>

	<p>engine and multi cylinder engine.</p> <ul style="list-style-type: none"> <li>• Swaying couple, hammer blow and tractive effort.</li> <li>• Conclusion of Unit including Real Life application</li> </ul>
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**C. RECOMMENDED STUDY MATERIAL:**

Sr.No	Reference Book	Author	Edition	Publication
1.	Theory of Machine”	Khurmi, R.S., Gupta, J.K.	Latest	S. Chand.
2.	Theory of Machines and Mechanisms	Shigley J.E. and Uicker J.J.	Latest	McGraw Hill, Inc.
3.	Theory of Machines	Rattan S. S.	Latest	Tata McGraw Hill.
4.	Theory of Machines	Ballaney P. L.	Latest	Khanna Publishers, Delhi.
5.	Mechanism and Machine Theory	Rao, J.S., and Dukkupati, R.V.	Latest	Wiley Eastern Ltd.
6.	Kinematics and Linkages Design	Hall A.S.	Latest	Prentice-Hall.
Important Web Links				
1	<a href="https://nptel.ac.in/courses/11210412/">https://nptel.ac.in/courses/11210412/</a>			
2	<a href="https://nptel.ac.in/courses/11210411/">https://nptel.ac.in/courses/11210411/</a>			



**COURSE OUTCOMES**

The student will be able to:

CO1 Analyze the various conventional manufacturing Processes.

CO2 Analyze the various joining Processes and techniques.

CO3 Analyze the various forming and shaping processes.

CO4 Analyze the powder metallurgy processes and principle and types of rapid prototyping techniques.

CO5 Analyze the functioning of various plastic technologies.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1.	Foundry Technology	9
2.	Metal Joining Processes	8
3.	Forming and Shaping Processes:	8
4.	Powder Metallurgy	7
5.	Plastic Technology	7

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1.</b>	<b>Foundry Technology</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Importance of manufacturing, Technological definition of manufacturing, Types of production &amp; production processes.</li> <li>• Foundry Technology: Patterns practices: Types of patterns, allowances and material used for patterns, moulding materials, moulding sands, Moulding sands; properties, grain fineness; moisture content, permeability test.</li> <li>• Moulding practices: Green, dry and loam sand moulding, pit and floor moulding; shell moulding.</li> <li>• Casting practices: Fundamental of metal casting, sand casting, Shell-Mould casting, investment casting, Permanent mould casting, die casting, centrifugal casting, continuous casting, casting defects, gating system design, and riser design.</li> <li>• Conclusion of Unit including real life applications</li> </ul>
<b>2.</b>	<b>Metal Joining Processes</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Metal Joining Processes: Principle of welding, Arc welding, Gas welding and cutting: Processes and equipments.</li> <li>• Resistance welding: principle and equipments; Spot, projection and seam welding process. Ultrasonic and laser beam welding, electron beam welding and special welding processes; TIG, MIG, friction and explosive welding, welding defects.</li> <li>• Conclusion of Unit including real life applications</li> </ul>
<b>3.</b>	<b>Forming and Shaping Processes</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Metal working, elastic and plastic deformation, concept of strain hardening, hot and cold working, rolling, principle and operations,</li> <li>• Forging: forging operations, wire and tube drawing processes. Method of forging. Cold working processes- Shearing, drawing, squeezing, blanking, piercing, deep drawing, coining and embossing.</li> <li>• Sheet Metal working: Presses and their classification, Die &amp; punch and press work methods and processes. Blanking and Piercing.</li> <li>• Conclusion of Unit including real life applications</li> </ul>

<b>4.</b>	<b>Powder Metallurgy</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit.</li> <li>• Powder manufacturing, mechanical pulverization, sintering, Electrolytic Process, chemical reduction, properties of metal powders, advantages and applications of Powder manufacturing.</li> <li>• Rapid Prototyping Operations: Introduction, subtractive processes, additive processes.</li> <li>• Conclusion of Unit including real life applications</li> </ul>
<b>5.</b>	<b>Plastic Technology</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Plastic Technology: Review of plastics, and its past, present &amp; future uses, Classification of Plastics, Ingredients of Moulding compounds, General Properties of Plastics, Manufacturing of Plastic components: Injection moulding, compression moulding, transfer moulding. Resins &amp; Adhesives.</li> <li>• Conclusion of Unit including real life application.</li> </ul>

### C. RECOMMENDED STUDY MATERIAL:

Sr.No	Reference Book	Author	Edition	Publication
1.	Production Technology Volume I & II	P.N. Rao	Latest	Tata McGraw Hill Publication.
2.	Production Technology	R.K. Jain	Latest	Khanna Publishers.
3.	Elements of Workshop Technology Volume I&II	HajaraChoudhari, Bose S.K.	Latest	Asia Publishing House
4.	Production Technology	HMT	Latest	Tata McGraw Hill Publishers
5.	Materials and Process Manufacturing	E. Paul De. Garmo,	Ninth	John Willey Publication
6.	Production Technology	P.C. Sharma	Latest	Khanna Publishers.
<b>Important Web Links</b>				
1	<a href="https://nptel.ac.in/courses/112107219/">https://nptel.ac.in/courses/112107219/</a>			
2	<a href="https://nptel.ac.in/courses/112107145/">https://nptel.ac.in/courses/112107145/</a>			

**COURSE OUTCOMES**

The student will be able to:

- CO1 Analyze the basic principles of fluid mechanics and develop ability to analyze fluid flow problems with the application of the momentum and energy equations.
- CO2. Apply the conservation laws in differential forms and apply them to determine velocities, pressures and acceleration in a moving fluid.
- CO3 Analyze the losses in pipes and evaluate the flow through pipes.
- CO4 Illustrate the design aspects of various types of hydraulic turbines.
- CO5 Examine the construction of centrifugal pumps and determine its efficiency.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the Unit	Time required for the Unit (Hours)
1	Fluid Statics	06
2	Fluid kinematics & Fluid dynamics	08
3	Closed conduit flow	07
4	Hydraulic Turbines	08
5	Centrifugal pumps	07

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1.</b>	<b>Fluid Statics</b>
	<ul style="list-style-type: none"> <li>Introduction of Unit</li> <li>Dimensions and units: physical properties of fluids- specific gravity, viscosity surface tension- vapor pressure and their influence on fluid motion- atmospheric gauge and vacuum pressure –measurement of pressure- Piezometer, U-tube and differential manometers.</li> <li>Conclusion and Summary of Unit</li> </ul>
<b>2.</b>	<b>Fluid kinematics &amp; Fluid dynamics</b>
	<ul style="list-style-type: none"> <li>Introduction of Unit</li> <li>Fluid kinematics: stream line, path line and streak lines and stream tube, classification of flows-steady &amp; unsteady, uniform, non-uniform, laminar, turbulent, rotational, and irrotational flows-equation of continuity for one dimensional flow.Fluid dynamics: surface and body forces –Euler’s and Bernoulli’s equations for flow along a stream line, momentum equation and its application on force on pipe bend.</li> <li>Conclusion and Summary of Unit</li> </ul>
<b>3.</b>	<b>Closed conduit flow</b>
	<ul style="list-style-type: none"> <li>Introduction of Unit</li> <li>Reynold’s experiment- Darcy Weisbach equation- Minor losses in pipes- pipes in series and pipes in parallel- total energy line-hydraulic gradient line. Measurement of flow: pilot tube, venturimeter, and orifice meter, Flow nozzle, Turbine flow meter</li> <li>Conclusion of Unit including Real Life Application</li> </ul>
<b>4.</b>	<b>Hydraulic Turbines</b>
	<ul style="list-style-type: none"> <li>Introduction of Unit</li> <li>classification of turbines, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine- working proportions, work done, efficiencies, hydraulic design –draft tube- theory- functions and efficiency.</li> <li>Conclusion of Unit including Real Life Application</li> </ul>
<b>5.</b>	<b>Centrifugal pumps</b>
	<ul style="list-style-type: none"> <li>Introduction of Unit</li> <li>Classification, working, work done – manometric head- losses and efficiencies- specific speed- pumps in series and parallel-performance characteristic curves, NPSH. Reciprocating pumps: Working, Discharge, slip, indicator diagrams</li> <li>Conclusion of Unit including Real Life Application</li> </ul>

**C. RECOMMENDED STUDY MATERIAL:**

<b>Sr.No</b>	<b>Reference Book</b>	<b>Author</b>	<b>Edition</b>	<b>Publication</b>
1.	Text book of Fluid Mechanics & Hydraulic Machines	R.K. Bansal	Latest	R.K. Bansal
2.	Hydraulic and Fluid Mechanics	Dr. P.N Modi ,Dr. S.M Seth	Latest	Standard Book House.
3	Fluid Mechanics and Machinery	D. Rama Durgaiah		New Age International.
4	Hydraulic Machines	Banga& Sharma	Latest	Khanna Publishers
<b>Important Web Links:</b>				
1	<a href="https://nptel.ac.in/courses/112105206/">https://nptel.ac.in/courses/112105206/</a>			
2	<a href="en.wikipedia.org/wiki/Fluid_Mechanics_and_Machinery">en.wikipedia.org/wiki/Fluid_Mechanics_and_Machinery</a>			

**COURSE OUTCOMES**

The student will be able to:

CO1 Analyze the different types of kinematic mechanism like four bar etc.

CO2 Apply the concept of slip and measure the slip of the belt drive.

CO3 Create the characteristic curves of governors and gyroscopic principle.

CO4 Analyze gear box types and epicyclic gear train torque transmitted and holding torque.

CO5 Analyze and perform the static and dynamic balancing of a rotor.

**A. LIST OF EXPERIMENTS**

1.	To study inversion of four bar chain Mechanism.
2.	Study of quick return mechanism. (Crank and Slotted lever mech.)
3.	To draw velocity and acceleration diagram for Crank and slotted lever mechanism.
4.	Study of inversion of Double slider chain Mechanism.
5.	To determine moment of inertia of the given object using of Trifler suspension.
6.	Study of various cam-follower arrangement.
7.	To Perform characteristics of a Watt/ Porter governor.
8.	Performance characteristics of a spring-loaded governor.
9.	Performance characteristics of a proell governor.
10.	Study and perform the gyroscopic effect principle
11.	Study of various types of gearboxes such as industrial gearboxes, Synchromesh gearbox, Differential gearbox.
12.	To study and perform epi-cyclic gear train and to measure torque transmitted and holding torque.
13.	To study and perform the dynamic balancing machine and to balance a rotor.

**Virtual Labs**

•	<a href="http://mm-nitk.vlabs.ac.in/exp1/index.html#">http://mm-nitk.vlabs.ac.in/exp1/index.html#</a>
•	<a href="http://mm-nitk.vlabs.ac.in/exp7/index.html">http://mm-nitk.vlabs.ac.in/exp7/index.html</a>
•	<a href="http://mm-nitk.vlabs.ac.in/exp9/index.html">http://mm-nitk.vlabs.ac.in/exp9/index.html</a>
•	<a href="http://mm-nitk.vlabs.ac.in/exp29/index.html">http://mm-nitk.vlabs.ac.in/exp29/index.html</a>
•	<a href="http://vlabs.iitb.ac.in/vlabs-dev/labs/nitk_labs/dynamics-of-machine-lab/labs/proell-governor-nitk/simulation.html">http://vlabs.iitb.ac.in/vlabs-dev/labs/nitk_labs/dynamics-of-machine-lab/labs/proell-governor-nitk/simulation.html</a>
•	<a href="http://vlabs.iitb.ac.in/vlabs-dev/labs/nitk_labs/dynamics-of-machine-lab/labs/porter-governer-nitk/index.html">http://vlabs.iitb.ac.in/vlabs-dev/labs/nitk_labs/dynamics-of-machine-lab/labs/porter-governer-nitk/index.html</a>
•	<a href="http://vlabs.iitb.ac.in/vlabs-dev/labs/nitk_labs/dynamics-of-machine-lab/labs/balancing-multiple-mass-single-plane-nitk/index.html">http://vlabs.iitb.ac.in/vlabs-dev/labs/nitk_labs/dynamics-of-machine-lab/labs/balancing-multiple-mass-single-plane-nitk/index.html</a>
•	<a href="http://vlabs.iitb.ac.in/vlabs-dev/labs/nitk_labs/dynamics-of-machine-lab/labs/balancing-multiple-mass-multiple-plane-nitk/index.html">http://vlabs.iitb.ac.in/vlabs-dev/labs/nitk_labs/dynamics-of-machine-lab/labs/balancing-multiple-mass-multiple-plane-nitk/index.html</a>

**COURSE OUTCOMES**

The student will be able to:

CO1 Apply the concept of joining processes and perform welding operation.

CO2 Create a pattern and mould for casting.

CO3 Analyze the mechanism of the shaper machine and tube bending techniques.

CO4 Apply the concept of machining processes and perform the operations on lathe like turning, knurling etc.

CO5 Apply the concept of sheet metal working and perform the blanking and piercing operation.

**A. LIST OF EXPERIMENTS**

1	Welding Shop- One job on welding (fabrication) preparing a component comprising welding joints such as shoe rack, book rack, stands for flower pots, house hold applications etc.
2	Machine Shop- One composite job involving different machine operation on Lathe, Shaper, Slotter, Drilling, Milling & Grinding operations.
3	Making a simple solid pattern involving wood turning – one job
4	Forging - power hammer study & operation
5	To study shaper machine, its mechanism and calculate quick return ratio.
6	To prepare mould of a given pattern requiring core and to cast it in aluminum.
7	To find clay content and moisture content from mould sand
8	To study Tube bending on tube bending m/c.
9	Strength Test (compressive, Tensile, Shear Transverse etc. in green and dry conditions) and Hardness Test (Mould and Core).
10	To perform step turning, knurling and chamfering on lathe machine as per drawing.
11	Press work experiment such as blanking/piercing, washer, making etc.

**Virtual Labs**

•	<a href="http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/machine_tools/labs/exp1/simulation.php">http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/machine_tools/labs/exp1/simulation.php</a>
•	<a href="https://fab-coep.vlabs.ac.in/exp1/Simulator.html?domain=Mechanical%20Engineering&amp;lab=FAB%20laboratory">https://fab-coep.vlabs.ac.in/exp1/Simulator.html?domain=Mechanical%20Engineering&amp;lab=FAB%20laboratory</a>
•	<a href="https://virtlabs.tech/metal-cutting/">https://virtlabs.tech/metal-cutting/</a>
•	<a href="https://fabcoep.vlabs.ac.in/exp7/Theory.html?domain=Mechanical%20Engineering&amp;lab=Welcome%20to%20FAB%20laboratory!">https://fabcoep.vlabs.ac.in/exp7/Theory.html?domain=Mechanical%20Engineering&amp;lab=Welcome%20to%20FAB%20laboratory!</a>

**COURSE OUTCOMES**

The student will be able to:

CO1 Analyze the viscosity of liquid and metacentric height of a given object

CO2 Analyze the head loss in length of pipe and also flow rate by venturi and orifice meter

CO3 Illustrate the laminar and turbulent flow by use of Reynolds apparatus and determine flow rate by nozzle meter

CO4 Illustrate the momentum equation and also determine coefficient of friction in pipe

CO5 Recommend the performance characteristic curves of hydraulic turbines.

**A. LIST OF EXPERIMENTS**

1	Determination of viscosity of liquids and its variation with temperature.
2	Determine Metacentric height of a given body
3	Determine head loss of given length of pipe.
4	Determine flow rate of air by Venturi meter and orifice meter
5	Study of Laminar and Turbulent flow by use of Reynolds apparatus
6	Determine flow rate of air by nozzle meter.
7	Study of momentum equation
8	Determination of co-efficient of friction in pipes
9	Determine Cd, Cv & Cc for given orifice
10	Performance characteristics of Pelton wheel turbine.
11	Performance characteristics of Francis turbine.
12	Performance characteristics of Kaplan turbine.
13	Performance test on reciprocating pump and centrifugal pump

**VIRTUAL LAB**

•	<a href="http://www.vlab.co.in/broad-area-mechanical-engineering">http://www.vlab.co.in/broad-area-mechanical-engineering</a>
•	<a href="http://vlabs.iitb.ac.in/vlab/labsme.html">http://vlabs.iitb.ac.in/vlab/labsme.html</a>
•	<a href="http://www.vlab.co.in/participating-institute-iit-kharagpur">http://www.vlab.co.in/participating-institute-iit-kharagpur</a>

**COURSE OUTCOMES**

The student will be able to:

- CO1 Understand the different coordinate system.
- CO2 Create basic mechanical components in 3-D Modeling..
- CO3 Apply the basic entities in 2D Drafting.
- CO4 Apply different surface modeling editing commands.
- CO5 Apply the shading and rendering techniques.

**LIST OF EXPERIMENTS**

1	Learn the basic initial setting and viewing of the 3D Modeling software's interface.
2	Understand different coordinate system and do a exercise.
3	Learn 3-D Modeling and draw basic mechanical components.
4	Learn and use of 3-D Advanced Modeling.
5	Feature Modification and Manipulation in 3D Modeling.
6	Learn and draw the basic entities in 2D Drafting with an example of machine element.
7	Learn and use of Detailing & Annotation.
8	Draw the different Surface model with different editing commands.
9	Learn and use of Sheet Metal with different editing commands.
10	Learn and use shading and rendering techniques for better visual appearance.
11	Use and learn import/export techniques and customization of drafting software.



