Curriculum Structure & Syllabi

(As per National Education Policy 2020)

of

B. Tech.

in

Mechanical Engineering

(w.e.f. 2024-25)

Vision

Mission

Program Educational Objectives

Program Outcomes

Program Specific Outcomes

Overall Credit Structure

Curriculum

Syllabus

Offered by

DEPARTMENT OF MECHANCAL ENGINEERING
MADAN MOHAN MALAVIYA UNIVERSITY OF TECHNOLOGY (MMMUT)
GORAKHPUR-273 010, UP, INDIA
JULY 2024

Mechanical Engineering Department

Vision

To become a leading centre of excellence fostering competent professional, innovators and researchers to address global challenges through sustainable technologies.

Mission

1. To provide quality education to the students in order to make them globally competitive Mechanical Engineers.
2. To enhance the skills of students using modern engineering tools and experimental techniques to solve real life mechanical engineering problems.
3. To make them work in groups with high level of societal, environmental and professional ethics with the self-learning attitude.
4. To establish linkages with the Industries, R&D organizations and educational institutions in India and abroad for excellence in teaching, research and innovation

Programme Educational Objectives (PEO)

PEO-1. To **prepare graduates** with a sound foundation in science, mathematics and mechanical engineering principles to formulate, analyse and solve real word problems in design, production and thermal engineering.

PEO-2. To empower graduates to succeed as professionals working independently or in team and to demonstrate leadership in project considering sustainable, societal and ethical implications.

PEO-3. To cultivate a desire for continuous learning, enabling them to pursue higher education, research and professional development to keep pace with technological developments

PEO-4. To inculcate innovation and entrepreneurship allowing graduates to develop solution that contribute to the industrial growth and economic development of national and society. .

Programme Outcome (POs)

PO-1 **Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO-2 **Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO-3 **Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO-4 **Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO-5 **Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO-6 **The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO-7 **Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO-8 **Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO-9 **Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO-10 **Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO-11 **Life-Long Learning:** Recognize the need for and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

Programme Specific Outcome (PSOs)

PSO-1. Ability to design, model, simulate, and analyze mechanical engineering systems using appropriate tools, techniques, and materials.

PSO-2. Ability to develop sustainable engineering solutions while adhering to ethical, safety, and economic constraints.

SYLLABUS AND CREDIT STRUCTURE FOR B. TECH. (ME)
(SESSION 2024-2025 AND ONWARDS)
OVERALL CREDIT STRUCTURE FOR B.TECH. (MED)

<table>
<tr><th colspan="4">Credit Courses</th></tr>
<tr><th colspan="2">Core Courses (CC)</th><th colspan="2">Electives Courses (EC)</th></tr>
<tr><th>Category</th><th>Min. Credits</th><th>Category</th><th>Min. Credits</th></tr>
<tr><td>Basic Sciences & Maths (BSM)</td><td>20</td><td rowspan="3">Professional Electives (PE)/ Open Electives (OE)</td><td rowspan="3">36</td></tr>
<tr><td>Engineering Fundamentals (EF)</td><td rowspan="2">24</td></tr>
<tr><td>Professional Skill (PS)</td></tr>
<tr><td>Professional Core (PC)</td><td>48</td><td>Humanities & Social Science Elective (HSSE)</td><td>04</td></tr>
<tr><td>Management (M)</td><td>04</td><td></td><td></td></tr>
<tr><td>Humanities & Social Science (HSS)</td><td>08</td><td></td><td></td></tr>
<tr><td>Minor Project (P)</td><td>06</td><td></td><td></td></tr>
<tr><td>Industrial Practice (IP) (In Industry)/ Major Project (MP) (In University)</td><td>10</td><td></td><td></td></tr>
<tr><td>Sub-total</td><td>120</td><td>Sub-total</td><td>40</td></tr>
<tr><td colspan="2">Grand Total</td><td colspan="2">160</td></tr>
<tr><th colspan="4">Non-Credit Courses</th></tr>
<tr><td colspan="3">One Expert Lecture per semester for students (Mandatory).
(BSM-Ist year), (PC-2nd Year), (T&P-3rd Year)</td><td>Non-Credit</td></tr>
<tr><td colspan="3">Social work/Training of at least 60 hours during break after first/ second semester (Mandatory) (Dean of Extension, Field Outreach and Alumni Relations).</td><td>Non-Credit</td></tr>
<tr><td colspan="3">Industrial Training during the summer break after fourth semester (Mandatory).</td><td>Non-Credit</td></tr>
<tr><td colspan="3">One -week workshop during the winter break after fifth semester on professional/ industry/ Social/ entrepreneurial orientation (Mandatory) (Dean of Extension, Field Outreach and Alumni Relations).</td><td>Non-Credit</td></tr>
<tr><td colspan="3">Value Added Courses (VAC) / Audit Courses (AC)
Two of the Value-Added Courses / Audit Courses are compulsory.</td><td>Non-Credit</td></tr>
<tr><td colspan="3">Extracurricular Activities Courses (ECA)
Two compulsory courses from the following S. No (ii) to (v) non-credit courses:
(i) Induction Program (compulsory)
(ii) Skill development
(iii) Unity and Discipline (NCC or NSS)
(iv) Sports, Cultural and Games
(v) Personality Development</td><td>Non-Credit</td></tr>
<tr><td colspan="4">Minor Degree (MD) from any Department and Micro Specializations (MS) within the Department</td></tr>
<tr><td colspan="3">• The total number of credits for graduation will be kept to minimum 160 and the additional 18-20 credits are required for Minor Degree.
• Micro specializations will be run by the department in order to align to industry careers or higher studies.</td><td>Offered as a Professional Electives (PE)</td></tr>
</table>