**COURSE OUTCOME**

The student will be able to:

- CO1 Analyze the vehicle propulsion and powertrain technologies
- CO2 Analyze the basics of hybrid electric vehicles, their plug-ins, hydraulic and pneumatic hybrid vehicles
- CO3 Analyze the basics of chassis systems of electric and hybrid electric vehicles.
- CO4 Analyze the vehicle kinematics and system performance characteristic
- CO5 Know the battery management system and its performance.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the unit (In hours)
1.	Introduction to Vehicle Propulsion and Powertrain Technologies	7
2.	Hybrid Electric Vehicles	8
3.	Body and Chassis	7
4.	Vehicle Dynamics Fundamentals	7
5.	Battery	7

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1.</b>	<b>Introduction to Vehicle Propulsion and Power train Technologies</b>
	<ul style="list-style-type: none"> <li>• History of Vehicle Development, Internal Combustion Engine Vehicles (ICEVs)</li> <li>• Vehicles with Alternative Fuels,</li> <li>• Power train Technologies,</li> <li>• Transmission Systems, Drive train and Differentials.</li> <li>• Electric and Hybrid Power train Technologies: Introduction, Battery Electric Vehicles (BEVs),</li> <li>• Fuel-Cell Electric Vehicles (FCEVs).</li> <li>• Review or case studies on vehicle development</li> </ul>
<b>2.</b>	<b>Hybrid Electric Vehicles</b>
	<ul style="list-style-type: none"> <li>• Hybrid Electric Vehicles,</li> <li>• Plug-in Hybrid Electric Vehicles (PHEVs),</li> <li>• Hybrid Hydraulic Vehicles (HHVs),</li> <li>• Pneumatic Hybrid Vehicles (PHVs),</li> <li>• Power/Energy Management Systems.</li> </ul>
<b>3.</b>	<b>Body and Chassis</b>
	<ul style="list-style-type: none"> <li>• Body and Chassis Technologies and Design: Introduction, General Configuration of Automobiles,</li> <li>• Body and Chassis Fundamentals,</li> <li>• Different Types of Structural Systems,.</li> <li>• Body and Chassis Materials,</li> <li>• Specific Considerations in Body and Chassis Design of Electric and Hybrid Electric Vehicles, Chassis Systems of Electric and Hybrid Electric Vehicles.</li> </ul>
<b>4.</b>	<b>Vehicle Dynamics Fundamentals</b>
	<ul style="list-style-type: none"> <li>• Concepts and Terminology,</li> <li>• Vehicle Kinematics,</li> <li>• Tire Mechanics and Modeling,</li> <li>• ICE Performance Characteristics, Electric Motor Performance Characteristics.</li> </ul>
<b>5.</b>	<b>Battery</b>
	<ul style="list-style-type: none"> <li>• Battery Performance Characteristics,</li> <li>• Transmission and Drive train Characteristics,</li> <li>• Regenerative Braking Characteristics,</li> <li>• Driving Cycles.</li> </ul>

- Power trains Components: Rechargeable Battery Vehicles, Hybrid Vehicles, Fuel Cell vehicles, Case studies

### C. RECOMMENDED STUDY MATERIAL

Sr.No	Reference Book	Author	Edition	Publication
1.	Electric and Hybrid Vehicles: Design Fundamentals.	Iqbal Hussein	2nd Edition,	CRC Press, 2003.
2.	Electric and Hybrid Vehicles, Technologies, modeling and control: A mechatronic approach	A. Khajepour,S. FallahandA. Goodarji,	1 <sup>st</sup> edition	Willey, 2014.
3.	Electric vehicle technology	J. Larminie and J. Lowry	2nd edition	Wiley, 2012.

#### Important Web Links

[https://onlinecourses.nptel.ac.in/noc20\\_ee99/preview](https://onlinecourses.nptel.ac.in/noc20_ee99/preview)

**COURSE OUTCOMES**

The student will be able to:

CO1 Analyze the fundamentals of Additive Manufacturing Technologies for engineering applications.

CO2 Recommend the methodology to manufacture the products using SLA and SGC technologies and study their applications, advantages and case studies.

CO3 Apply the methodology to manufacture the products using LOM and FDM technologies and study their applications, advantages and case studies.

CO4 Illustrate the methodology to manufacture the products using SLS and 3D Printing technologies and study their applications, advantages and case studies.

CO5 Apply the Preparation of making of 3D Printer Model.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1.	Introduction to Additive Manufacturing Technology	07
2.	Liquid based systems	09
3.	Solid based systems	08
4.	Powder Based Systems	09
5.	Three dimensional printing (3DP)	09

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1.</b>	<b>Introduction to Additive Manufacturing Technology</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Introduction, Prototyping fundamentals, Historical development, Advantages of AMT, Commonly used terms, process chain, 3D modelling, Data Conversion, and transmission, Checking and preparing, Building, Post processing, RP data formats, Classification of AMT process, Applications to various fields</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
<b>2.</b>	<b>Liquid based systems</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Stereo lithography apparatus (SLA): Models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies. Solid ground curing (SGC): Models and specifications, process, working, principle, applications, advantages and disadvantages, case studies.</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
<b>3.</b>	<b>Solid based systems</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Laminated object manufacturing (LOM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages.</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
<b>4.</b>	<b>Powder Based Systems</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Selective laser sintering (SLS): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies.:</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
<b>5.</b>	<b>Three dimensional printing (3DP)</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Models and specification, process, working principle, applications, advantages and disadvantages, case studies.</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>

### C. RECOMMENDED STUDY MATERIAL

Sr. No	Book	Author	Edition	Publication
<b>Reference Books</b>				
1	3D Printing and Additive Manufacturing	Chee kai chua&kah Fai Leong	5 <sup>th</sup> Edition	World Scientific
2.	Rapid Prototyping	M. Adithan	Latest	Atlantic Publishers and Distributors Pvt Ltd
3.	Rapid Prototyping; A Brief Introduction	A Ghosh	Latest	Ewp
<b>Important Web Links</b>				
1.	<a href="https://www.freecodecamp.org/news/a-beginners-guide-to-rapid-prototyping-71e8722c17df/">https://www.freecodecamp.org/news/a-beginners-guide-to-rapid-prototyping-71e8722c17df/</a>			
2.	<a href="https://www.lynda.com/3D-Printing-tutorials/Rapid-Prototyping-Product-Design/169615-2.html">https://www.lynda.com/3D-Printing-tutorials/Rapid-Prototyping-Product-Design/169615-2.html</a>			
3.	<a href="https://nptel.ac.in/courses/112104265/">https://nptel.ac.in/courses/112104265/</a>			

**COURSE OUTCOME**

The student will be able to:

CO1 Describe the importance of non-destructive testing methods for evaluation of products/materials.

CO2 Apply the basic testing knowledge of liquid penetrant testing methods for product testing.

CO3 Illustrate the flaw detection using magnetic particle inspection and eddy current methods.

CO4 Analyze the various defects occurred in the products during manufacturing through ultrasonic testing.

CO5 Select the appropriate technique and exposure time for a better imaging in radiography testing.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the Unit	Time required for the Unit (Hours)
1.	<b>Introduction to Non Destructive Evaluation and Testing</b>	6
2.	<b>Optical Methods and Liquid Penetrant Testing</b>	6
3.	<b>Electro-Magnetic Testing</b>	7
4.	<b>Ultrasonic Testing</b>	8
5.	<b>Radiographic Testing</b>	9

**B. DETAILED SYLLABUS**

Unit	Unit Details
1.	<b>Introduction to Non Destructive Evaluation and Testing</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterization, Relative merits and limitations.</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
2.	<b>Optical Methods and Liquid Penetrant Testing</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Optical Methods: holography- Principles and practices of Optical holography, x-ray and electron beam holography techniques</li> <li>• Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results.</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
3.	<b>Electro-Magnetic Testing</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Magnetic Particle Inspection – Principle, procedure, Interpretation and evaluation of test indications, Principles and methods of demagnetization</li> <li>• Eddy Current Testing- Introduction to electrical impedance, principles of eddy current testing, flaw detection using eddy currents</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
4.	<b>Ultrasonic Testing</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Ultrasonic Testing- Generation of ultrasonic waves, Horizontal and shear waves, Near field and far field acoustic wave description, Ultrasonic probes- Straight beam, direct contact type, Angle beam, Transmission/reflection type, and delay line transducers, acoustic coupling and media, Transmission and pulse echo methods, A-scan, B-scan, C-scan, F- scan and P-scan modes, Flaw sizing in ultrasonic inspection.</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>

<b>5.</b>	<b>Radiographic Testing</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Radiographic Methods- Introduction to x-ray radiography, the radiographic process, X-ray and Gamma ray sources, Geometric principles, Factors governing exposure, radiographic screens, scattered radiation, arithmetic of exposure, radiographic image quality and detail visibility, industrial X-ray films.</li> <li>• X-Ray Radiography Processes- Fundamentals of processing techniques, process control, the processing room, special processing techniques, paper radiography, and film graininess signal to noise ratio in radiographs.</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>

### C. RECOMMENDED STUDY MATERIAL

Sr.No	Reference Book	Author	Edition	Publication
1	NDT & Evaluation of Materials	J. Prasad & C G K Nair	Latest	Tata McGraw Hill
2	Non Destructive Testing of Materials	V. Jayakumar & K. Elangovan	Latest	Laxmi Publication
3	Radiography in Modern Industry	W. R. Garrett, H. R. Splettstosser, D. E. Titus	1980	Eastman Kodak Company
4	Introduction to the Non-Destructive Testing of Welded Joints	R Halmshaw	1960	Woodhead Publishing Ltd.
<b>Important Web links</b>				
1	<a href="https://nptel.ac.in/courses/113106070">https://nptel.ac.in/courses/113106070</a>			
2	<a href="https://www.asnt.org/MajorSiteSections/About/Introduction_to_Nondestructive_Testing.aspx">https://www.asnt.org/MajorSiteSections/About/Introduction_to_Nondestructive_Testing.aspx</a>			

**Course Outcomes:**

On successful completion of the course the learners will be able to

CO	Cognitive Abilities	Course Outcomes
CO1	Understanding/ Applying	Integrate their understanding into their leadership skills development process.
CO2	Understanding/ Applying	Demonstrate knowledge of the working environment impacting business organizations and exhibit an understanding of ethical implications of decisions.
CO3	Understanding/ Applying	Assess leadership styles and sharpen the managerial skills to communicate effectively and facilitate decision making in relation with self-management, stress management and conflict management.
CO4	Understanding / Applying	Generate a creative thinking, something beyond the obvious answers and solution to a specific problem.
CO5	Creating/Applying	Understand the significance of trust and team skills, creating new innovative ideas with the help of brainstorming and learn work etiquettes.

UNIT NO.	UNIT NAME	Hours
1	Leadership Skills	4
2	Entrepreneurial Skills	4
3	Managerial Skills: Self –Management, Stress Management & Conflict Management	6
4	Creative Thinking & Design Thinking	6
5	Team Building & Confidence Building	5

#### LIST OF LABS

1.	Leadership Skills: Stages of development
2.	Leadership Skills I: Attributes of great leaders, decision making, activities to enhance such qualities
3.	Leadership Through Biographies
4.	Entrepreneurial Skills: Traits & Competencies of an Entrepreneur
5.	Managerial Skills: Conflict Management
6.	Self-Management: Challenges & Solutions
7.	Stress Management : Causes of stress and regulation
8.	Creating Business Plans: Problem Identification and Idea Generation
9.	Design Thinking: Transforming Challenges into Opportunities
10.	Creative Thinking & Analytical Thinking: Presentation
11.	Team building: Developing teams and team work
12.	Confidence Building : Improving engagement, communicating effectively & activities to facilitate decision making

**COURSE OVERVIEW AND OBJECTIVES:**

The objective of Discipline and TEP is to provide students with the opportunities to enhance job fetching skills and at the same time to cultivate the student's personal interests and hobbies while maintaining the good disciplinary environment in the University. TEP is integrated into the curriculum for holistic development of students through active participation in various activities falling in Technical and non-technical categories.

Discipline and Talent Enrichment Programme (TEP) -IV shall be evaluated irrespective of period/time allocation (as in the case of Extra Curricular activity) in the teaching scheme as a **1 credit** course. The record related to discipline and related activities are maintained for each student and they shall be evaluated for the same also. It shall be counted in calculation of SGPA but it is not a backlog subject. However, the attendance of these classes shall be recorded and accounted in the total attendance.

Activities included in this category in the IV Semester are as follows:

Code	Activities	Hours	Credits
BMECME4601	Talent Enrichment Programme (TEP) - IV	-	1
	Library/MOOC/Online Certification Courses	1	
	Non Syllabus Project (NSP) / Industrial Visit / Campus Recruitment Training (CRT) - IV	2	



# FIFTH SEMESTER

**Code: BMECME5101**

**DESIGN OF MACHINE ELEMENTS-I**

**3 Credits [LTP: 3-0-0]**

## Course Outcomes

The student will be able to:

CO1 Analyze the process to identify the material for respective output, know about the basic knowledge of fits & tolerances.

CO2 Analyze the design on a Pin, cotter and keyed joints, Design of screw fastening.

CO3 Illustrate the design the bending stress in beam, leaf spring.

CO4 Recommend the designing of shafts subjected to combine twisting moment and bending moment.

CO5 Analyze the design procedure for Shaft under combined stresses, Screw fasteners subjected to eccentric loading.

## A. OUTLINE OF THE COURSE

Unit No.	Title of the unit	Time required for the Unit (Hours)
1.	Design processes and Material selection	7
2.	Design for strength:	7
3.	Design of members in Bending:	8
4.	Design of members in torsion	7
5.	Combined Stresses	7

## B. DETAILED SYLLABUS

Unit	Unit Details
<b>1.</b>	<b>Design processes and Material selection</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Materials: Properties and IS coding of various materials, Selection of material from properties and economic aspects.</li> <li>• Manufacturing aspects in Design: Selection of manufacturing processes on the basis of design and economy, Influence of rate of production, standard size, Influence of limits, fits tolerances and surface finish. Change in the shape of the designed element to facilitate its production, Design of castings, working drawing.</li> <li>• Conclusion and Summary of Unit</li> </ul>
<b>2.</b>	<b>Design for strength</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Design for strength: Allowable stresses, detailed discussion on factor of safety (factor of ignorance): Stress concentration. Causes &amp; mitigation. Introduction of various design considerations like strength, stiffness, weight, cost, space etc. Concept of fatigue failures.</li> <li>• Design of machine elements subjected to direct stress, Pin, cotter and keyed joints, Design of screw fastening.</li> <li>• Conclusion and Summary of Unit</li> </ul>
<b>3.</b>	<b>Design of members in Bending</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Bending stress in straight &amp; curved beam, springs, Laminated springs, stress and deflection equation, spring design – trial and error method, Leaf spring design, Multi leaf spring, Nipping in leaf spring, Materials used for leaf spring manufacturing, Design against fluctuating load.</li> <li>• Types of levers &amp; working principle, Lever Manufacturing &amp; Applications, Various sections for levers, Design of Levers.</li> <li>• Conclusion and Summary of Unit</li> </ul>
<b>4.</b>	<b>Design of members in torsion</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Transmission shafts, Shafts design on strength basis, ASME code for shaft design, Design consideration &amp; causes of failure of shaft, Shaft subjected to combine twisting moment and bending moment. Design of hollow shaft on strength basis &amp; Torsional rigidly basis. Flexible shafts, Shaft subjected to fluctuating loads</li> <li>• Shaft couplings ;Design procedure and applications of Keys ,Muff couplings ,Clamp coupling, Rigid Flange</li> </ul>

	coupling, Rigid flange couplings, Bushes-pin flexible coupling, Oldham coupling, Universal coupling, Design of lateral rigidity • Conclusion and Summary of Unit
<b>5.</b>	<b>Combined Stresses</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Design of Shaft under combined stresses. Design procedure for Shaft under combined stresses. Bolted joint-simple analysis. Eccentrically loaded bolted joints in shear, Eccentric loads perpendicular to axis of bolts. Eccentric loads on a bracket with circular base, Bolted joints under fluctuating load, Deflections of shapes in combined torsion and bending, Deflection of shafts in combined, Bending and axial Bending</li> <li>• Screw fasteners subjected to eccentric loading. Eccentric loading of riveted joints, welded joints, threaded joints, Brackets, Bolts &amp; bending</li> <li>• Conclusion and Summary of Unit</li> </ul>

**C. RECOMMENDED STUDY MATERIAL:**

Sr. No	Reference Book	Author	Edition	Publication
1.	Introduction to Machine Design	Bhandari, V.B.,	Latest	Tata McGraw-Hill
2.	A Text book of Machine Design	Khurmi, R.S., Gupta, J.K.,	Latest	S. Chand Publication.
3.	Design of Machine element	Bhandari, V.B.,	Latest	Tata McGraw-Hill
4.	Mechanical Engineering Design	Shigley, J.E.,	5 <sup>th</sup> Ed.	---
5.	Machine Design Databook	Lingaiah, K.	Latest	Tata McGraw-Hill
6.	Design of Machine Elements	C.S.Sharma& Kamlesh	Latest	Prentice Hall of India Pvt. Ltd.
<b>Important Web Links</b>				
1	<a href="https://nptel.ac.in/courses/112105124/">https://nptel.ac.in/courses/112105124/</a>			
2	<a href="en.wikipedia.org/wiki/Machine_element">en.wikipedia.org/wiki/Machine_element</a>			

**COURSE OUTCOMES**

The student will be able to:

CO1 Illustrate the functioning of single point cutting tool and aspects.

CO2 Analyze the mechanical measuring tools and their functioning.

CO3 Examine the importance of CNC Machine and its advantages and limitation.

CO4 Apply the design of lathe bed and its strength constraint.

CO5 Analyze the finishing processes and High Velocity Forming Methods.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1	Theory of Metal Cutting	9
2	Precision Methods	7
3	Numerical Control of Machine Tools	7
4	Design of Machine Tool Element	8
5	Finishing Processes and High Velocity Forming Methods	8

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1</b>	<b>Theory of Metal Cutting</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Theory of Metal Cutting</b>, Mechanics of chip formation single point cutting tool, method of machining, type of chips, determination of shear angle, undeformed chip thickness, force relation, Energy considerations in metal cutting, Tool wear and tool life, Tool material.</li> <li>• <b>Design of Single Point Cutting Tools</b>: Introduction; functions of various tool angles; design of single point turning tool; parting tool; empirical determination of force components.</li> <li>• <b>Design of Multipoint Cutting Tool</b>: Introduction; angle of contact; force analysis; approach through dimensional analysis.</li> <li>• Conclusion of Unit including Real Life application</li> </ul>
<b>2</b>	<b>Precision Methods</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Precision Measurement and Instruments</b>: Standards of linear measurements; linear and angular measurements; screw thread measurement; measurement of effective diameter, pitch and thread angles; Gear measurement, measurement of tooth profile, tooth thickness and pitch, Measurement of surface roughness, Comparators types.</li> <li>• <b>Jigs and Fixtures</b>: -Introduction, definition and difference; usefulness of jigs and fixtures; materials used; principles and methods of location; clamping elements; assembly fixtures.</li> <li>• Conclusion of Unit including Real Life application</li> </ul>
<b>3</b>	<b>Numerical Control of Machine Tools</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Numerical Control of Machine Tools</b>; Introduction, Numerical Control &amp; its growth, NC Machines tools, Axes of NC Machines, Classification of NC System, CNC, DNC and Machining Centre. Machine Control unit, NC tools &amp; Tool changer. Manual Part Programming; coordinate, Feed, Speed &amp; Tool.</li> <li>• Conclusion of Unit including Real Life application</li> </ul>
<b>4</b>	<b>Design of Machine Tool Element</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Design of Lathe bed</b>, Material and construction feature, various bed section, designing for torsional rigidity, Theoretical aspect of design of guide ways.</li> <li>• <b>Press Tool Design</b>: Introduction, Press operation, classification of power presses, Press selection, press working terminology, working of cutting die.</li> <li>• Conclusion of Unit including Real Life application</li> </ul>
<b>5</b>	<b>Finishing Processes and High Velocity Forming Methods</b>

<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Finishing Processes:-</b> Principle of operation, advantages, limitations and applications of: Grinding, Honing, Lapping, Buffing, Burnishing, Polishing.</li> <li>• <b>High Velocity Forming Methods:</b> Hydraulic forming, Explosive forming, Electro-hydraulic forming, Magnetic pulse forming</li> <li>• Conclusion of Unit including Real Life application</li> </ul>
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**C. RECOMMENDED STUDY MATERIAL:**

Sr.No	Book	Author	Edition	Publication
<b>a. Reference Books</b>				
1.	Manufacturing Process I & II -	Bawa,	Latest	Tata McGraw Hill Publication
2.	Materials and Process Manufacturing.	E. Paul DeGarmo, J.T. Black, Ronald A. Kohser,	Latest	John Willey Publication Ninth edition
3.	Jig and Fixture Design	Erik K. Henriksen	Latest	Manual - Industrial Press
4.	Tool Design	Donaldson, Lecain, Goold	Latest	Tata McGraw Hill
5.	A Textbook of Production Engineering	P. C. Sharma	Latest	S. Chand & Company. Ltd.
6.	CAD/CAM	Grover M. P.	Latest	Tata McGraw hill Publication
7.	Advanced Machining Processes	V. K. Jain	Latest	Allied Publication
<b>b. Important Web links</b>				
1	<a href="https://nptel.ac.in/courses/112107144/">https://nptel.ac.in/courses/112107144/</a>			
2	<a href="https://en.wikipedia.org/wiki/Manufacturing_Science_and_Technology">https://en.wikipedia.org/wiki/Manufacturing Science and Technology</a>			

**COURSE OUTCOME**

The student will be able to:

CO1 Analyze the linear programming models and able to optimize the modeled problem by graphical approach and simplex method.