DEPARTMENT OF MECHANICAL ENGINEERING
MADAN MOHAN MALAVIYA UNIVERSITY OF TECHNOLOGY (MMMUT)
GORAKHPUR-273 010, UP, INDIA

SEMESTER WISE CREDIT STRUCTURE FOR B. TECH. (MED)

Category/Semesters	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**
Basic Sciences & Maths (BSM)	8	8	0/4	4/0					**20***
Humanities & Social Science (HSS)	4	4							**08***
Humanities & Social Science Elective (HSSE)						4			**04***
Management (M)					4				**04***
Engineering Fundamentals (EF)	4	4	8/4	0/4					**16***
Professional Skill (PS)	4	4							**08***
Professional Core (PC)			12	12	12	12			**48***
Professional Electives (PE)/ Open Electives (OE)				4-8	28-32				**36***
Minor Project (P)						0	6		**06***
Industrial Practice (IP) (in Industry)/ Major Project (MP) (In University)								10	**10***
Total Credit	**20***	**20***	**20***	**20-24***	**16*-32***	**16*-32***	**6-30***	**10-30***	**160***
	80-84*				**76-80***				
Total Courses Offered	**05***	**05***	**05***	**05*-06***	**04*-08***	**04*-08***	**00-06***	**00-05***	**36***

**Minor variation is allowed as per need of the respective disciplines.*

First Year, Semester I

S. N.	**Category**	**Paper Code**	**Subject**	**L**	**T**	**P**	**Credit**
1.	BSM	BSM-110	Engineering Mathematics-1	3	1	0	4
2.	BSM	BSM-131/181	Environmental Science and Green Chemistry	3	0	2	4
3.	EF	BEE- 110 / BEE-160	Basic Electrical Engineering	3	0	2	4
4.	PS	BME-104	Manufacturing Practice Workshop	2	0	4	4
5.	HSS	BHS-102/152	Technical Writing and Professional Communication	2	1	2	4
			Total	**13**	**2**	**10**	**20**
6.	ECA-I		Induction Program	-	-	-	0

 # Group-1: CSE, IT, CH, CE; Group-2: ECE, ECE (IOT), ME, EE.

First Year, Semester II

S. N.	**Category**	**Paper Code**	**Subject**	**L**	**T**	**P**	**Credit**
1.	BSM	BSM-160	Engineering Mathematics-2	3	1	0	4
2.	BSM	BSM 131/181	Engineering Physics	3	0	2	4
3.	EF	BIT-103	Programming in C	3	0	2	4
4.	PS	BME-157	Engineering Graphics with AutoCAD	2	0	4	4

5.	HSS	BHS-101/151	Universal Human values: understanding Harmony	3	1	0	4
			Total	**14**	**2**	**8**	**20**
6.	VAC/AC	BME-158	Engineering Innovation & Design	0	0	2	0
7.	ECA-II			-	-	-	**0**