CO2 Examine and formulate the transportation and assignment problem and optimize by advance methods.

CO3 Analyze the Queuing Theory and able to process n Jobs through 3 Machines, process of 2 Jobs through m machines, process n Jobs through m Machines.

CO4 Illustrate game theory to solve complex problem like Rectangular game, Saddle point, Solution of games with saddle points, Rectangular games without saddle points, Dominance principle on  $m \times 2$  &  $2 \times n$  games.

CO5 Apply the project management tools and utilize the concept of PERT and CPM to manage the complex project schedule.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1	Introduction and Linear programming problem	6
2	Transportation and Assignment problem	5
3	Queuing Theory and Sequencing problem	9
4	Theory of Games	8
5	PERT & CPM	8

**B. DETAILED SYLLABUS**

Unit No.	Unit Details
<b>1.</b>	<b>Introduction and Linear programming problem</b>
	<ul style="list-style-type: none"> <li>• <b>Introduction of Unit</b></li> <li>• Introduction to Operations Research, Historical development, Main characteristics, phases, scope and limitations of Operations Research.</li> <li>• Linear Programming: Formulation of the problem, Graphical solution of LPP, Simplex method - slack, surplus and artificial variables.</li> <li>• <b>Conclusion and Summary of Unit</b></li> </ul>
<b>2.</b>	<b>Transportation and Assignment problem</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Transportation problem formulation, unbalanced Transportation problem, Basic feasible solutions by Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: The stepping stone method and MODI method.</li> <li>• Assignment problem formulation, Hungarian method for optimal solution, unbalanced assignment problem.</li> <li>• Conclusion and Summary of Unit</li> </ul>
<b>3.</b>	<b>Queuing Theory and Sequencing problem</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Queuing Theory: Introduction of the queuing system, various components of a queuing system. Operating characteristics of a queuing system, Classification of Queuing models, simple queuing models, simple Numericals.</li> <li>• Sequencing models. Solution of Sequencing Problem, Processing of n Jobs through 2 Machines, Processing of n Jobs through 3 Machines, Processing of 2 Jobs through m machines, Processing n Jobs through m Machines.</li> <li>• Conclusion and Summary of Unit</li> </ul>
<b>4.</b>	<b>Theory of Games</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Games Theory: Introduction of Game theory, Rectangular game, Saddle point, Minimax (Maximin),</li> </ul>

	<p>Method of optimal strategies, Value of the game, Two person-Zero sum game, Solution of games with saddle points, Rectangular games without saddle points, Dominance principle on <math>m \times 2</math> &amp; <math>2 \times n</math> games.</p> <ul style="list-style-type: none"> <li>• Conclusion and Summary of Unit</li> </ul>
<b>5.</b>	<b>PERT &amp; CPM</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• PERT and CPM: Introduction to PERT (Project Evaluation and review Technique) and CPM (Critical Path method), Basic steps and techniques, Network Diagram Representation, Forward and Backward Pass-computation, Representation in Tabular form. Critical path calculation by network analysis, Determination of floats, Construction of time chart and resource labeling.</li> <li>• Conclusion and Summary of Unit</li> </ul>

### C. RECOMMENDED STUDY MATERIAL

Sr. No	Reference Books	Author	Publication
1.	Introduction to Operations Research	Hillier F.S. and Lieberman G.J.	CBS Publishers.
2.	Operations Research	Taha H.A.	Pearson Education.
3.	Operations Research	Ravindran, Phillips and Solberg	Wiley India.
4.	Principles of Operations Research	Wagner H.M.	Prentice Hall of India
5.	Linear Programming and Network Flows	Bazaraa , Jarvis and Sherali	Wiley India.
6.	Operations Research	Gupta and Heera	S. Chand Publications
<b>Important Web links</b>			
1	<a href="https://nptel.ac.in/courses/112106134/">https://nptel.ac.in/courses/112106134/</a>		
2	<a href="http://www.orcomplete.com/">http://www.orcomplete.com/</a>		

**COURSE OUTCOMES**

The student will be able to:

CO1 Examine the nomenclature and performance of IC engine, characteristics of SI and CI engines and components.

CO2 Analyze the fuel injection system like Electronic Injection Systems Multi-Point Fuel Injection (MPFI) System, Injection Timing, Electronic Diesel Injection System and also lubrication and ignition system in engine.

CO3 Categorize the transmission system, suspension, steering system like gear box, gears & gear ratios, types of gear boxes, Automatic transmission system; overdrive, propeller shaft, universal joints, Differential, Steering layout, tyres, tyre materials.

CO4 Investigate the automotive electrical, air conditioning and safety systems.

CO5 Analyze the characteristics, components and functioning of battery charging system.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1	I C Engines	7
2	Engine Operating Systems	8
3	Chassis Systems	7
4	Automotive Systems	7
5	Chassis & Body	7

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1</b>	<b>I C Engines:</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Introduction:</b> Classification, Engine nomenclature, engine operating and performance parameters, Valve timing diagram of SI &amp; CI Engines, Comparison of SI and CI engine.</li> <li>• <b>Engine Components, function &amp; Materials:</b> piston assembly; connecting rod; crankshaft; cylinder head; cylinder block; flywheel, ports; valves; valve actuating mechanism; cams; camshaft drives</li> <li>• <b>Latest Development in IC Engine:</b> Bio Fuel Operated Engine, Direct Injection Engine, Low Temperature Diesel Combustion Engine, Dual Fuel Technology, VCR Engine, VVT Engine, HCCI Engine, Hybrid Vehicle, Fuel Cell Technology</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
<b>2</b>	<b>Chassis &amp; Body</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Introduction to Automobile: Historical Development of automobiles, classification of automobiles, Layout of Automobile Vehicle, their constructional features and materials, Current developments in vehicles.</li> <li>• Chassis, Frame &amp; Body: Types of frames, engine location, Comparison of front and rear mounting of engine, arrangement of clutch assembly, gearbox, and propeller shaft with universal joints. front and rear differentials, rear, front and four wheel drives, their relative merits, types of chassis, pre requirements of body, types of bodies &amp; their construction, aerodynamic considerations in body profiling, ergonomical considerations, defects in frames and body..</li> <li>• Conclusion of Unit including Real Life application</li> </ul>
<b>3</b>	<b>Engine Operating Systems :</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Fuel Injection:</b> Classification of Injection Systems, Injection in SI Engine, Electronic Injection Systems Multi-Point Fuel Injection (MPFI) System, Sequential Fuel injection, Injection Timing, Electronic Diesel Injection System.</li> <li>• <b>Lubrication:</b> Functions of Lubrication, Types of lubrication, Properties, Rating and Classification of lubricating oil, Additives.</li> <li>• <b>Ignition:</b> Energy requirement for ignition, requirements of an ignition system, modern ignition systems (TCI and CDI), Triple Spark Technology, distributor-less ignition system, firing order, Ignition timing.</li> <li>• Conclusion of Unit including Real Life application</li> </ul>

<b>4.</b>	<b>Chassis Systems</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Transmission System:</b> Functions of gear box, gears &amp; gear ratios, types of gear boxes, Automatic transmission system; overdrive, propeller shaft, universal joints. Differential.</li> <li>• <b>Suspension System:</b> Principle, type of suspension system, conventional and independent front and rear axle, rubber and air suspensions, shock absorbers.</li> <li>• <b>Steering System:</b> Steering layout, types of steering gears, checking wheel alignment and steering geometry</li> <li>• <b>Wheels &amp; Tyres:</b> Types of wheels, types of tyres, tyre materials, tyre designations and factors affecting tyre life.</li> <li>• <b>Braking System:</b> Principle and working of various types of brakes, anti-lock brake systems (ABS).</li> <li>• Conclusion of Unit including Real Life application</li> </ul>
<b>5.</b>	<b>Automotive systems</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Automotive Electrical System:</b> Battery System and Charging, Alternator construction, regulation and rectification. Ignition System: magneto and coil ignition systems, System components and requirements, automotivelighting: Wiring systems.</li> <li>• <b>Automotive Air Conditioning:</b> Introduction, Air conditioning system Components, Refrigerants, Fault Diagnosis.</li> <li>• <b>Automotive Electronics:</b> Fundamentals of Automotive Electronics, Sensors, Actuators, microprocessor and micro computer applications in automobiles, Major Applications, Components for engine management system.</li> <li>• <b>Automotive Safety:</b> Safety requirements, Safety Devices, Air bags, belts, radio ranging, NVS (Night Vision System) GPS (Global Positioning System) etc.</li> <li>• Conclusion of Unit including Real Life application</li> </ul>

### C. RECOMMENDED STUDY MATERIAL

S. No.	Book	Author	Edition	Publication
<b>Reference Books</b>				
1	Fundamentals of Internal Combustion Engines	Gupta H.N.,	Latest	Prentice Hall of India
2	Internal Combustion Engines	Mathur & Sharma,	Latest	Dhanpat Rai & Sons
3	Automotive Engines	William H. Crouse,	Latest	McGraw-Hill.
4	Internal Combustion Engines	Ganesan. V	Latest	Tata McGraw-Hill
5	Automobile Engineering	Narang G.B.S	2001	Khanna Publishers, Delhi
6	Course in Automobile Engineering	Sharma R. P.	Latest	Dhanpat Rai & Sons
<b>Important Web Links</b>				
<a href="https://nptel.ac.in/courses/112104033/">https://nptel.ac.in/courses/112104033/</a> <a href="https://swayam.gov.in/nd1_noc20_me42">https://swayam.gov.in/nd1_noc20_me42</a> <a href="http://web.iitd.ac.in/~ravimr/courses/mel345/classification.pdf">http://web.iitd.ac.in/~ravimr/courses/mel345/classification.pdf</a>				



**COURSE OUTCOMES**

The student will be able to:

CO1 Analyze the basic concepts of heat transfer through conduction, convection and radiation.

CO2 Apply the concept of heat conduction through extended surfaces and transient heat conduction.

CO3 Analyze the heat transfer through forced and natural convection over flat plate, sphere and cylinder.

CO4 Recommend the design aspects of various types of heat exchange and their applications

CO5 Analyze the heat transfer by radiation from grey and black body and to analyze the concepts of mass transfer.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1.	Basics of Heat and Mass Transfer	7
2.	Fins and Transient Conduction	7
3.	Forced Convection and Natural Convection	8
4.	Heat Exchanger:	7
5.	Thermal Radiation and Mass Transfer	7

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1.</b>	<b>Basics of Heat and Mass Transfer</b>
	<ul style="list-style-type: none"> <li>Introduction of Unit</li> <li><b>Introduction to Heat Transfer:</b> Concepts of the mechanisms of heat flows; Conduction, convection and radiation; Effect of temperature on thermal conductivity of materials; Introduction to combined heat transfer mechanism. <b>Fourier's law of heat conduction:</b> Thermal conductivity, thermal conductivity of solids, liquids and gases, effect of temperature on thermal conductivity. <b>Conduction:</b> General 3-Dimensional conduction equation in Cartesian; different kinds of boundary conditions; nature of differential equations; one dimensional heat conduction with and without heat generation; heat conduction through composite walls; critical thickness of insulation.</li> <li>Conclusion of Unit including Real Life application</li> </ul>
<b>2.</b>	<b>Fins and Transient Conduction</b>
	<ul style="list-style-type: none"> <li>Introduction of Unit</li> <li><b>Fins:</b> Heat transfer from extended surfaces, Types of fins, governing equation, Fin performance, fin efficiency, fin effectiveness, overall fin effectiveness. Fins of uniform cross-sectional area.</li> <li><b>Transient Conduction:</b> Transient heat conduction; Lumped capacitance method.</li> <li>Conclusion of Unit including Real Life application</li> </ul>
<b>3.</b>	<b>Forced Convection and Natural Convection</b>
	<ul style="list-style-type: none"> <li>Introduction of Unit</li> <li><b>Forced Convection:</b> Basic concepts; Hydrodynamic boundary layer; Thermal boundary layer; Analogy between momentum and heat transfer in turbulent flow over a flat surface; Flow over a flat plate; Flow across a single cylinder and a sphere.</li> <li><b>Natural Convection:</b> Physical mechanism of natural convection; Buoyant force; Empirical heat transfer relations for natural convection over vertical plates and cylinders, horizontal plates and cylinders.</li> <li>Conclusion of Unit including Real Life application</li> </ul>
<b>4.</b>	<b>Heat Exchanger:</b>
	<ul style="list-style-type: none"> <li>Introduction of Unit</li> <li><b>Heat Exchanger:</b> Different types of heat exchangers, arithmetic and logarithmic mean temperature differences, heat transfer coefficient for parallel, counter and cross flow type heat exchanger; effectiveness of heat exchanger, N.T.U. method.</li> <li>Conclusion of Unit including Real Life application</li> </ul>

<b>5.</b>	<b>Thermal Radiation and Mass Transfer</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Thermal Radiation: Basic radiation concepts, Plank distribution law, Krichoff's law; Wein's displacement law, Stefan Boltzmann law. Radiation intensity, heat exchange between two black bodies heat exchanger between gray bodies.</li> <li>• Mass Transfer:- Introduction, Modes of Mass transfer, Concentrations, Velocities and fluxes, Concentrations, Fick's Law.</li> <li>• Conclusion of Unit including Real Life application</li> </ul>

### C. RECOMMENDED STUDY MATERIAL

Sr. No.	Book	Author	Edition	Publication
<b>Reference Books</b>				
1.	Heat Transfer	S.P. Sukhatme,	2019	Universities Press ( India )
2.	Heat and Mass Transfer	R.K. Rajput	Latest	S.Chand& Company Ltd
3.	Heat and Mass Transfer	D.S.Kumar	Latest	S.K.Kataria& Sons
4.	Heat Transfer	J.P. Holman,	2019	McGraw Hill,
5.	Heat and Mass Transfer	E.R.G. Eckert and Robert M. Drake	Latest	McGraw Hill,
6.	Fundamentals of Heat and Mass transfer	Kothandraman. C.P.,	2019.	New Age International
<b>Important Web Links</b>				
1	<a href="https://nptel.ac.in/courses/112108149/">https://nptel.ac.in/courses/112108149/</a>			
2	<a href="https://nptel.ac.in/courses/112101097/">https://nptel.ac.in/courses/112101097/</a>			

**COURSE OUTCOMES**

The student will be able to:

CO1 Perform operations on lathe by orthogonal and oblique and also calculate the machining time.

CO2 Perform operation on lathe for making of bolt and also perform operation of gear cutting on milling.

CO3 Analyze the different tools, angles and jigs and fixtures and their uses.

CO4 Perform operation on tool grinder and also determine shear angle on lathe machine.

CO5 Perform operation on shaper and determine various length on Vernier.

**A. LIST OF EXPERIMENTS:**

1.	Study and Practice of Orthogonal & Oblique Cutting on a Lathe.
2.	Machining time calculation and comparison with actual machining time while cylindrical turning on a Lathe and finding out cutting efficiency.
3.	Bolt (thread) making on Lathe machine
4	Gear cutting on Milling machine.
5	Study of different types of tools and its angles & materials.
6	Experiment on jigs/Fixtures and its uses
7	Tool grinding (to provide tool angles) on tool-grinder machine
8	Shear-angle determination (using formula) with tube cutting (for orthogonal) on lathe machine
9	Machining a block on shaper machine.
10	Measurement of Length, Height And Diameter By Vernier Calipers, Vernier Height Gauge And Micrometer
11	Measurement of Bores Using Dial Bore Indicator
12	Angle And Taper Measurement Using Bevel Protractor And Sine Bar
13	Measurement of Thickness of Gear Teeth By Vernier Tooth Caliper
14	Flatness of Surface Plate By Using Spirit Level

**VIRTUAL LAB**

1	<a href="http://www.vlab.co.in/broad-area-mechanical-engineering">http://www.vlab.co.in/broad-area-mechanical-engineering</a>
2	<a href="http://www.vlab.co.in/ba-nptel-labs-mechanical-engineering">http://www.vlab.co.in/ba-nptel-labs-mechanical-engineering</a>
3	<a href="http://vlabs.iitb.ac.in/vlab/labsme.html">http://vlabs.iitb.ac.in/vlab/labsme.html</a>

**COURSE OUTCOMES**

The student will be able to:

CO1 Illustrate the construction and working of various types of clutches with their application

CO2 Analyze design aspects of various types of steering system

CO3 Demonstrate the working of automotive transmission system

CO4 Analyze various automotive braking system and their application

CO5 Apply the test on petrol and diesel engine to determine their operating characteristics

**A. LIST OF EXPERIMENTS:**

1.	To study and prepare report on the constructional details, working principles and operation of the following Automotive Clutches. a. Coil-Spring Clutch b. Diaphragm – Spring Clutch. c. Double Disk Clutch.
2.	To study and prepare report on the constructional details, working principles and operation of the following Automotive Engine Systems & Sub Systems. a. Multi-cylinder: Diesel and Petrol Engines. b. Engine cooling & lubricating Systems. c. Engine starting Systems. d. Contact Point & Electronic Ignition Systems.
3.	Demonstration of steering system and measurement of steering geometry angles and their impact on vehicle performance
4.	To study and prepare report on the constructional details, working principles and operation of the following Automotive Tyres & wheels. a. Various Types of Bias & Radial Tyres. b. Various Types of wheels.
5.	To study and prepare report on the constructional details, working principles and operation of different Automotive Transmission systems.
6.	Drive Lines & Differentials. a. Rear Wheel Drive Line. b. Front Wheel Drive Line. c. Differentials, Drive Axles and Four Wheel Drive Line
7.	Trouble shooting in braking system with specific reference to master cylinder, brake shoes, overhauling of system and the adjusting of the system and its testing.
8.	To study and prepare report on the constructional details, working principles and operation of the following Automotive Steering Systems. a. Manual Steering Systems, e.g. Pitman –arm steering, Rack & Pinion steering. b. Power steering Systems, e.g. Rack and Pinion Power Steering System
9.	Trial on a petrol engine and calculation of air/fuel ratio, volumetric, thermal and mechanical efficiencies.
10.	Trial of a Diesel engine and calculation of air/fuel ratio, volumetric, thermal and mechanical efficiencies.
11.	Study of cooling systems.
12.	Study of lubrication systems

**VIRTUAL LAB**

•	<a href="http://vlabs.iitkgp.ernet.in/rtvlas/">http://vlabs.iitkgp.ernet.in/rtvlas/</a>
•	<a href="https://www.iitg.ac.in/mech/lab_ice.php">https://www.iitg.ac.in/mech/lab_ice.php</a>
•	<a href="https://ocw.mit.edu/courses/mechanical-engineering/2-61-internal-combustion-engines-spring-2017/labs/">https://ocw.mit.edu/courses/mechanical-engineering/2-61-internal-combustion-engines-spring-2017/labs/</a>

**COURSE OUTCOMES**

The student will be able to:

CO1 Analyze the heat conduction through insulating powder and metal rod.