Second Year, Semester III

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	BSM	BSM-214/264	Numerical Methods	3	0	2	4
2.	EF	BME-205	Basics of Mechanical Engineering	3	0	2	4
3.	PC	BME-206	Mechanics of Solids	3	0	2	4
4.	PC	BME-207	Material Science and Engineering	3	0	2	4
5.	PC	BME-208	Theory of Machines	3	0	2	4
			Total	**15**	**1**	**8**	**20**
6.	VAC	AUC102-AUC115		2	0	0	0
7.	AC	AUC-119	Fundamentals of Artificial Intelligence	2	0	0	0
8.	ECA-III			-	-	-	0

Second Year, Semester IV

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	EF	BME-256	Software Applications for Mechanical Engineering	2	0	4	4
2.	PC	BME-257	Fluid Mechanics & Hydraulic Machines	3	0	2	4
3.	PC	BME-258	Metrology and Quality Engineering	3	0	2	4
4.	PC	BME-259	Energy Conversion Technologies	3	0	2	4
	Student may choose either PE-1 or PE-2 or Both PE-1 and PE-2.						
5.	PE		PE-1	3	0/1	2/0	4
6.	PE		PE-2	3	0/1	2/0	4
			Total	**15-18**	**1-2**	**8**	**20-24**
7.	VAC/AC	AUC-101	Constitution of India	2	0	**0**	0
8.	ECA-IV			-	-	-	0

Third Year, Semester V

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	PC	BME-305	Design of Machine Elements	3	0	2	4

2.	PC	BME-306	Heat Transfer	3	0	2	4
3.	PC	BME-307	Manufacturing Science and Technology I	3	0	2	4
4.	M	BMS-301	Principles of Industrial Management	3	1	0	4
Student may choose maximum up to 04 courses from the list of PE category courses (PE-1 to PE-9).							
5.	PE		PE-1	3	0/1	2/0	4
6.	PE		PE-2	3	0/1	2/0	4
7.	PE		PE-3	3	0/1	2/0	4
8.	PE		PE-4	3	0/1	2/0	4
9.	PE		PE-5	3	0/1	2/0	4
10.	PE		PE-6	3	0/1	2/0	4
11.	PE		PE-7	3	0/1	2/0	4
12.	PE		PE-8	3	0/1	2/0	4
13.	PE		PE-9	3	0/1	2/0	4
			Total	**12-24**	**1-5**	**6-14**	**16-32**
14.	ECA-V			-	-	-	0

Third Year, Semester VI

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	PC	BME-354	Refrigeration and Air Conditioning	3	0	2	4
2.	PC	BME-355	CAD/CAM	3	0	2	4
3.	PC	BME-356	Manufacturing Science and Technology II	3	0	2	4
4.	HSSE	BHS-351	Engineering and Managerial Economics	3	1	0	4
5.	P	BME-390	Minor Project-1	0	0	0	0
Student may choose maximum up to 04 courses from the list of PE category courses (PE-1 to PE-9).							
6.	PE		PE-1	3	0/1	2/0	4
7.	PE		PE-2	3	0/1	2/0	4
8.	PE		PE-3	3	0/1	2/0	4
9.	PE		PE-4	3	0/1	2/0	4
10.	PE		PE-5	3	0/1	2/0	4
11.	PE		PE-6	3	0/1	2/0	4

12.	PE		PE-7	3	0/1	2/0	4
13.	PE		PE-8	3	0/1	2/0	4
14.	PE		PE-9	3	0/1	2/0	4
			Total	**12-24**	**1-5**	**6-14**	**16-32**
15.	ECA-VI			-	-	-	0

Final Year, Semester VII

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	P	BME-490	Minor Project-2	0	0	12	6
Student may choose maximum up to 06 courses from the list of PE category courses (PE-1 to PE-9).							
2.	PE		PE-1	3	0/1	2/0	4
3.	PE		PE-2	3	0/1	2/0	4
4.	PE		PE-3	3	0/1	2/0	4
5.	PE		PE-4	3	0/1	2/0	4
6.	PE		PE-5	3	0/1	2/0	4
7.	PE		PE-6	3	0/1	2/0	4
8.	PE		PE-7	3	0/1	2/0	4
9.	PE		PE-8	3	0/1	2/0	4
10.	PE		PE-9	3	0/1	2/0	4
			Total	**0-18**	**0-6**	**12-24**	**6-30**
11.	ECA-VII			-	-	-	0