CO2 Analyze the thermal conductivity of liquid and temperature distribution in extended surface.

CO3 Apply the Stefan Boltzmann constant of heat transfer and determine the emissivity of plate.

CO4 Analyze the heat transfer coefficient for heated vertical cylinder and critical heat flux in saturated pool boiling.

CO5 Apply the performance of simple heat pipes and analyze the effectiveness of LMTD between parallel and counter flow.

**A. LIST OF EXPERIMENTS:**

1.	To Determine Thermal Conductivity of Insulating Powders.
2.	To Determine Thermal Conductivity of a Good Conductor of Heat (Metal Rod).
3.	To Measure the thermal Conductivity of Liquid.
4.	To determine the transfer Rate & Temperature Distribution for a Pin Fin.
5.	To Measure the Emissivity of the Test plate Surface.
6.	To Determine Stefan Boltzmann Constant of Radiation Heat Transfer.
7.	To Determine the Surface Heat Transfer Coefficient For Heated Vertical Cylinder in Natural Convection.
8.	To Determine Critical Heat Flux in Saturated Pool Boiling.
9.	To Study Performance of Simple Heat Pipes.
10.	To Study and Compare LMTD and Effectiveness in Parallel and Counter Flow Heat Exchangers
11.	To Find the Heat transfer Coefficient in Forced Convection in a tube.
12.	To study the rates of heat transfer for different materials and geometries

**VIRTUAL LAB**

•	<a href="http://htv-au.vlabs.ac.in/">http://htv-au.vlabs.ac.in/</a>
•	<a href="http://vlabs.iitb.ac.in/vlab/chemical/exp8/index.html">http://vlabs.iitb.ac.in/vlab/chemical/exp8/index.html</a>
•	<a href="https://sites.google.com/view/vlab-bnmitmech/home/heat-transfer-lab">https://sites.google.com/view/vlab-bnmitmech/home/heat-transfer-lab</a>
•	<a href="https://www.iitk.ac.in/me/heat-transfer-laboratory">https://www.iitk.ac.in/me/heat-transfer-laboratory</a>

**COURSE OUTCOMES**

The student will be able to:

CO1 Understand the basic principles of control system.

CO2 Apply characteristics and learning the concepts of time response analysis.

CO3 Understand and apply concepts of frequency response analysis.

CO4 Recommend the suitable thermal sensors for different measurement applications

CO5 Illustrate and understand the principle of various mechanical and electrical sensors used in industrial applications.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1.	The Control System	8
2.	Time Response analysis	9
3.	Control System Components	9
4.	Thermal Sensors	8
5.	Mechanical and Electrical Sensors	9

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1</b>	<b>The Control System</b>
	<ul style="list-style-type: none"> <li>• Introduction to unit</li> <li>• Open loop &amp; closed control; Servomechanism, Transfer functions, Block diagram algebra</li> <li>• Signal flow graph, Mason's gain formula Reduction of parameter variation and effects of disturbance by using negative feedback</li> <li>• Conclusion and Summary of Unit</li> </ul>
<b>2</b>	<b>Time Response analysis</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Standard test signals, time response of first and second order systems, time response specifications, steady state errors and error constants</li> <li>• Design specifications of second order systems: Derivative error, derivative output, integral error, P-I-D controller, applications and case studies. P-I-D compensations, design considerations for higher order systems, performance indices</li> <li>• Conclusion and Summary of Unit</li> </ul>
<b>3</b>	<b>Control System Components</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Concept of stability and necessary conditions,</li> <li>• Routh-Hurwitz criteria and limitations.</li> <li>• Root Locus Technique: The root locus concepts, construction of root loci, Bode Plot, and Nyquist Criterion</li> <li>• Conclusion and Summary of Unit</li> </ul>
<b>4</b>	<b>Thermal Sensors</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Definition of Temperature: Thermal Energy, absolute and relative Temperature, Metal resistance versus temperature devices: Resistance versus Temperature Approximations, Resistance-Temperature Detectors (RTD), Thermistors</li> <li>• Thermocouples: Thermoelectric Effects, Thermocouple Characteristics, Thermocouple Sensors, Other thermal sensor: Bimetal Strips, Thermometers and its types, Solid-State Temperature Sensor, Design considerations and optical sensors</li> <li>• Conclusion and Summary of Unit</li> </ul>
<b>5</b>	<b>Mechanical and Electrical Sensors</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Displacement, Location, or Position Sensors: Resistive-, Capacitive-, and Inductive Sensors, Variable-Reluctance Sensors, LVDT, Level Sensors, Metal Strain Gauges and Semiconductor Strain Gauges (SGs) ,</li> </ul>

	<p>Load Cells and sensors in modern machine tools.</p> <ul style="list-style-type: none"> <li>• Motion sensors: Types of Motion, Accelerometer Principles, Types of Accelerometers,</li> <li>• Pressure sensors: Pressure Principles, Pressure Sensors (<math>p &gt; 1</math> atmosphere), Pressure Sensors (<math>p &lt; 1</math> atmosphere) and Flow sensors</li> <li>• Case studies on use of sensors in daily life</li> <li>• Conclusion and Summary of Unit</li> </ul>
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**C. RECOMMENDED STUDY MATERIAL:**

Sr. No	Reference Book	Author	Edition	Publication
1.	Process Control Instrumentation Technology	Curtis D. Johnson	Latest	Prentice Hall International Edition
2.	Measurement, Instrumentation, and Sensors Handbook	John G. Webster	Latest	CRC – Press – Taylor and Francis Group
3.	Introduction to Instrumentation and Measurement	Robert B. Northrop	3rd Edition	CRC – Press – Taylor and Francis Group
Important Web Links				
1	<a href="https://nptel.ac.in/content/storage2/courses/112103174/pdf/mod2.pdf">https://nptel.ac.in/content/storage2/courses/112103174/pdf/mod2.pdf</a>			
2	<a href="en.wikipedia.org/wiki/sensor_and_control">en.wikipedia.org/wiki/sensor_and_control</a>			

**COURSE OUTCOMES**

The student will be able to:

CO1 Understand the scope of operation management and demand forecasting.

CO2 Analyze the various types of production system and capacity planning.

CO3 Apply the production planning objectives and techniques.

CO4 Analyze the concepts of production control system, JIT, pull system etc.

CO5 Apply the concept of material management, requirement, functions.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1.	Basics of Operation Management	7
2.	Production Systems	8
3.	Production Planning	8
4.	Production Control	7
5.	Material Management	8

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1.</b>	<b>Basics of Operation Management</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Introduction: Scope of Operations Management, operations manager and the management process. Operations Strategy, Competitiveness and Productivity.</li> <li>• Demand Forecasting: components of forecasting demand, Approaches to forecasting: Qualitative methods, Time series methods, Regression methods, Selection of forecasting technique.</li> <li>• Conclusion of Unit including real life applications</li> </ul>
<b>2.</b>	<b>Production Systems</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Products and Services, Process, Types of Production Systems:</b> Mass, Batch, Job shop production. Product and process matrix. Process planning and Process analysis. <b>Capacity Planning:</b> Defining and measuring capacity, steps in capacity planning process, determining capacity requirements, Capacity alternatives.</li> <li>• Conclusion of Unit including real life applications</li> </ul>
<b>3.</b>	<b>Production Planning</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Production Planning:</b> Production planning objective and functions, Bill of material, Capacity and man power requirement planning, Planning levels: long range, Intermediate range and Short range planning, aggregate planning; Objective, Strategies.</li> <li>• Conclusion of Unit including real life applications</li> </ul>
<b>4.</b>	<b>Production Control</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Production Control:</b> Capacity control and priority control, production control functions; Routing, scheduling, dispatching, expediting and follow up, batch production and mass production systems,</li> <li>• <b>Just in Time and Lean Production</b> Basic element in JIT, Pull system, Push system, Kanban production control system, Benefits of JIT.</li> <li>• Conclusion of Unit including real life applications</li> </ul>
<b>5.</b>	<b>Material Management</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Material Management:</b> Objectives, scope and functions of material management, planning, procurement, storing, ending and inventory control. Purpose of inventory, inventory cost, inventory control systems, Selective inventory control systems, Determination of EOQ, Lead time and reorder point.</li> <li>• Conclusion of Unit including real life applications</li> </ul>



### C . RECOMMENDED STUDY MATERIAL

S. No	Book	Author	Edition	Publication
<b>Reference Books</b>				
1.	Operations Management	Krajewski, Ritzman, Kansal	Latest	Pearson
2.	Operations Management	Roberta S. Russell	Latest	Pearson/ PHI
3.	Production and Operations Management	Everette. Adam Jr., Ronald J. Ebert	Latest	PHI
4.	Operations Management	Russell & Taylor III	Latest	Pearson
5.	Operations Management	McGregor D	Latest	McGraw-Hill
6.	Operations Management	Chase, Jacobs, Aquilano, Agarwal		TMH
<b>Important Web Links</b>				
•	<a href="https://nptel.ac.in/courses/112107238/">https://nptel.ac.in/courses/112107238/</a>			
•	<a href="https://nptel.ac.in/courses/110106046/">https://nptel.ac.in/courses/110106046/</a>			
•	<a href="https://nptel.ac.in/courses/110106045/">https://nptel.ac.in/courses/110106045/</a>			

**COURSE OUTCOME**

The student will be able to:

CO1 Examine the importance of new product and their importance.

CO2 Identify the design problems of new product and their solution.

CO3 Assess the various concept selection of new product and apply on a new product.

CO4 Examine the management technique of a new product.

CO5 Evaluate the reliability of a new product using Bath tub curve, Reliability of systems in series and parallel, Failure rate, MTTF and MTBF.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1.	Introduction to Product Design and Development	5
2.	Morphology of Design	4
3.	Generation of Alternatives and Concept Selection	5
4.	Management of New Product	5
5.	Reliability	5

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1.</b>	<b>Introduction to Product Design and Development</b>
	<ul style="list-style-type: none"> <li>Introduction of Unit</li> <li>Importance of new product-Definition-importance-Development Process. Introduction to PDD, Applications, Relevance, Product Definition, Scope, Terminology. Design definitions, the role and nature of design, old and new design methods, Design by evolution. Examples such evolution of bicycle, safety razor etc.Physical reliability &amp; Economic feasibility of design concepts. New product development process and organization.</li> <li>Conclusion of Unit including real life applications</li> </ul>
<b>2.</b>	<b>Morphology of Design</b>
	<ul style="list-style-type: none"> <li>Introduction of Unit</li> <li>Need analysis- Problem Formulation: Establishing economic existence of need, Need Identification and Analysis, Divergent, transformation and convergent phases of product design. Design criteria, functional aspects. Aesthetics, ergonomics, form (structure). Shape, size, color. Mental blocks, Removal of blocks.</li> <li>Conclusion of Unit including real life applications</li> </ul>
<b>3.</b>	<b>Generation of Alternatives and Concept Selection</b>
	<ul style="list-style-type: none"> <li>Introduction of Unit</li> <li><b>Generation of Alternatives and Concept Selection:</b> Concept generation- a creative process, Creativity,Road Elects to creative thinking-Fear of criticism and Psychological set. Tools of creativity like brain storming, Analogy, Inversion etc., Creative thinking Process. Brainstorming &amp;Synectics. Morphological techniques. Utility concept, Utility value, Utility index. Decision making under multiple criteria. Economic aspects of design.</li> <li>Conclusion of Unit including real life applications</li> </ul>
<b>4</b>	<b>Management of New Product</b>
	<ul style="list-style-type: none"> <li>Introduction of Unit</li> <li>Preliminary &amp; detailed design- Design Review: Preliminary design- Identification of subsystems, Subsystem specifications, Compatibility. Detailed design of subsystems, component design, Preparation of assembly drawings. Management of New Product – development and Launch: New Product Management’s Challenges Maintaining focus, Promotion of Right Culture, Management of Creativity, Top Management attention.</li> <li>Conclusion of Unit including real life applications</li> </ul>
<b>5.</b>	<b>Reliability</b>

	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Reliability considerations, Bath tub curve, Reliability of systems in series and parallel. Failure rate, MTTF and MTBF. Optimum spares from reliability consideration. Design of displays and controls, Man-Machine interface, Compatibility of displays and controls. Ergonomic aspects.</li> <li>• Conclusion of Unit including real life applications</li> </ul>
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**C. RECOMMENDED STUDY MATERIAL:**

Sr. No	Book	Author	Edition	Publication
<b>a. Reference Books</b>				
1.	Product Design & Manufacturing	A.K.Chitab&R.C.Gupta	Latest	PHI (EEE).
2.	Product Design & Decision Theory	M.K. Starr	Latest	Prentice Hall
3.	Quality Control & Reliability Analysis	Bijendra Singh	Latest	Khanna Publications.
4.	The Technology of Creation Thinking	R.P. Crewford	Latest	Prentice Hall
5.	Engineering: An Introduction to Creativeprofession	G.C. BeakleyHw leach	Latest	Macmillan
6.	Industrial Design In Engineering – Amarriage of Techniques	Charles H .Flurschein	Latest	The Design Council - London
<b>b. Important Web links</b>				
<a href="https://nptel.ac.in/courses/112/107/112107217/">https://nptel.ac.in/courses/112/107/112107217/</a> <a href="https://ocw.mit.edu/courses/sloan-school-of-management/15-783j-product-design-and-development-spring-2006/lecture-notes">https://ocw.mit.edu/courses/sloan-school-of-management/15-783j-product-design-and-development-spring-2006/lecture-notes</a>				

**Course Outcomes:**

On successful completion of the course the learners will be able to:

CO	Cognitive Abilities	Course Outcomes
CO1	Understanding/ Applying	Compare the professional and personal approach towards any task and demonstrate their understanding by displaying professional attitude in the assigned tasks.
CO2	Understanding/ Applying/Creating	Recognize, explain, and use the formal elements of specific genres of organizational communication: reports, proposals, memorandums, web pages, wikis, blogs, business letters, and promotional documents etc.
CO3	Understanding/ Applying	Prepare and deliver a clear and fluent demonstrative, informative, and persuasive presentation and enlarge their vocabulary by keeping a vocabulary journal.
CO4	Understanding / Applying	Demonstrate preparedness for any type of interview from classic one-on-one interview to panel interviews, Phone/Skype interviews, Behavioral/Situational etc. along with sharpening the ability to critically analyze a given piece of information and collectively work in a group to arrive at a solution or develop a perspective.
CO5	Creating/Applying	Understand negotiation and time management to identify steps for proper negotiation preparation & learn bargaining techniques and strategies of inventing options for mutual gain and move negotiations from bargaining to closing.

UNIT NO.	UNIT NAME	Hours
1	Professional Attitude & Approach	4
2	Professional Writing-I	6
3	Presentation Skills: Structure Study	4
4	Interview Skills & Group Discussion	6
5	Negotiation Skills & Time Management	5

LIST OF ACTIVITIES	
1.	Professional & Ethical Approaches : Degree of adherence, Business world & meeting deadlines
2.	Job Hunting and Networking: Skill Branding & Usage of Online Platforms
3.	Trust Building & Cultural Etiquettes
4.	Professional Writing-I: Direct-Indirect approaches to Business Writing-Five main stages of writing Business Messages.
5.	Professional Email Writing
6.	Resume Building-I: Difference between C.V. & Resume, formats, points to cover, practice sessions
7.	E-Learning & E-Content Development-I
8.	Presentation Skills: format & structure of presentations, using tools & techniques
9.	Job Interviews I: Preparation and Presentation
10.	Advanced Group Discussion – I
11.	Negotiation Skills & and Conflict Resolution-I
12.	Professional Code of Ethics & Effective Time Management

**Course Outcomes:**

On successful completion of the course the learners will be able to:

CO	Cognitive Abilities	Course Outcomes
CO-01	Understanding/ Applying/Creating	Demonstrate depth of understanding, observing complexity, improve insight and develop independent thought and persuasiveness.
CO-02	Understanding/ Applying	Determine the main ideas of the text by using key details and compare & contrast the most important points with the help of their perspective.
CO-03	Understanding/ Applying/Creating	Practice the qualities of writing style by applying the concepts of sentence conciseness, accuracy, readability, coherence and by avoiding wordiness or ambiguity.
CO-04	Understanding / Applying	Distinguish words and phrases as per their intonation patterns and interpret the audios based on different situations
CO-05	Understanding/Applying	Demonstrate the understanding of impactful conversational skills, presentation skills & telephonic conversation by considering the need of the audience.

UNIT NO.	UNIT NAME	Hours
1	Intrapersonal/Interpersonal Skills	6
2	Reading Skills	4
3	Writing Skills	6
4	Listening Skills	4
5	Speaking Skills	5

LIST OF ACTIVITIES	
1.	Self – Awareness & Self-Introduction
2.	Goal Setting: Ambition induced, interest induced or environment conditioned
3.	Cultivating Conversational Skills
4.	Role Plays : Selection of varied plots, characters & settings
5.	Reading skills I: Newspaper Reading & General Article Reading
6.	Writing Skills I: Story Making by jumbled words
7.	Understanding and Applying Vocabulary
8.	Listening Skills I: Types and practice by analyzing situational listening
9.	Speaking Skills I: JAM
10.	PowerPoint Presentation Skills-I
11.	Telephonic Etiquettes and Communication
12.	Recognizing, understanding and applying communication style (Verbal/Non-Verbal)

**COURSE OVERVIEW AND OBJECTIVES:**

- To practice various activities involved in a seminar talk – gathering information, preparation of slides, discussion, reporting.
- To develop the communicative and writing skills in technical reporting.

**1. For seminar every student will individually study a topic assigned to him / her and submit a report and shall deliver a short lecture / Seminar on the topic at the end of term.**

**2. Selection of topic should be done by students in consultation with concerned guide**

- a). Topic should be related to branch but it should be extended part of the branch (latest and advance topic).
- b). The topic should be such that the student can gain latest knowledge. Student should preferably refer at least one research paper

**3. Seminar topic should not be repeated in the department and registration of the same should be done on first come first served basis.**

**4. Seminar report should be submitted in paper bound copy prepared with computer typing**

- a). Size of report depends on advancement of topic.
- b). Student should preferably refer minimum 5 reference books / magazines.
- c). Format of content: i. Introduction. ii. Literature survey. iii. Theory 1) Implementation 2) Methodology 3) Application 4) Advantages, Disadvantages. iv. Future scope. v. Conclusion

**OVERVIEW AND OBJECTIVES:**

The objective of Discipline and TEP is to provide students with the opportunities to enhance jobfetching skills and at the same time to cultivate the student's personal interests and hobbies while maintaining the good disciplinary environment in the University. TEP is integrated into the curriculum for holistic development of students through active participation in various activities falling in Technical and non technical categories.

Discipline and Talent Enrichment Programme (TEP)-V shall be evaluated on the basis of its sub constituent programmes, as a complete **1 credit** course. It shall be counted in calculation of SGPA but it is not a backlog subject. However, the attendance of these classes shall be recorded and accounted in the total attendance.

Activities included in this category in the FIFTH Semester are as follows:

Code	Activity	Hours	Credits
BMECME5601	Talent Enrichment Programme (TEP) - V	-	1
	Library/MOOC/Online Certification Courses	-	
	Non Syllabus Project (NSP) / Industrial Visit / Campus Recruitment Training (CRT) - V	1	

# SIXTH SEMESTER

Code: BMECME6301

MINOR PROJECT

1 Credit [LTP: 0-0-2]

1. Every student individually or in a group (group size is of 4 students. However, if project complexity demands a maximum group size of 5 students, the committee should be convinced about such complexity and scope of the work.) Shall take a project in the beginning of the seventh term in consultation with the guide and the project must be completed in the eighth term.
2. The project proposal must be submitted in the institute in the beginning of the seventh term. While submitting project proposal care is to be taken that project will be completed within the available time of two term. The final title of the project work should be submitted at the beginning of eighth semester.
3. The group should maintain a logbook of activities. It should have entries related to the work done, problems faced, solution evolved etc., duly signed by guide.
4. The group is expected to complete details system design, layout etc. in seventh term, as a part of term work in the form of a joint report. Project report must be submitted in the prescribed format only. No variation in the format will be accepted.
5. One guide will be assigned at the most three project groups.
6. The guides should regularly monitor the progress of the project work.
7. Assessment of the project for award of TW marks shall be done by the guide and a departmental committee (consisting of minimum two teachers with experience more than three years) as per the guidelines given in the following table.
8. The guide should be internal examiner for oral examination (If experience is greater than three years).
9. The external examiner should be from the related area of the concerned project. He should have minimum of five Years of experience at degree level / industry.
10. The evaluations at final oral examination should be done jointly by the internal and external examiners.



**OBJECTIVE:** To expose engineering students to technology development at workplaces and appraise them regarding shop-floor problems. To provide practical experience in solving open ended problems in real work setting so as to cause transfer of college based knowledge and skills to solve practical problems and thereby develop confidence in the students in the analysis, synthesis and evaluation of practical problems leading to creative thinking.

- At the end of the VI semester each student would undergo Industrial Training in an industry/ Professional organization / Research Laboratory with the prior approval of the Head of Department and Training & Placement Officer,
- Students shall be required to submit a **written typed report** along with a certificate from the organization and present a PPT based on the training.
- Students shall be required to give the presentations in the allotted period about the training attended after 5<sup>th</sup> Semester.
- The presentation and report of the Training shall be evaluated during this period (=2 hrs per week) by Board of Examiners to be appointed by the Faculty Coordinator-Training Seminar who will award the grades.

**COURSE OVERVIEW AND OBJECTIVES:**

The objective of Discipline and TEP is to provide students with the opportunities to enhance jobfetching skills and at the same time to cultivate the student's personal interests and hobbies while maintaining the good disciplinary environment in the University. TEP is integrated into the curriculum for holistic development of students through active participation in various activities falling in Technical and non technical categories.

Discipline and Talent Enrichment Programme (TEP)-VI shall be evaluated on the basis of its sub constituent programmes, as a complete **1 credit** course. It shall be counted in calculation of SGPA but it is not a backlog subject. However, the attendance of these classesshall be recorded and accounted in the total attendance.

Activities included in this category in the SIXTH Semester are as follows:

Code	Activity	Hours	Credits
BMECME6601	Talent Enrichment Programme (TEP) - VI	-	1
	Library/MOOC/Online Certification Courses	1	
	Non Syllabus Project (NSP) / Industrial Visit / Campus Recruitment Training (CRT) - VI	-	

# SEVENTH SEMESTER

## CORE THEORY SUBJECTS

CODE: BMECME7101

DESIGN OF MACHINE ELEMENT-II

3 Credits [LTP: 3-0-0]

### COURSE OUTCOMES

The student will be able to:

CO1 Analyze the effect of stress concentration on beams

CO2 Inspect the load bearing capacity of curved beams

CO3 Analyze the selection of belts from the given application

CO4 Illustrate the terminologies of gears and selection of gears on the basis of force analysis

CO5 Analyze the selection of bearing from the given application

### A. OUTLINE OF THE COURSE

Unit No.	Title of the unit	Time required for the Unit (Hours)
1.	Design for Fluctuating Loads	8
2.	Design of Machine Members	7
3.	Design of Drive Systems	6
4.	Design of Gears	8
5.	Design of Bearings	7

### B. DETAILED SYLLABUS

Unit	Unit Details
<b>1.</b>	<b>Design for Fluctuating Loads</b>
	<ul style="list-style-type: none"><li>• Introduction of Unit</li><li>• Stress concentration – causes &amp; remedies, Fatigue Considerations in Design: S-N curve, Variable load, loading pattern, Endurance stresses, influence of size, surface finish, notch sensitivity and reversed stresses. Goodman line, Soderberg, Design of machine members subjected to combined, steady and alternating stresses</li><li>• Conclusion of Unit including Real Life Application</li></ul>
<b>2.</b>	<b>Design of Machine Members</b>
	<ul style="list-style-type: none"><li>• Introduction of Unit</li><li>• Pre loading of bolts; effect of initial tension &amp; applied loads, Bolts subjected to variable stresses. Design of members which are curved like crane hook, body of C-clamp, machine frame etc.</li><li>• Conclusion of Unit including Real Life Application</li></ul>
<b>3.</b>	<b>Design of Drive Systems</b>
	<ul style="list-style-type: none"><li>• Introduction of Unit</li><li>• <b>Power Transmissions Systems, Pulleys:</b> Design of helical compression, tension Springs. Springs under variable stresses. Design of belt, rope and pulley drive system, selection of chain &amp; sprocket drive systems. Transmission efficiencies &amp; Materials.</li><li>• Conclusion of Unit including Real Life Application</li></ul>
<b>4.</b>	<b>Design of Gears</b>
	<ul style="list-style-type: none"><li>• Introduction of Unit</li><li>• <b>Gears:</b> Classification, Selection of gears, Terminology of gears, Design of gear teeth, Force analysis, Selection of material for gears, Beam &amp; wear strength of gear tooth, Form or Lewis factor for gear tooth, Dynamic load on gear teeth –Barth equation and Buckingham equation and their comparison. Design of spur and helical.</li><li>• Conclusion of Unit including Real Life Application</li></ul>
<b>5.</b>	<b>Design of Bearings</b>

- Introduction of Bearing, uses and their types.
- Design of pivot and collar bearing , Design of sliding & journal bearing; Selection of ball and roller bearing based on static and dynamic load carrying capacity using load-life relationship, Selection of Bearings from manufacturer's catalogue, types of lubrication – Boundary, mixed and hydrodynamic lubrication. Design of journal bearings using Raimondi and Boyd's Charts, Lubricants and their properties.
- Conclusion of Unit including Real Life Application

### C. RECOMMENDED STUDY MATERIAL

Sr. No.	Book	Author	Edition	Publication
<b>Reference Books</b>				
1.	Machine Design	Black P.H. and O. Eugene Adams	Latest	Tata McGraw Hill
2.	Fundamentals of Machine Components Design	Juvinal R.C	Latest	John Wiely and Sons
3.	Mechanical Engineering Design	Shigley J.E. and Mischke C.R.	Latest	McGraw Hill Pub. Co. Ltd.
4.	Design of machine elements	Bhandari V.B	Latest	Tata McGraw Hill
5.	Machine Design	P. Kannaiah	Latest	Scitech Publication
6.	Design Data Hand Book	K. Lingaiah,	Latest	McGraw Hill,
<b>Important Web Links</b>				
1	<a href="https://nptel.ac.in/courses/112105125/">https://nptel.ac.in/courses/112105125/</a>			
2	<a href="https://nptel.ac.in/courses/112105124/">https://nptel.ac.in/courses/112105124/</a>			
3	<a href="https://nptel.ac.in/courses/112101005/">https://nptel.ac.in/courses/112101005/</a>			

**COURSE OUTCOME**

The student will be able to:

CO1 Define and apply productivity concept to engineering applications

CO2 Demonstrate techniques to increase productivity

CO3 Describe the implementation of work and time study at a workplace

CO4 Assess the importance of ergonomics for design of machines

CO5 Apply the concepts of aesthetics at interiors and exteriors of a workplace

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the Unit	Time required for the Unit (Hours)
1.	Productivity and Work Study	7
2.	Quality and Inventory Control	8
3.	Production Planning & Control	7
4.	Manufacturing Cost Analysis	7
5.	Plant Layout and Material Handling	7

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1.</b>	<b>Productivity and Work Study</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Productivity: Introduction, definition, various method of measurement, factors effecting productivity, strategies for improving productivity.</li> <li>• Work Study: Objectives, Method study, Principle of motion economy, Techniques of method study - Various charts, THERBLIGS, Work measurement - various methods, time study, determining time, Work sampling, Simple Numerical.</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
<b>2.</b>	<b>Quality and Inventory Control</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Quality control: Definition of quality, Various approaches, Concept of quality assurance systems, Costs of quality, Statistical quality Control (SQC), Variables &amp; Attributes, X, R, P &amp; C - charts, Acceptance sampling, OC - curve, Concept of AOQL, Sampling plan - Single, Double &amp; sequential, Introduction to TQM &amp; ISO - 9000.</li> <li>• Inventory control: Inventory control models - Inventory control models - Economic order quantity (EOQ), Economic batch quantity (EBQ) with &amp; without shortage, Purchase discounts, Sensitivity analysis, Inventory control systems - P,Q,Ss Systems, Service level, Stock out risk, determination of order point &amp; safety stock, Selective inventory control - ABC, FSN, SDE, VED and three dimensional, Numericals.</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
<b>3.</b>	<b>Production Planning &amp; Control</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Production Planning &amp; Control: Production Planning &amp; Control: Introduction to Forecasting - Simple &amp; Weighted moving average methods, Objectives &amp; variables of PPC, Aggregate planning - Basic Concept, its relations with other decision areas, Decision options - Basic &amp; mixed strategies, Master production schedule (MPS), Scheduling Operations, Various methods for line &amp; intermittent production systems, Gantt chart, Sequencing – Johnson algorithm for n-Jobs-2 machines, n- Jobs-3 machines, 2 Jobs n-machines, n- Jobs m-machines Various means of measuring effectiveness of PPC, Introduction to JIT, Numericals.</li> <li>• Conclusion of Unit</li> </ul>
<b>4.</b>	<b>Manufacturing Cost Analysis</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Manufacturing Cost Analysis: Fixed &amp; variable costs, Direct, indirect &amp; overhead costs, &amp; Job costing, Recovery of overheads, Standard costing, Cost control, Cost variance Analysis - Labour, material, overhead in volume, rate &amp; efficiency, Break even Analysis, Marginal costing &amp; contribution, Numericals</li> <li>• Conclusion of Unit</li> </ul>

<b>5.</b>	<b>Plant Layout and Material Handling</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Plant Layout and Material Handling: Plant location, site selection- Plant layout types, need, factors influencing the layout - Tools and techniques for developing layout, process chart, flow diagram, string diagram, Template and Scale models- Layout Planning procedure- Assembly line balancing. Material Handling, scope and importance- Types of material handling systems-factors influencing material handling- methods of material handling.</li> <li>• Material Requirements Planning (MRP): Introduction, MRP system structure, master production schedule (MPS), bill of materials, inventory status, MRP Procedure.</li> <li>• Conclusion of Unit</li> </ul>

### C. RECOMMENDED STUDY MATERIAL

Sr. No	Reference Book	Author	Edition	Publication
1	Industrial Engineering and Management	Khanna O. P	Latest	Khanna publishers
2	Principles and practice of Management	Prasad, L.M.	Latest	Sultan Chand & Sons
3	Works Organisation & Management	Sushil Kumar Basu, K. C. Sahu, N. K. Datta	Latest	Oxford & IBH
4	Principles of Industrial Organization	Dexter S. Kimball	Latest	Read Books
5	Essentials of Industrial Management	Lawrence L. Bethel	Latest	McGraw-Hill.
6	Engineering Economics,	Riggs, J.L., Bedworth, D.J.	Latest	Tata McGraw-Hill.
<b>Important Web Links</b>				
1	<a href="https://nptel.ac.in/courses/112/107/112107142/">https://nptel.ac.in/courses/112/107/112107142/</a>			
2	<a href="https://nptel.ac.in/courses/112/107/112107292/">https://nptel.ac.in/courses/112/107/112107292/</a>			

**OVERVIEW AND OBJECTIVES:** The objective of Unconventional Machining is to lead the students to completely understand the unconventional machining processes. Therefore the course starting from the classification of unconventional machining processes based on the elementary mechanism and the machinability of materials with different unconventional processes, presents for each process the basic principles, the most relevant industrial solutions, and the main applications.

**Course Outcome**

The Student will be able to:

- CO1 Illustrate the Methods of various Non Traditional Machining.
- CO2 Examine the use of mechanical energy of Non Traditional Machining.
- CO3 Analyze the use of electrical energy of Non Traditional Machining.
- CO4 Examine the use of thermal energy of Non Traditional Machining.
- CO5 Illustrate the Chemical and Hybrid Machining Processes.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1.	Non Traditional Machining Methods	07
2.	Mechanical Energy Techniques	09
3.	Electrical Energy Techniques	08
4.	Thermal and Thermo Electrical Energy Techniques	09
5.	Chemical and Hybrid Machining Techniques	08

**B. DETAILED SYLLABUS**

Unit	Unit Details
1.	<b>Non Traditional Machining Methods</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Introduction:</b> Introduction to nontraditional machining methods, Need for non - traditional machining, Sources of metal removal, Classification on the basis of energy sources, Parameters influencing selection of process. Limitations of conventional manufacturing processes, future possibilities.</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
2.	<b>Mechanical Energy Techniques</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Abrasive Jet Machining (AJM):</b> Operating principles, Equipment, Parameters influencing metal removal, Applications, Advantages and Limitations.</li> <li>• <b>Water Jet Machining (WJM):</b> Operating principles, Equipment, Parameters influencing metal removal, Applications, Advantages and limitations.</li> <li>• <b>Ultra Sonic Machining (USM):</b> Operating principles, Equipment and sub systems, Parameters influencing metal removal, Applications, Advantages and limitations.</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
3.	<b>Electrical Energy Techniques</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Electro Chemical Machining (ECM):</b> Operating principles, Equipment and sub systems, Parameters influencing metal removal, Applications, Advantages and limitations, Current developments in ECM.</li> <li>• <b>Electro Chemical Grinding (ECG):</b> Operating principles, Equipment and sub systems, Parameters influencing metal removal, Applications, Advantages and limitations</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
4.	<b>Thermal and Thermo Electrical Energy Techniques</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> </ul>

	<ul style="list-style-type: none"> <li>• <b>Thermal Energy Techniques</b> Operating principles, Equipment and sub systems, Parameters influencing metal removal, Applications, Advantages and limitations of Electron Beam Machining (EBM), Plasma Arc Machining (PAM) and Laser Beam Machining (LBM).</li> <li>• <b>Thermo Electrical Energy Techniques</b> Electrical Discharge Machining (EDM) and Wire Cut Electrical Discharge Machining (WCEDM): Operating principles, Equipment and sub systems, Parameters influencing metal removal, Applications, Advantages and limitations. Electrical Discharge Grinding (EDG): Operating principles, Equipment and sub systems, Parameters influencing metal removal, Applications, Advantages and limitations.</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
<b>5.</b>	<b>Chemical and Hybrid Machining Techniques</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Chemical Machining:</b> Elements of the process: Resists (maskants), Etchants. Types of chemical machining process- chemical blanking process, chemical milling process. Process characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process.</li> <li>• <b>Hybrid Machining Processes:</b> Concept, classification, process capabilities, and applications of various hybrid machining methods based on USM, EDM, ECM, etc.</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>

### C. RECOMMENDED STUDY MATERIAL

Sr.No	Book	Author	Edition	Publication
<b>a. Reference Books</b>				
1.	Non-Conventional Machining	Mishra, P. K	Latest	The Institution of Engineers (India), New Delhi
2.	Unconventional Machining Process	Garry F. Benedict	Latest	Marcel Dekker Publication, New York
3.	Non Traditional Machining Techniques	Benedict, G. F.	Latest	Marcel Decker, New York
4.	Advanced Machining Processes	Jain Vijay K.	Latest	Allied
5.	A Text book of Production Engineering	Sharma, P. C	Latest	Text Book Series
6.	Modern Manufacturing Process	Pandey and Sha	Latest	Prentice Hall, New Jersey.
<b>b. Websites</b>				
	<ul style="list-style-type: none"> <li>• <a href="http://www.nptel.com">www.nptel.com</a></li> <li>• <a href="http://www.newagepublishers.com/samplechapter/001566.pdf">www.newagepublishers.com/samplechapter/001566.pdf</a></li> <li>• <a href="http://www.nprcet.org/.../10122MEE17%20-%20Unconventional%20Manufac..">www.nprcet.org/.../10122MEE17%20-%20Unconventional%20Manufac..</a></li> </ul>			



**COURSE OUTCOMES**

The student will be able to:

CO1 Analyze the basic concepts of vibration and damped vibration in single degree of freedom.

CO2 Examine modelling of vibrating systems in undamped free vibration of single degree freedom systems.

CO3 Illustrate the concept of critical damping and its importance in damped free vibration of single degree freedom system

CO4 Recommend the principal modes of vibration in multi degree of vibration.