Final Year, Semester VIII

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	IP	IME-410	Industrial Practice (IP)	0	0	20	10
	Without Industrial Practice (IP)						
2.	MP	IME-411	Major Project (MP)	0	0	20	10
Student may choose maximum up to 05 courses from the list of PE category courses (PE-1 to PE-9).							
2	PE		PE-1	3	0/1	2/0	4
3	PE		PE-2	3	0/1	2/0	4
4	PE		PE-3	3	0/1	2/0	4

5	PE		PE-4	3	0/1	2/0	4
6	PE		PE-5	3	0/1	2/0	4
7	PE		PE-6	3	0/1	2/0	4
8	PE		PE-7	3	0/1	2/0	4
9	PE		PE-8	3	0/1	2/0	4
10	PE		PE-9	3	0/1	2/0	4
			Total	**0-15**	**0-5**	**20-30**	**10-30**

List of Professional Electives

PE-1					
Subject Code	Subject Name	Credit			Total Credits
		L	T	P	
EME-101	Introduction to Robotics	3	1	0	4
EME-102	Fundamentals of Renewable Energy Sources	3	1	0	4
EME-103	Smart Manufacturing	3	1	0	4
EME-104	Numerical Methods for Engineers	3	1	0	4

PE-2					
Subject Code	Subject Name	Credit			Total Credits
		L	T	P	
EME-201	Additive Manufacturing Technology	3	1	0	4
EME-202	Energy conservation and waste heat recovery	3	1	0	4
EME-203	Gas Dynamics	3	1	0	4
EME-204	Fundamental of EV and HEV	3	1	0	4

PE-3					
Subject Code	Subject Name	Credit			Total Credits
		L	T	P	
EME-301	Smart Materials for Mechatronics	3	1	0	4
EME-302	Renewable Energy Technologies	3	1	0	4
EME-303	Additive Manufacturing	3	1	0	4

EME-304	Software Application for Engineering Problem	2	0	4	4
EME-305	Internal Combustion Engine and Automobile Engineering	3	0	2	4

PE-4					
Subject Code	Subject Name	Credit			Total Credits
		L	T	P	
EME-401	Design for Additive Manufacturing	3	1	0	4
EME-402	Bioenergy	3	1	0	4
EME-403	Alternate fuels	3	1	0	4
EME-404	EV/HEV Power Train	3	1	0	4

PE-5					
Subject Code	Subject Name	Credit			Total Credits
		L	T	P	
EME-501	Sensors and Actuators	3	1	0	4
EME-502	Energy Storage Systems	3	1	0	4
EME-503	Smart Materials and Structures	3	1	0	4
EME-504	Computational Modelling & Simulation	3	0	2	4
EME-505	Machine Design	3	0	2	4
EME-511	Vehicle Dynamics and Control	3	1	0	4

PE-6					
Subject Code	Subject Name	Credit			Total Credits
		L	T	P	
EME-601	Post Processing & Characterization Methods for Additive Manufacturing	3	1	0	4
EME-602	Selection of Nanomaterials for Energy Harvesting and Storage Applications	3	1	0	4
EME-603	Engine system and performance	3	1	0	4
EME-604	Vehicle Dynamics	3	1	0	4

PE-7					
Subject Code	Subject Name	Credit			Total Credits
		L	T	P	
EME-701	Industrial Automation	3	1	0	4
EME-702	Environmental Impact Assessment	3	1	0	4
EME-703	Automation in Manufacturing	3	1	0	4
EME-704	Optimization Techniques in Engineering	3	1	0	4
EME-711	Sustainable Energy and EVs	3	1	0	4

PE-8					
Subject Code	Subject Name	Credit			Total Credits
		L	T	P	
EME-801	Machine learning for Additive Manufacturing	3	1	0	4
EME-802	Energy Economics and Policy	3	1	0	4
EME-803	Aircraft Propulsion	3	1	0	4
EME-804	Charging Infrastructure for EV and HEV	3	1	0	4

PE-9					
Subject Code	Subject Name	Credit			Total Credits
		L	T	P	
EME-901	Mechanics of Robotics	3	1	0	4
EME-902	Performance Assessment and Economics	3	1	0	4
EME-903	Machine Learning for Production Optimization	3	1	0	4
EME-904	Finite Element Methods	3	0	2	4

List of Value-Added Courses (VAC)/Audit Courses (AC)

S.No.	Subjects	Codes
1.	Constitution of India	AUC101
2.	Indian Culture and Heritage	AUC102
3.	Indian Architecture	AUC103
4.	Indian Festivals	AUC104
5.	Vedic Mathematics	AUC105