CO5 Apply Holzer's method and Stodola's method to solve many degree of vibration problems.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1	Introduction to Vibration System	05
2	Undamped free vibration of single degree freedom systems	04
3	Damped free vibration of single degree freedom systems	04
4	Multi Degree of Freedom System	06
5	Solution of Vibration Problems	05

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1.</b>	<b>Introduction to Vibration System</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Scope of vibration, important terminology and classification, Degrees of freedom, Harmonic motion; vectoral representation, complex number representation, addition. Derivation of equation of motion for one dimensional longitudinal, transverse and torsional vibrations without damping using Newton's second law, D' Alembert's principle and Principle of conservation of energy.</li> <li>• Compound pendulum and centre of percussion. Damped vibrations of single degree of freedom systems. Viscous damping, Logarithmic decrement.</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
<b>2.</b>	<b>Undamped free vibration of single degree freedom systems</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Undamped free vibration of single degree freedom systems:</b> Modelling of Vibrating Systems, Evaluation of natural frequency – differential equation, Energy &amp; Rayleigh's methods, Equivalent systems.</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
<b>3.</b>	<b>Damped free vibration of single degree freedom systems</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Damped free vibration of single degree freedom systems:</b> Different types of damping, Concept of critical damping and its importance, study of vibration response of viscous damped systems for cases of under damping, critical damping</li> </ul>
<b>4.</b>	<b>Multi Degree of Freedom System</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Two Degree of Freedom Systems:</b> Introduction, Principal modes of vibration, Other cases of simple two degree of freedom systems, System with damping. <b>Multi-Degree of Freedom Systems:</b> Introduction, Free vibrations equations of motion, Influence coefficients.</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
<b>5.</b>	<b>Solution of Vibration Problems</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Solution of Vibration Problems:</b> Many degrees of freedom systems: Approximate methods (or) Numerical methods – Holzer's method, Stodola's method – Rayleigh's Approach – Close coupled systems.</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>

**C. RECOMMENDED STUDY MATERIAL:**

S. No	Book	Author	Edition	Publication
<b>Reference Books</b>				
1	Theory of Mechanism and Machines	Gosh A. and Malik A. K.	Latest	East - West Press Pvt. Ltd. New Delhi.
2	Vibration and Noise for Engineering	Pujara, K.,	Latest	Dhanpat Rai and Company.
3	Mechanical Vibrations	Rao S. S.	Latest	Pearson Education Inc.
4	Theory of Machines	Rattan S. S.	Latest	Tata McGraw Hill
5	Mechanical Vibrations	Grover G. K.	Latest	Nem Chand and Bros.,Roorkee
6	Theory of Machines	Beven, T,	Latest	CBS Publishers and Distributors, New Delhi
7	Mechanical Vibrations	Kelly S. G.	Latest	Tata McGraw Hill Publishing Co. Ltd.,
<b>Important Web Links</b>				
<a href="https://nptel.ac.in/courses/112104194/">https://nptel.ac.in/courses/112104194/</a>				
<a href="https://nptel.ac.in/courses/112103111/">https://nptel.ac.in/courses/112103111/</a>				

**COURSE OUTCOMES**

The student will be able to:

CO1 Examine the basic principles of refrigeration and air conditioning.

CO2 Analyze air refrigeration systems and vapor compression refrigeration systems.

CO3 Analyze vapour absorption refrigeration systems and steam jet refrigeration systems.

CO4 Apply the concept in designing and selection of refrigeration and air conditioning equipments.

CO5 Analyze the psychometric properties of air and evaluate applications and design calculations of RSHF, ERSHF, GFSH.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1.	Basics of Refrigeration	05
2.	Vapour Compression Refrigeration System	06
3.	Vapour Absorption Refrigeration System	05
4.	Air-conditioning systems	05
5.	Psychrometry and load Analysis	05

**B. DETAILED SYLLABUS**

Unit No.	Unit Details
<b>1</b>	<b>Basics of Refrigeration</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Refrigeration:</b> Introduction to refrigeration system, Methods of refrigeration, Carnot refrigeration cycle, Unit of refrigeration, Refrigeration effect &amp; C.O.P.</li> <li>• <b>Air Refrigeration cycle:</b> Open and closed air refrigeration cycles, Bell Coleman or Reversed Joule air refrigeration cycle, Aircraft refrigeration system, Classification of aircraft refrigeration system. Boot strap refrigeration, Regenerative, reversed Brayton cycle, Brayton cycle with regenerative H.E.</li> <li>• Conclusion of Unit including real life applications</li> </ul>
<b>2</b>	<b>Vapour Compression Refrigeration System</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Vapour Compression System:</b> Single stage system, Analysis of vapour compression cycle, Effect of change in suction and discharge pressures on C.O.P, Effect of sub cooling of condensate &amp; superheating of refrigerant vapour on C.O.P of the cycle, Actual vapour compression refrigeration cycle, Multistage vapour compression system requirement,</li> <li>• <b>Refrigerants:</b> Classification of refrigerants, Nomenclature, Desirable properties of refrigerants, Common refrigerants, Secondary refrigerants and CFC free refrigerants.</li> <li>• Conclusion of Unit including real life applications</li> </ul>
<b>3</b>	<b>Vapour Absorption Refrigeration System</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Vapour Absorption system:</b> Working Principal of vapour absorption refrigeration system, Comparison between absorption &amp; compression systems, Elementary idea of refrigerant absorbent mixtures, Temperature – concentration diagram &amp; Enthalpy – concentration diagram , Adiabatic mixing of two streams,</li> <li>• Ammonia – Water vapour absorption system, Lithium- Bromide water vapour absorption system, Comparison. Electrolux Refrigerator</li> <li>• Conclusion of Unit including real life applications</li> </ul>
<b>4</b>	<b>Air-conditioning systems</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Air-conditioning systems:</b> classification, system components, all air, all water, air water systems, room air conditioners, packaged air conditioning plant, central air-conditioning systems, split air conditioning systems.</li> </ul>

	<ul style="list-style-type: none"> <li>• <b>Air conditioning system components:</b> fans types, classification and selection, air cleaning devices classification, types, construction and working, humidifiers and dehumidifiers</li> <li>• Conclusion of Unit including real life applications</li> </ul>
5	<b>Psychrometry and load Analysis</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Psychrometry:</b> Psychrometric properties, psychrometric relations, psychrometric charts, psychrometric processes, cooling coils, By-pass factor and air washers.</li> <li>• <b>Cooling load calculations:</b> Internal heat gain, system heat gain, RSHF, ERSHF, GSHP, cooling load estimation, heating load estimation, psychrometric calculation for cooling, selection of air conditioning.</li> <li>• Conclusion of Unit including real life applications</li> </ul>

### C. RECOMMENDED STUDY MATERIAL

Sr. No	Reference Book	Author	Edition	Publication
1	Refrigeration and Air Conditioning	CP Arora	Latest	TMH.
2	Refrigeration and Air Conditioning	. Sapali S.N.,	Latest	PHI Learning Private Ltd
3	Refrigeration and Air Conditioning	Manohar Prasad	Latest	New Age. International
4	Refrigeration and Air Conditioning	R.S. Khurmi & J.K Gupta	Latest	S.Chand
5	Refrigeration and Air-conditioning	Ramesh Arora ,	Latest	Prentice Hall of India,
6	A Course in Refrigeration and Air conditioning	SC Arora & Domkundwar	Latest	Dhanpatrai
7	Basic Refrigeration and Air- Conditioning	Ananthanarayanan	Latest	TMH
Important Web links				
1	<a href="https://nptel.ac.in/courses/112105128/">https://nptel.ac.in/courses/112105128/</a>			
2	<a href="https://beeindia.gov.in/">https://beeindia.gov.in/</a>			
3	<a href="https://www.ashrae.org/">https://www.ashrae.org/</a>			

**COURSE OUTCOMES**

The student will be able to:

CO1 Determine standard time for job preparation.

CO2 Prepare flow process chart, operation process chart and man-machine charts for an existing setup and development of an improved process.

CO3 Detect through fixed sensors for various robotic applications.

CO4 Determine 5 Axis Robotic Arm movement and its degree of rotation..

CO5 Detect distance (10cm to 80 cm) with infrared object detector.

**A. LIST OF EXPERIMENTS:**

1.	Determination of time standard for a given job using stopwatch time-study.
2.	Preparation of flow process chart, operation process chart and man-machine charts for an existing setup and development of an improved process.
3.	Study of existing layout of a workstation with respect to controls and displays and suggesting improved design from ergonomic viewpoint.
4.	To design a sampling scheme based on OC curve.
5.	ROBOTICS: To detect the sensor scanning systems to overcome limitation of fixed sensors on various robotic applications, ultrasonic sensor, laser range finders, infrared detectors and miniature.
6.	To detect objects with infrared ray detector.
7.	To determine object distance (3cm – 300cm).
8.	To detect distance (10cm to 80 cm) with infrared object detector.
9.	To determine 5 Axis Robotic Arm movement and its degree of rotation.
10.	To study various Robotic Arm Configurations.
11.	To study Pick and Place Robot.
12.	Experiment on transfer line/material handling.
13.	Experiment on study of system devices such as motors and feedback devices.

**Virtual Lab**

<http://www.vlab.co.in/broad-area-mechanical-engineering>

[http://vlabs.iitb.ac.in/vlabs-dev/labs/mit\\_bootcamp/refrigeration/labs/exp1/index.php](http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/refrigeration/labs/exp1/index.php)

**COURSE OUTCOMES**

The student will be able to:

CO1 Analyze the relation of a simple pendulum and compound pendulum.

CO2 Analyze the radius of gyration of bifilar suspension and analyze the torsional vibration of single rotor system.

CO3 Analyze free vibration of two rotor system and determine natural frequency.

CO4 Apply the Dunkerley's Rule and determine frequency and time period of oscillatory.

CO5 Apply the undamped and damped vibration of equivalent spring mass system.

**B. LIST OF EXPERIMENTS:**

1.	To verify the relation of a simple pendulum.
2.	To verify the relation of a compound pendulum.
3.	To determine the radius of gyration of a given bar by using bi-filer suspension.
4.	To study the torsional vibrations of single rotor system.
5.	To study the free vibration of two rotor system and to determine the natural frequency of vibration thematically and experimentally.
6.	To study the damped torsional oscillation and to determine the dampening coefficient.
7.	To verify Dunkerley's rule.
8.	To study the longitudinal vibrations of helical spring and to determine the frequency and time period of oscillation thematically and actually by experiment.
9.	To study the undamped free vibration of equivalent spring mass system.
10.	To study the forced damped vibration of equivalent spring mass system.
11.	To study the forced vibration of the beam for different damping.
12.	To study analytically and experimentally the vibrations of a base stationed as flexible springs.
13.	To study whirling phenomenon in a shaft.
14.	Study of Vibration measuring instruments.

**VIRTUAL LAB**

•	<a href="http://mdmv-nitk.vlabs.ac.in/">http://mdmv-nitk.vlabs.ac.in/</a>
•	<a href="http://www.vlab.co.in/broad-area-mechanical-engineering">http://www.vlab.co.in/broad-area-mechanical-engineering</a>
•	<a href="http://rtlabs.nitk.ac.in/?q=page/vibration-lab">http://rtlabs.nitk.ac.in/?q=page/vibration-lab</a>
•	<a href="https://www.iitk.ac.in/me/vibration-and-control-laboratory">https://www.iitk.ac.in/me/vibration-and-control-laboratory</a>

**Course Outcomes**

The student will be able to:

CO1 Illustrate the the fundamental principles and different methods of refrigeration and air conditioning.

CO2 Analyze refrigeration cycles and evaluate performance using refrigerant property tables.

CO3 Differentiate refrigerants with respect to properties, applications and environmental issues.

CO4 Illustrate air conditioning processes on psychometric charts, calculate cooling load for its applications in comfort and industrial air conditioning.

CO5 Examine equipment-operating principles, operating and safety controls employed in refrigeration air conditioning systems.

**A. LIST OF EXPERIMENTS:**

1.	Study of various elements of a mechanical refrigerator system through cut sections models / actual apparatus.
2.	Study and performance of domestic refrigerator,
3.	Study of an Ice plant and visit to a cold storage for study.
4.	Calculation/ Estimation of cooling load for large building.
5.	Study and trial on cooling towers.
6.	Study of measuring instruments and various tools used in refrigeration and air-conditioning systems.
7.	Study of thermostat and humidistat, dryer, oil separator.
8	Study of construction of hermetically sealed compressor and actual viewing of a cut model of the same (reciprocating, rotary and car A/C compressor).
9.	Experiment on desert coolers.
10.	To study basic components of air-conditioning system.
11.	Experiment on air conditioning test rig and calculation of various performance
12.	Study and performance of window type room air conditioner.
13.	Visit to a central Air conditioning plant for study of processes for winter and summer air conditioning.

**Virtual Lab**

1. [http://vlabs.iitb.ac.in/vlabs-dev/labs/mit\\_bootcamp/refrigeration/index.php](http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/refrigeration/index.php)
2. [http://vlabs.iitb.ac.in/vlabs-dev/labs/mit\\_bootcamp/refrigeration/labs/exp1/index.php](http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/refrigeration/labs/exp1/index.php)

**COURSE OUTCOMES**

The student will be able to:

- CO1 Discuss about the different types of energy storage system.
- CO2 Apply the concepts of battery management system and design the battery pack.
- CO3 Explain about the battery testing, disposal and recycling.
- CO4 Analyse different types of batteries
- CO5 Describe about the battery characteristic & parameters

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1.	Energy Storage Devices: Basic Introduction	7
2.	Types of Batteries	8
3.	Battery Pack up Design	7
4.	Charging Infrastructure, Battery Charging	7
5.	Charging Station and Charging Point	7

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1.</b>	<b>Energy Storage Devices: Basic Introduction</b>
	Selected energy storage devices and connect with their electric power applications in electric vehicles, energy requirement of vehicles, power requirement of vehicles, sizing of energy storage ratings.
<b>2.</b>	<b>Types of Batteries</b>
	Types of batteries Li-Ion, Metal Air Batteries: Aluminum air battery, Zinc air battery, fuel cells, super capacitors, Hydrogen energy storage.
<b>3.</b>	<b>Battery Pack up Design</b>
	Fundamental of Battery pack design: Mechanical Design, Thermal Design, Electrical Design.
<b>4.</b>	<b>Charging Infrastructure, Battery Charging</b>
	Charging Infrastructure, Battery Charging : Types of chargers slow and fast, Battery Swapping, Standardization and On board Chargers, public chargers, bulk chargers, swap stations, economics of public chargers.
<b>5.</b>	<b>Charging Station and Charging Point</b>
	Difference between charging station and charging point; Inductive charging, Flash Charging; Charger protocols, OCPP, V2G, CHADEMO, Bharat Charger; Impact of charging on grid; Renewable energy integration to chargers; Application of IoT to charging infrastructure.

**C. RECOMMENDED STUDY MATERIAL**

Sr. No	Reference Book	Author	Edition	Publication
1.	Electric Vehicle Battery Systems	S.Dhameja	1 <sup>st</sup> edition,	Newnes, 2001
2.	Electric Powertrain - Energy Systems, Power electronics and drives for Hybrid, electric and fuel cell vehicles	J. G. Hayes and A. Goodarzi,	1 <sup>st</sup> edition	Wiley, 2018.
3.	Advances in Battery Technologies for Electric Vehicle	B. Scrosati, J. Garche and W. Tillmetz	1 <sup>st</sup> edition	Woodhead,2015.



**OVERVIEW AND OBJECTIVES:** The course provides knowledge on the maintenance policies and techniques as corrective maintenance, preventive maintenance, breakdown maintenance, predictive maintenance, condition based maintenance and reliability maintenance so that the student is able to manage independently a maintenance department in the industry.

The student will be able to:

CO1 Apply the fundamental principles of mechanical engineering.

CO2 Analyze the the latest changes in mechanical technological world.

CO3 Develop the capability to communicate efficiently among industry people.

CO4 Identify, formulate and model problems and find engineering solution based on a systems approach.

CO5 Awareness of the social, cultural, global and environmental responsibility as an engineer.

### A. OUTLINE OF THE COURSE

Unit No.	Title of the unit	Time required for the Unit (Hours)
1.	Reliability	7
2.	Types and Improvements	8
3.	Testing and Management	9
4.	Introduction to Maintenance	9
5.	Maintenance and Testing	8

### B. DETAILED SYLLABUS

Unit	Unit Details
1.	<b>Reliability</b>
	<ul style="list-style-type: none"> <li>• <b>Introduction:</b> Definition of reliability, types of failures, definition and factors influencing system effectiveness, various parameters of system effectiveness.</li> <li>• <b>Reliability Mathematics:</b> Definition of probability, laws of probability, conditional probability, Bay's theorem; various distributions; data collection, recovery of data, data analysis Procedures, empirical reliability calculations.</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
2.	<b>Types and Improvements</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Reliability:</b> Types of system- series, parallel, series parallel, stand by and complex; development of logic diagram, methods of reliability evaluation; cut set and tie set methods, matrix methods event trees and fault trees methods, reliability evaluation using probability distributions, Markov method, frequency and duration method.</li> <li>• <b>Reliability Improvements:</b> Methods of reliability improvement, component redundancy, system redundancy, types of redundancies-series, parallel, series - parallel, stand by and hybrid, effect of maintenance.</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
3.	<b>Testing and Management</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Reliability Testing:</b> Life testing, requirements, methods, test planning, data reporting system, data reduction and analysis, reliability test standards.</li> <li>• <b>Spare Parts Management:</b> Spare parts, features and categorization of spares, cost considerations, Techniques of cost reduction; Selective controls used in spare parts control; ABC analysis, FSN, XYZ, VED and other approaches. Inventory control of spares.</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
4.	<b>Introduction to Maintenance</b>

	<ul style="list-style-type: none"> <li>• <b>Introduction:</b> Maintenance Objectives and Functions; Maintenance Organisation and Administration of Maintenance Systems. Need of planned maintenance. Maintenance policies; Breakdown, time based maintenance: Block replacement, age replacement and periodic replacement policy.</li> <li>• <b>Corrective and preventive maintenance.</b> Maintenance planning, Scheduled maintenance. Cost of maintenance versus Cost of equipment and production delays. Inspection: Inspection intervals, Inspection reports, card history system</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>
<b>5.</b>	<b>Maintenance and Testing</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Predictive maintenance. Equipment wear records, standards. Equipment used in predictive maintenance. Computerized maintenance, Total Productive Maintenance.</li> <li>• Methods of condition monitoring, Non-destructive testing, Liquid Penetrate, Magnetic particles, Ultrasonic testing, and Vibration analysis. Oil analysis, Radiographic testing.</li> <li>• Conclusion of Unit including Real Life Application</li> </ul>

### C. RECOMMENDED STUDY MATERIAL

Sr. No	Book	Author	Edition	Publication
<b>a. Reference Books</b>				
1.	Reliability Evaluation of Engineering and Systems	R.Billinton & R.N. Allan	Latest	Plenum Press.
2.	Reliability in Engineering and Design	K.C. Kapoor & L.R. Lamberson	Latest	John Wiley and Sons.
3.	Life Testing and Reliability Estimation	S.K. Sinha & B.K. Kale	Latest	Wiley Eastern Ltd.
4.	Probabilistic Reliability, An Engineering Approach	M.L. Shooman	Latest	McGraw Hill.
5.	System Reliability Engineering	G.H. Sandler	Latest	Prentice Hall.
<b>b. Websites</b>				
	<ul style="list-style-type: none"> <li>• <a href="http://www.nptel.com">www.nptel.com</a></li> <li>• <a href="http://en.wikipedia.org/wiki/Reliability_engineering">en.wikipedia.org/wiki/Reliability_engineering</a>.</li> <li>• <a href="http://web.utk.edu/~kkirby/IE591/ReliabEg_1.pdf">web.utk.edu/~kkirby/IE591/ReliabEg_1.pdf</a></li> </ul>			

**COURSE OUTCOMES**

The student will be able to:

CO1 Analyze the finite element method and its applications.

CO2 Analyze problems using numerical methods in finite element method.

CO3 Analyze and solve the problem of one-dimensional finite element analysis.

CO4 Analyze and solve problem of two-dimensional finite element analysis.

CO5 Analyze the finite element formulation of field problems and finite element formulation of solid mechanics problems.

**A. OUTLINE OF THE COURSE**

UnitNo.	Title of the unit	Time required for the Unit (Hours)
1.	Introduction to Finite Element Method	7
2.	Numerical Methods in FEM	8
3.	One-dimensional Finite Element Analysis	8
4.	Two dimensional Finite Element Analysis	7
5.	Finite Element Formulation	8

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1.</b>	<b>Introduction to Finite Element Method</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Introduction:</b> Introduction to finite difference method and finite elements method, Advantages and limitations, Mathematical formulation of FEM, Different approaches in Finite Element Method - Direct Stiffness approach, simple examples, Variational approach, Elements of variational calculus.</li> <li>• Conclusion of Unit including real life applications.</li> </ul>
<b>2.</b>	<b>Numerical Methods in FEM</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Types of Elements Used :</b> Interpolation Polynomials - Linear elements Shape function - Analysis of simply supported beam - Element and Global matrices - Two-dimensional elements, triangular and rectangular elements</li> <li>• <b>Numerical Methods in FEM:</b> Evaluation of shape functions - One dimensional &amp; triangular elements, Quadrilateral elements.</li> <li>• Conclusion of Unit including real life applications.</li> </ul>
<b>3.</b>	<b>One-dimensional Finite Element Analysis</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>One-dimensional Finite Element Analysis:</b> Basics of structural mechanics : stress and strain tensor, constitutive relation. Principle of minimum Potential. General steps of FEM, Generalized coordinate approach, derivation of element equation - Assembly of element equation Imposition of boundary conditions - Solution of equation - Cholesky method.</li> <li>• Conclusion of Unit including real life applications.</li> </ul>
<b>4</b>	<b>Two dimensional Finite Element Analysis</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Two dimensional Finite Element Analysis:</b> Finite element formulation using three noded triangular (CST) element and four noded rectangular element, Plane stress and Plain strain problems. Shape functions, node numbering and connectivity.</li> <li>• Conclusion of Unit including real life applications</li> </ul>
<b>5</b>	<b>Finite Element Formulation</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• <b>Finite Element Formulation of Field Problems:</b> 1-D and 2-D heat transfer, fluid flow (incompressible and non viscous fluid) in ducts, Simple electrical and magnetic field problems.</li> <li>• <b>Finite Element Formulation of Solid Mechanics Problems:</b> 1-D problem of shaft.</li> <li>• Conclusion of Unit including real life applications</li> </ul>

### C. RECOMMENDED STUDY MATERIAL:

S.No	Book	Author	Edition	Publication
<b>Reference Books</b>				
1.	Numerical Methods	E Balagurusamy	Latest	Tata McGraw Hill
2.	Introduction to Finite Elements in Engineering	T.R Chandragupta and A.D. Belegundu	Latest	Prentice Hall India
3.	Finite Element Analysis	C.S. Krishnamoorthy	Latest	Tata McGraw Hill
4.	Finite Element Procedure in Engineering Analysis	K.J. Bathe	Latest	Tata McGraw Hill
5.	An Introduction to Finite Element Method	J. N. Reddy	Latest	Tata McGraw Hill
6.	Concepts and Application of FiniteElement Analysis	R.D. Cook, D.S. Malcus and M.E. Plesha	Latest	John Wiley
<b>Important web Links</b>				
•	<a href="https://nptel.ac.in/courses/112106135/">https://nptel.ac.in/courses/112106135/</a>			
•	<a href="https://nptel.ac.in/courses/112104193/">https://nptel.ac.in/courses/112104193/</a>			
•	<a href="https://nptel.ac.in/courses/112104205/">https://nptel.ac.in/courses/112104205/</a>			

**Course Outcomes:**

On successful completion of the course the learners will be able to:

CO	Cognitive Abilities	Course Outcomes
CO1	Understanding/ Applying	Learn how to update and manage the experience, education, and skills & expertise sections on social media & formulate appropriate updates as a means to promote business activities.
CO2	Understanding/ Applying	Understand how to leverage grammar and formatting in formal documents & demonstrate how to follow the stages of the writing process (prewriting/writing/rewriting) and apply them to technical and workplace writing tasks.
CO3	Understanding/ Applying	Evaluate presentation's weak spots and areas for improvement & learn, practice and acquire the skills necessary to deliver effective presentation with clarity and impact.
CO4	Understanding / Applying	Evaluate basic factors such as personal skills & abilities, career fields, willingness to learn and strengthen the chances to get desirable jobs.
CO5	Creating/Applying	Understand negotiation and team skills dynamics and how to prepare for uncertainty & learn to craft agile strategy and be quick on your feet in changing circumstances.

UNIT NO.	UNIT NAME	Hours
1	Personal Branding	4
2	Professional Writing-II	6
3	Presentation Skills: Professional Setting	4
4	Job Interview & Group Discussion : Preparation by Mock Practice	6
5	Negotiation Skills, Team Management & Professional Awareness	5

**LIST OF ACTIVITIES**

1.	Personal Branding : Its best practices
2.	Professional Writing II: Abstract Writing, Statement of purpose and other formal documents
3.	Expanding Professional Vocabulary
4.	Resume Building-II: Revising & Updating
5.	E-Learning & E-Content Development-II
6.	Presentation Skills in Professional Setting
7.	Job Interviews II: Preparation and Presentation for Mock Interviews
8.	Advanced Group Discussion-II: Analysis of professional GD Videos and Practices on Topics/Video/Article based topics
9.	Negotiation Skills & and Conflict Resolution-II
10.	Change and Transition Management
11.	Team Building Strategies: Project Management
12.	Career Awareness & Productive Mindset

**Course Outcomes:**

On successful completion of the course the learner will be able to:

CO	Cognitive Abilities	Course Outcomes
CO1	Understanding/ Applying	To develop analytical framework to recognize, understand, and manage new social practices online, together with a familiarity with the literature regarding social media and identity, community, collective action, public sphere, social capital, and social networks.
CO2	Understanding/ Applying	Learn to use new social media, assess a new social medium's potential cognitive, social, and political impact, and to tune or relinquish use of the medium for their own purposes.
CO3	Understanding/ Applying	Understand the importance of monitoring and responding to the community that forms around your message or lack of message.
CO4	Understanding / Applying	Understand the difference between traditional marketing and social media marketing & learn the functionality of LinkedIn, Facebook, Instagram etc.
CO5	Creating/Applying	Learn how to update and manage the experience, education, and skills & expertise sections & formulate appropriate updates as a means to promote business activities.

Unit No.	Title of the Unit	Time required for the Unit (Hours)
1	<b>Introduction to Social Media</b>	2
2	<b>The shift of marketing and PR tactics</b>	3
3	<b>Utilization of social media platforms like Facebook, Blogging, Twitter &amp; LinkedIn, Instagram, Pinterest, YouTube &amp; Snapchat best Practices</b>	10
4	<b>Introduction to web, domain, IP, web hosting, website creation, various platforms and CMS</b>	5
5	<b>How to create website using WordPress CMS, themes and plugins and how to make website live.</b>	5

**A. DETAILED SYLLABUS**

Unit	Unit Details	Method
1.	<b>Introduction to Social Media</b>	
	<ul style="list-style-type: none"> <li>Introduction of the Course &amp; the topic</li> <li>Know your why - why you want to be on social media.</li> <li>Attraction towards social online portals</li> <li>Practice Sessions.</li> <li>Conclusion &amp; Summary of the Unit.</li> </ul>	<ul style="list-style-type: none"> <li>Theory/Practical</li> <li>Practical</li> <li>Practical</li> <li>Practical</li> <li>Theory/Practical</li> </ul>
2.	<b>The shift of marketing and PR tactics</b>	
	<ul style="list-style-type: none"> <li>Introduction of the Course &amp; the topic.</li> <li>What value your SM profiles will add on your resume.</li> <li>Practice Sessions.</li> <li>Conclusion &amp; Summary of the Unit.</li> </ul>	<ul style="list-style-type: none"> <li>Theory/Practical</li> <li>Practical</li> <li>Practical</li> <li>Theory/Practical</li> </ul>
3.	<b>Utilization of Social Media Platforms like Facebook, Blogging, Twitter, LinkedIn, Instagram, Pinterest,</b>	

	<b>YouTube &amp; Snapchat best Practices</b>	
	<ul style="list-style-type: none"> <li>● Introduction of the Course &amp; the topic</li> <li>● Practice Sessions.</li> <li>● Conclusion &amp; Summary of the Unit</li> </ul>	<ul style="list-style-type: none"> <li>● Theory/Practical</li> <li>● Practical</li> <li>● Theory/Practical</li> </ul>
<b>4.</b>	<b>Introduction to web, domain, IP, web hosting, website creation, various platforms and CMS</b>	
	<ul style="list-style-type: none"> <li>● Introduction of the Course &amp; the topic</li> <li>● Practice Sessions.</li> <li>● Conclusion &amp; Summary of the Unit.</li> </ul>	<ul style="list-style-type: none"> <li>● Theory/Practical</li> <li>● Practical</li> <li>● Theory/Practical</li> </ul>
<b>5.</b>	<b>How to create website using WordPress CMS, themes and plugins and how to make website live.</b>	
	<ul style="list-style-type: none"> <li>● Introduction of the Course &amp; the topic</li> <li>● Practice Sessions.</li> <li>● Conclusion &amp; Summary of the Unit.</li> </ul>	<ul style="list-style-type: none"> <li>● Theory/Practical</li> <li>● Practical</li> <li>● Theory/Practical</li> </ul>

**COURSE OVERVIEW AND OBJECTIVES:**

The objective of Discipline and TEP is to provide students with the opportunities to enhance jobfetching skills and at the same time to cultivate the student's personal interests and hobbies while maintaining the good disciplinary environment in the University. TEP is integrated into the curriculum for holistic development of students through active participation in various activities falling in Technical and non technical categories.

Discipline and Talent Enrichment Programme (TEP)-VII shall be evaluated on the basis of its sub constituent programmes, as a complete **1 credit** course. It shall be counted in calculation of SGPA but it is not a backlog subject. However, the attendance of these classes shall be recorded and accounted in the total attendance.

Activities included in this category in the SIXTH Semester are as follows:

Code	Activity	Hours	Credits
BMECME7601	Talent Enrichment Programme (TEP) - VII	-	1
	Library/MOOC/Online Certification Courses	1	
	Non Syllabus Project (NSP) / Industrial Visit / Campus Recruitment Training (CRT) - VII	2	



# EIGHT SEMESTER

Code: BMECME8101

SIX SIGMA

3 Credits [LTP: 3-0-0]

## COURSE OUTCOME

The student will be able to:

CO1 Understand lean assessment and Six Sigma SIPCO,QFD.

CO2 Apply the various Tools and Techniques of six sigma.

CO3 Carry out Failure Mode Effect Analysis (FMEA).

CO4 Apply the Regression analysis, Hypothesis testing, ANOVA, Multivariate analysis.

CO5 Apply the Evaluation and Continuous Improvement Methods for six sigma.

## A. OUTLINE OF THE COURSE

Unit No.	Title of the Unit	Time Required for the Unit (Hours)
1	Introduction to Six Sigma	07
2	Scope of Tools and Techniques	07
3	Six Sigma Methodologies	08
4	Six sigma process	07
5	Evaluation and Continuous Improvement Methods	07

## B. DETAILED SYLLABUS

Unit	Contents
<b>1.</b>	<b>Introduction to Six Sigma</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Lean metrics identify lean metrics; kaizen cloud identification in VSM ; lean assessment. improving targets and benchmarks; Six Sigma SIPCO,QFD; voice of the customer, kano models, cost of poor quality (COPQ)</li> <li>• Conclusion of Unit</li> </ul>
<b>2.</b>	<b>Scope of Tools and Techniques</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Tools for definition – IPO diagram, SIPOC diagram, Flow diagram, CTQ Tree, Project Charter -Tools for measurement – Check sheets, Histograms, Run Charts, Scatter Diagrams, Cause and effect diagram, Pareto charts, Control charts, Flow process charts, Process Capability Measurement, Tools for analysis – Process Mapping, Regression analysis, RU/CS analysis, SWOT, PESTLE, Five Whys, interrelationship diagram, overall equipment effectiveness, TRIZ innovative problem solving – Tools for improvement – Affinity diagram, Normal group technique, SMED, 5S, mistake proofing, Value stream Mapping, forced field analysis – Tools for control -Gantt chart, Activity network diagram, Radar chart, PDCA cycle, Milestone tracker diagram, Earned value management.</li> <li>• Conclusion of Unit</li> </ul>
<b>3.</b>	<b>Six Sigma Methodologies</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Design For Six Sigma (DFSS),Design For Six Sigma Method – Failure Mode Effect Analysis (FMEA), FMEA process – Risk Priority Number (RPN)- Six Sigma and Leadership, committed leadership – Change Acceleration Process (CAP)- Developing communication plan – Stakeholder.</li> <li>• Conclusion of Unit</li> </ul>
<b>4.</b>	<b>Six sigma process</b>

	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Six sigma process – Measure phase, Six sigma tools (CTQ tree, Process capability calculation, Measurement system analysis using gauge R&amp;R) – Measure phase, Six sigma process – analyse phase, Six sigma tools (Histogram, box plot, control chart, scatter chart, fish bone diagram, pareto analysis chart, interrelations diagram) – analyse phase, Six sigma special tools (Regression analysis, Hypothesis testing, ANOVA, Multivariate analysis), Affinity diagram, DOE.</li> <li>• Conclusion of Unit</li> </ul>
<b>5.</b>	<b>Evaluation and Continuous Improvement Methods</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Evaluation strategy – the economics of six sigma quality, Return on six Sigma (ROSS), ROI, poor project estimates – continuous improvement – lean manufacturing – value, customer focus, Perfection, focus on waste, overproduction – waiting, inventory in process (IIP), processing waste, transportation, motion, making defective products, underutilizing people – Kaizen – 5S.</li> <li>• Conclusion of Unit</li> </ul>

### C. RECOMMENDED STUDY MATERIAL

Sr. No	Reference Book	Author	Edition	Publication
1	The Six Sigma Handbook	Thomas Pyzdek and Paul A. Keller	2020	McGraw Hill
2	Six Sigma Quality Improvement with MINITAB	Henderson, G. R.	Latest	Wiley
3	The certified six sigma Green Belt Handbook	Roderick A. Munro and Govindarajan Ramu and Daniel J. Zrymiak	2017	ASQ Quality Press and Infotech Standards India Pvt. Ltd
4	The Certified Six Sigma Black Belt Handbook	T. M. Kubiak and Donald W. Benbow	Latest	Pearson Publication
Important Web links:				
1	<a href="https://onlinecourses.nptel.ac.in/noc20_mg19/preview">https://onlinecourses.nptel.ac.in/noc20_mg19/preview</a>			

**COURSE OUTCOME**

The student will be able to:

CO1 Analyze the role of CAM in manufacturing and its components.

CO2 Analyze the various part programming languages of conventional NC and CNC.

CO3 Illustrate the computer aided process planning in manufacturing firm with group technology.

CO4 Examine the role and importance of production management system via computers in manufacturing.

CO5 Analyze manufacturing systems like FMS and Collaborative Engineering.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1.	Computer Aided Manufacturing	07
2.	Part programming	07
3.	Computer Aided Process Planning	08
4.	Computer Aided Production Management Systems	07
5.	Computer Integrated Manufacturing Systems	07

**B. DETAILED SYLLABUS**

Unit	Unit Details
1.	<b>Computer Aided Manufacturing</b> <ul style="list-style-type: none"> <li>Introduction of Unit</li> <li><b>Introduction:</b> Overview of manufacturing processes, types of manufacturing systems, the product cycle, computer's role in manufacturing, sources and types of data used in manufacturing.</li> <li><b>The Beginning of CAM:</b> Historical Background, Basic components of NC systems, NC Procedure, NC coordinate system and machine motions, applications and economics of NC.</li> <li>Conclusion of Unit including real life applications</li> </ul>
2.	<b>Part programming</b> <ul style="list-style-type: none"> <li>Introduction of Unit</li> <li><b>Part programming-</b> manual and computer assisted such as APT Language. Computer Controls In NC Systems: Problems with conventional NC computer numerical control, Direct numerical control, combined CNC/ DNC systems, adaptive control machining system computer process interfacing,</li> <li>Conclusion of Unit including real life applications</li> </ul>
3.	<b>Computer Aided Process Planning</b> <ul style="list-style-type: none"> <li>Computer Aided Process Planning: Traditional Process Planning, Retrieval process planning system, Generative Process Planning, Machinability data system, computer generated time standards.</li> <li>Group Technology: Part families, part classification and coding, coding system and machining cells.</li> <li>Conclusion of Unit including real life applications</li> </ul>
4.	<b>Computer Aided Production Management Systems</b> <ul style="list-style-type: none"> <li>Computer Aided Production Management Systems: Introduction to computer aided PPC, Introduction to computer aided inventory management, manufacturing resource planning (MRPII), computer process monitoring and shop floor control, computer process control. Computer Aided Quality Control.</li> <li>Non contact inspection methods, optical and non optical computer aided testing, Computer Aided Material Handling: Computer control on material handling, conveying, picking.</li> <li>Conclusion of Unit including real life applications</li> </ul>
5.	<b>Computer Integrated Manufacturing Systems</b> <ul style="list-style-type: none"> <li>Introduction of Unit</li> <li><b>Computer Integrated Manufacturing Systems:</b> Introduction, types special manufacturing systems, flexible manufacturing systems (FMS).</li> <li><b>Collaborative Engineering:</b> Introduction, Faster Design throughput, Web based design, changing design approaches, extended enterprises, concurrent engineering, Agile and lean manufacturing.</li> <li>Conclusion of Unit including real life applications</li> </ul>

### C. RECOMMENDED STUDY MATERIAL

Sr. No.	Book	Author	Edition	Publication
<b>Reference Books</b>				
1.	Automation, Production System and CIM	Groover, M.P.,	Latest	Prentice-Hall of India
2.	Computer Integrated Design and Manufacturing	David Bedworth	Latest	TMH, NewDelhi
3.	Computer Integrated Manufacturing Systems	YoremKoren,	Latest	McGraw Hill,
4.	Computer Integrated Manufacturing	Ranky, Paul G	Latest	Prentice Hall International
5.	Design rules for a CIM system	R.W. Yeomamas	Latest	North Holland Amsterdam
<b>Important Web links</b>				
				<ul style="list-style-type: none"><li>• <a href="https://nptel.ac.in/courses/112104289/">https://nptel.ac.in/courses/112104289/</a></li><li>• <a href="https://www.sciencedirect.com/book/9780408007337/computer-integrated-manufacturing">https://www.sciencedirect.com/book/9780408007337/computer-integrated-manufacturing</a></li></ul>

**COURSE OUTCOME**

The student will be able to:

CO1 Explain about the codes (G-code and M-Code) used in CNC machines for programming

CO2 Create part program for turning operation in CNC Machine

CO3 Create part program for milling operation on CNC Machine

CO4 Create part program for drilling operation on CNC Machine

CO5 Demonstration of CNC machine with user interface.

**A. LIST OF EXPERIMENTS:**

1	To study the characteristic features of CNC machine
2	To prepare part programming for plain turning operation.
3	To prepare part programming for turning operation in absolute mode.
4	To prepare part program in inch mode for plain turning operation.
5	To prepare part program for slot milling operation.
6	To prepare part program for drilling operation.
7	To prepare part program for multiple drilling operation in Z-axis.
8	Write the CNC Milling part programming for a given geometry using tool radius compensation.
9	To prepare CNC Milling part program for a drilling of holes using pack drilling cycle and repeat loop feature
10	Demonstration of CNC milling machine with user interface and calculation of coordinates of given geometry in absolute & incremental mode of cutter path.
<b>Virtual Lab</b>	
1	<a href="http://vlabs.iitkgp.ac.in/cim/#">http://vlabs.iitkgp.ac.in/cim/#</a>
2	<a href="https://www.malinc.com/products/virtual-cnc/">https://www.malinc.com/products/virtual-cnc/</a>

**Course outcomes**

The student will be able to:

CO1 Illustrate and apply commands of Inventor Modeling Software on 3D-Part modeling components.

CO2 Apply command on assembly of 3D – Part modeling of a components.

CO3 Develop a Plummer block, automobile component (Piston) and Screw jack using Inventor modeling software.

CO4 Create an assembly of Flange coupling, Plummer block, Screw jack in 3D using Inventor modeling software.

CO5 Simulate of Slider crank mechanism in 3D using Inventor modeling software.

**A. LIST OF EXPERIMENTS**

1.	Study and practice on working features and commands of Inventor Modeling Software.
2.	3D – Part modeling of a component –I
3.	3D – Part modeling of a component –II
4.	3D –Part modeling of a component- III
5.	3D –Part modeling of a component- IV
6.	3D Part modeling of Plummer block using Inventor modeling software
7.	3D –Part modeling of a automobile component (Piston) using Inventor modeling software
8.	3 D Part Modeling of Screw jack using Inventor modeling software
9.	Assembly of Flange coupling in 3D using Inventor modeling software
10.	Assembly of Plummer block in 3D using Inventor modeling software
11.	Assembly of Screw jack in 3D using Inventor modeling software –II
12.	Animation of Screw jack in 3D using Inventor modeling software
13.	Animation of Slider crank mechanism in 3D using Inventor modeling software

**Virtual Labs**

1	<a href="http://vlabs.iitb.ac.in/vlabs-dev/labs/oops/labs/exp1/index.php">http://vlabs.iitb.ac.in/vlabs-dev/labs/oops/labs/exp1/index.php</a>
2	<a href="http://vlabs.iitb.ac.in/vlabs-dev/labs/oops/labs/exp3/index.php">http://vlabs.iitb.ac.in/vlabs-dev/labs/oops/labs/exp3/index.php</a>
3	<a href="http://vlabs.iitb.ac.in/vlabs-dev/labs/oops/labs/exp2/index.php">http://vlabs.iitb.ac.in/vlabs-dev/labs/oops/labs/exp2/index.php</a>
4	<a href="http://vlabs.iitb.ac.in/vlabs-dev/labs/oops/labs/exp5/index.php">http://vlabs.iitb.ac.in/vlabs-dev/labs/oops/labs/exp5/index.php</a>

## Department Elective Subject

**Code: BMEEME8111 DESIGN AND DEVELOPMENT OF ELECTRIC & HYBRID VEHICLE 3 Credits [LTP: 3-0-0]**

**COURSE OUTCOMES** The student will be able to:

CO1: Understand the working of different configurations of electric vehicles

CO2: Understand the basic calculation of motor torque

CO3: Analysis of Electric Vehicle Architecture based on different energy system

CO4: Analyze different types of controller used in electric vehicle

CO5: Design and Development of hybrid electric vehicles

### A. OUTLINE OF THE COURSE

Unit No.	Title of the unit	Time required for the Unit (Hours)
1.	Introduction: Electric Vehicle	7
2.	Motor Torque Calculations For Electric Vehicle	8
3.	Electric Vehicle Architecture Design	7
4.	Electric Drive and controller	7
5.	Hybrid and Electrical Vehicles	7

### B. DETAILED SYLLABUS

Unit	Unit Details
<b>1.</b>	<b>Introduction: Electric Vehicle</b>
	History, Components of Electric Vehicle, Comparison with Internal combustion Engine: Technology, Comparison with Internal combustion Engine: Benefits and Challenges, EV classification and their electrification levels., EV Terminology. Case studies and research paper work on design and development of electric and hybrid vehicles
<b>2.</b>	<b>Motor Torque Calculations For Electric Vehicle</b>
	Calculating the Rolling Resistance, calculating the grade resistance, Calculating The Acceleration Force, Finding The Total Tractive Effort, Torque Required On The Drive Wheel.
<b>3.</b>	<b>Electric Vehicle Architecture Design</b>
	Types of Electric Vehicle and components, Electrical protection and system requirement, Photovoltaic solar based EV design, Battery Electric vehicle (BEV), Hybrid electric vehicle HEV), Plug-in hybrid vehicle (PHEV), Fuel cell electric vehicle (FCEV), Electrification Level of EV, Comparison of fuel vs Electric and solar power, Solar Power operated Electric vehicles.
<b>4.</b>	<b>Electric Drive and controller</b>
	Types of Motors, Selection and sizing of Motor, RPM and Torque calculation of motor, Motor Controllers, Component sizing, Physical locations, Mechanical connection of motor, Electrical connection of motor.
<b>5.</b>	<b>Hybrid and Electrical Vehicles</b>
	Electric Vehicle drive train: Transmission configuration, Components – gears, differential, clutch, brakes regenerative braking, motor sizing. Hybrid Electrical Vehicles:-Types – series, parallel and series, parallel configuration – Design – Drive train, sizing of components.

### C. RECOMMENDED STUDY MATERIAL:

Sr.No	Reference Book	Author	Edition	Publication
1	Electric & Hybrid Vehicles – Design Fundamentals	IqbalHussain	Second Edition,	CRC Press, 2011.
2	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals	MehrdadEhsani, YiminGao, Ali Emadi		CRC Press, 2010.
3	Electric Vehicle Battery Systems”	SandeepDhameja		Newnes, 2000

**COURSE OUTCOME**

The student will be able to:

CO1 Analyze the real life IoT applications using off the shelf hardware and software.

CO2 Illustrate the Sensor and Interfacing functioning systems.

CO3 Recommend the protocol and cloud services and its business models: Saas, Paas, Iaas.

CO4 Illustrate the importance of Vulnerabilities of IoT, Privacy, Security requirements.

CO5 Analyze the Role of Analytics in IOT and real-life applications of Internet of Things.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1	Introduction to IOT and Architectures	11
2	Sensor and Interfacing	6
3	Protocols and Cloud	6
4	Privacy, Security and Governance	6
5	IOT Analytics and Applications	7

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1.</b>	<b>Introduction to IOT and Architectures</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Introduction to IOT, What is IIOT? IOT Vs. IIOT, History of IIOT, Components of IIOT - Sensors, Interface, Networks, People &amp; Process, Hype cycle, IOT Market, Trends &amp; future Real life examples; Role of IIOT in Manufacturing Processes Use of IIOT in plant maintenance practices, Sustainability through Business excellence tools Challenges &amp; Benefits in implementing IIOT.</li> <li>• Overview of IOT components; Various Architectures of IOT and IIOT, Advantages &amp; disadvantages, Industrial Internet - Reference Architecture; IIOT System components: Sensors, Gateways, Routers, Modem, Cloud brokers, servers and its integration,</li> <li>• Conclusion of Unit</li> </ul>
<b>2.</b>	<b>Sensor and Interfacing</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Introduction to sensors, Transducers, Classification, Roles of sensors in IIOT , Various types of sensors , Design of sensors, sensor architecture, special requirements for IIOT sensors, Role of actuators, types of actuators. Hardwire the sensors with different protocols such as HART, MODBUS-Serial &amp; Parallel, Ethernet, BACNet , Current, M2M etc</li> <li>• Conclusion of Unit</li> </ul>
<b>3.</b>	<b>Protocols and Cloud</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Need of protocols; Types of Protocols, Wi-Fi, Wi-Fi direct, Zigbee, Z wave, Bacnet, BLE, Modbus, SPI , I2C, IIOT protocols –COAP, MQTT, 6lowpan, lwm2m, AMPQ IIOT cloud platforms : Overview of cots cloud platforms, predix, thingworks, azure etc. Data analytics, cloud services, Business models: Saas, Paas, Iaas.</li> <li>• Conclusion of Unit</li> </ul>
<b>4.</b>	<b>Privacy, Security and Governance</b>
	<ul style="list-style-type: none"> <li>• Introduction to Unit</li> <li>• Introduction to web security, Conventional web technology and relationship with IIOT, Vulnerabilities of IoT, Privacy, Security requirements, Threat analysis, Trust, IoT security tomography and layered attacker model, Identity establishment, Access control, Message integrity, Non-repudiation and availability, Security model for IoT, Network security techniques Management aspects of cyber security</li> <li>• Conclusion of Unit</li> </ul>
<b>5.</b>	<b>IOT Analytics and Applications</b>



- Introduction to Unit
- IOT Analytics: Role of Analytics in IOT, Data visualization Techniques, Introduction to R Programming, Statistical Methods. Internet of Things Applications : Smart Metering, e-Health Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards, Plant Automation, Real life examples of IIOT in Manufacturing Sector
- Conclusion of Unit

### C. RECOMMENDED STUDY MATERIAL

Sr.No	Reference Book	Author	Edition	Publication
1	Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications	Daniel Minoli	Latest	Willy Publications
2	Architecting the Internet of Things	Michahelles	Latest	Springer
3	Hands-On Industrial Internet of Things	Giacomo Veneri Antonio Capasso	Latest	Ingram short title
4	Industry 4.0: The Industrial Internet of Things	Alasdair Gilchrist	Latest	Apress
5	Industrial Internet of Things and Cyber-Physical Systems: Transforming the Conventional to Digital	Pardeep Kumar , VasakiPonn usamy	Latest	Business Science Reference
Important Web Links				
1	<a href="https://nptel.ac.in/courses/106105195/">https://nptel.ac.in/courses/106105195/</a>			
2	<a href="https://www.classcentral.com/">https://www.classcentral.com/</a>			

**OVERVIEW AND OBJECTIVES:** Students will gain an understanding of the current state of vehicle technology, they will study the impact of alternative fuels, hybrid-electric drives, and other technology emerging in the transportation marketplace. Emissions, fuel economy benefits and regulations, and safety and service requirements will be enhanced.

**The student will be able to:**

CO1 Understand the challenges and concepts of automotive industries and fuel cell technology

CO2 Analyze the latest and conventional automotive technologies

CO3 Understand the concepts and challenges of Electric and Hybrid vehicle systems.

CO4 Illustrate the Automotive system through X-by wire systems

CO5 Analyze the vehicle transmission system.

**A. OUTLINE OF THE COURSE**

Unit No.	Title of the unit	Time required for the Unit (Hours)
1.	Automotive Industry	07
2.	Latest Engine Technology	09
3.	Electrical And Hybrid Vehicles	08
4.	X-By Wire Technology	09
5.	Vehicles Systems	08

**B. DETAILED SYLLABUS**

Unit	Unit Details
<b>1</b>	<b>Automotive Industry</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Future of Automotive Industry: Challenges and Concepts for the 21 century. Crucial issues facing the industry and approaches to meet these challenges.</li> <li>• Fuel Cell Technology For Vehicles: What is fuel cell, Type of fuel cell, Advantages of fuel cell. Current state of the technology. Potential and challenges. Advantages and disadvantages of hydrogen fuel.</li> <li>• Conclusion of Unit including real life applications</li> </ul>
<b>2</b>	<b>Latest Engine Technology</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Latest Engine Technology Features : Advances in diesel engine technology. Direct fuel injection Gasoline engine. Diesel particulate emission control. Throttling by wire. Variable Valve Timing, Method used to effect variable Valve Timing. Electromagnetic Valves, Camless engine actuation.</li> <li>• Conclusion of Unit including real life applications</li> </ul>
<b>3</b>	<b>Electrical And Hybrid Vehicles</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• 42 Volt System : Need, benefits, potentials and challenges. Technology Implications for the Automotive Industry. Technological evolution that will occur as a result of the adoption of 42 volt systems.</li> <li>• Electrical And Hybrid Vehicles : Types of hybrid systems, Objective and Advantages of hybrid systems. Current status, Future developments and Prospects of Hybrid Vehicles</li> <li>• Conclusion of Unit including real life applications</li> </ul>
<b>4</b>	<b>X-By Wire Technology</b>
	<ul style="list-style-type: none"> <li>• Introduction of Unit</li> <li>• Integrated Starter Alternator: Starts stop operation, Power Assist, Regenerative Braking. Advanced lead acid batteries, Alkaline batteries, Lithium batteries, Development of new energy storage systems, Deep discharge and rapid charging ultra capacitors.</li> <li>• X-By Wire Technology : What is X-By Wire, Advantage over hydraulic systems. Use of Automotive micro controllers. Types of sensors. Use of actuators in an automobile environment.</li> <li>• Conclusion of Unit including real life applications</li> </ul>
<b>5</b>	<b>Vehicles Systems</b>

- Introduction of Unit
- Vehicles Systems : Constantly Variable Transmission, Benefits, Brake by wire, Advantages over power Braking System. Electrical assist steering, Steering by wire, Advantages of Steering by wire. Semi-active and fully-active suspension system. Advantages of fully active suspension system.
- Conclusion of Unit including real life applications

### C RECOMMENDED STUDY MATERIAL

Sr. No	Book	Author	Edition	Publication
<b>a. Reference Books</b>				
1.	Advanced Vehicle Technologies	Heinz Heisler	Latest	SAE International Publication.
2.	Electric and Hybrid Electric vehicles	Ronald K. Jurgan	Latest	SAE International Publication.
3.	Electronic Braking, Traction and Stability control	Hardbound papers.	Latest	SAE International Publication.
4.	42 Volt system	Daniel J. Holt	Latest	SAE International Publication.
5.	Fuel Cell Technologies for vehicles	Richard Stobart-	Latest	SAE Hardbound papers.
6.	Diesel Particulate Emission	J.H. Johnson-	Latest	SAE Hardbound papers.
<b>b. Websites</b>				
	<a href="http://www.nptel.com">www.nptel.com</a>			
	<a href="http://www.technicalsymposium.com/alllecturenotes_auto.html">www.technicalsymposium.com/alllecturenotes_auto.html</a>			
	<a href="http://c501400.r0.cf2.rackcdn.com/.../Automotive%20Transmission%20-Lectu...">c501400.r0.cf2.rackcdn.com/.../Automotive%20Transmission%20-Lectu...</a>			

**Course Outcomes:**

On successful completion of the course the learners will be able to

CO	Cognitive Abilities	Course Outcomes
CO-01	Understanding/ Applying	Develop the ability to identify difficult sounds, words and phrases to strengthen listening and applying these improved skills in spoken communication.
CO-02	Understanding/ Applying	Cultivating knack for reading and writing by understanding the nuances of sentence structure and presentation style.
CO-03	Understanding/ Applying	Understand negotiation and Identify steps for proper negotiation preparation & learn bargaining techniques and strategies of inventing options for mutual gain and move negotiations from bargaining to closing.
CO-04	Understanding / Applying	Develop a heightened awareness of the potential of digital communication and apply their knowledge in creating documents considering the needs of the netizens.
CO-05	Creating/Applying	Propose their outlook through exposure to new and different experiences and ideas and enrich their understanding of the issues under discussion.

UNIT NO.	UNIT NAME	Hours
1	Advanced Listening & Speaking Skills	6
2	Advanced Reading & Writing Skills	6
3	Art of Negotiation Skills	4
4	Email Etiquettes	4
5	Group Discussion	5

#### LIST OF LABS

1.	Listening Skills II: Analysis of videos/audios by famous personalities
2.	Speaking Skills II: Extempore, Debate etc.
3.	Public Speaking: Key Concepts, Overcoming Stage Fear
4.	Story-Telling Skills: Techniques of Story Telling, Prompts for story creation
5.	Situational Conversational Skills
6.	PowerPoint Presentation Skills-II
7.	Reading Skills II: Technical Writings, Research Papers& Articles
8.	Writing Skills II: Blog Writing &Review Writing
9.	Picture Perception & Discussion
10.	Art of Negotiation: Identify the qualities of successful and unsuccessful negotiators. Identify different negotiation situations to practice during class.
11.	Email Etiquettes
12.	Group Discussion: Dos &Don'ts, Informal GD

1. The Project group in seventh term will continue the project work in eighth term and complete project in all respect (assembly, testing, fabrication, tabulation, test result etc.)
2. The group should maintain a logbook of activities. It should have entries related to the work done, problems faced, solution evolved etc., duly signed by guide.
3. The guides should regularly monitor the progress of the project work.
4. The project work along with project report should be submitted as part of term work in eighth term on or before the last day of the eighth term
5. Project report must be submitted in the prescribed format only. No variation in the format will be accepted.
6. Assessment of the project for award of marks shall be done by the guide and a departmental committee.
7. The guide should be internal examiner for oral examination.
8. The external examiner should be from the related area of the concerned project. He should have experience at degree level / industry.
9. The evaluation at final oral examination should be done jointly by the internal and external examiners.

**COURSE OVERVIEW AND OBJECTIVES:**

The objective of Discipline and TEP is to provide students with the opportunities to enhance job fetching skills and at the same time to cultivate the student's personal interests and hobbies while maintaining the good disciplinary environment in the University. TEP is integrated into the curriculum for holistic development of students through active participation in various activities falling in Technical and nontechnical categories.

Discipline and Talent Enrichment Programme (TEP)-VIII shall be evaluated on the basis of its sub constituent programmes, as a complete **one credit** course. It shall be counted in calculation of SGPA but it is not a backlog subject. However, the attendance of these classes shall be recorded and accounted in the total attendance.

Activities included in this category in the EIGHTH Semester are as follows:

Code	Activity	Hours	Credits
BMECME8601	Talent Enrichment Programme (TEP) - VIII	-	1
	Library/MOOC/Online Certification Courses	2	
	Non Syllabus Project (NSP) / Industrial Visit / Campus Recruitment Training (CRT) - VIII	-	

\*\*\*\*\***END**\*\*\*\*\*