6.	Astronomy	AUC106
7.	Arts of India	AUC107
8.	Intellectual Property Rights	AUC108
9.	Human Rights	AUC109
10.	Logical Research	AUC110
11.	Professional Ethics	AUC111
12.	Environmental Law	AUC112
13.	Health Law	AUC113
14.	National Cadet Corps	AUC114
15.	Basics of Human Health and Preventive Medicines	AUC115
16.	Constitution Of India And Environmental Governance: Administration And Adjudication	AUC116
17.	Directive Principles Of State Policy And Fundamental Duties: Constitutional Imperative	AUC117
18.	Introduction To Intellectual Property To Engineers And Technologists	AUC118
19.	Fundamentals of Artificial Intelligence	AUC119
20.	Indian Knowledge Through Classical Languages	IKS101
21.	Indian Knowledge System: Concepts And Applications In Science	IKS102
22.	Indian Knowledge System: Concepts And Applications In Engineering	IKS103
23.	Indian Knowledge System	IKS104

List of Extra Curricular Activity (ECA) Courses

ECA-II						
S. No.	Branch	Category	Subject Name	Subject Code	Hours/ Week	Credit
1.	Open to all Branches	ECA	Skill Development-I	ECA-151	2	0
2.	Open to all Branches	ECA	Unity and Discipline (NCC)-I	ECA-171	2	0
3.	Open to all Branches	ECA	Unity and Discipline (NSS)-I	ECA-172	2	0
4.	Open to all Branches	ECA	Games & Sports-I	ECA-181	2	0
5.	Open to all Branches	ECA	Cultural, Art & Literary-I	ECA-182	2	0

ECA-III						
S. No.	Branch	Category	Subject Name	Subject Code	Hours/ Week	Credit
1.	Open to all Branches	ECA	Skill Development-II	ECA-201	2	0
2.	Open to all Branches	ECA	Unity and Discipline (NCC)- II	ECA-221	2	0
3.	Open to all Branches	ECA	Unity and Discipline (NSS)-II	ECA-222	2	0
4.	Open to all Branches	ECA	Games & Sports-II	ECA-231	2	0
5.	Open to all Branches	ECA	Cultural, Art & Literary-II	ECA-232	2	0

ECA-IV						
S. No.	Branch	Category	Subject Name	Subject Code	Hours/ Week	Credit
1.	Open to all Branches	ECA	Skill Development-III	ECA-251	2	0
2.	Open to all Branches	ECA	Unity and Discipline (NCC)-III	ECA-271	2	0
3.	Open to all Branches	ECA	Unity and Discipline (NSS)-III	ECA-272	2	0
4.	Open to all Branches	ECA	Games & Sports-III	ECA-281	2	0
5.	Open to all Branches	ECA	Cultural, Art & Literary-III	ECA-282	2	0

ECA-V						
S. No.	Branch	Category	Subject Name	Subject Code	Hours/ Week	Credit
1.	Open to all Branches	ECA	Skill Development-IV	ECA-301	2	0
2.	Open to all Branches	ECA	Unity and Discipline (NCC)- IV	ECA-321	2	0
3.	Open to all Branches	ECA	Unity and Discipline (NSS)-IV	ECA-322	2	0
4.	Open to all Branches	ECA	Games & Sports-IV	ECA-331	2	0
5.	Open to all Branches	ECA	Cultural, Art & Literary-IV	ECA-332	2	0
ECA-VI						
S. No.	Branch	Category	Subject Name	Subject Code	Hours/ Week	Credit
1.	Open to all Branches	ECA	Skill Development-V	ECA-351	2	0
2.	Open to all Branches	ECA	Games & Sports-V	ECA-381	2	0
3.	Open to all Branches	ECA	Cultural, Art & Literary-V	ECA-382	2	0

ECA-VII						
S. No.	Branch	Category	Subject Name	Subject Code	Hours/ Week	Credit
1.	Open to all Branches	ECA	Skill Development-VI	ECA-401	2	0
2.	Open to all	ECA	Games & Sports-VI	ECA-431	2	0

	Branches					
3.	Open to all Branches	ECA	Cultural, Art & Literary-VI	ECA-432	2	0

SKILLS-ENHANCEMENT COURSES FOR EXIT (MECHANICAL ENGINEERING):

2-Months internship for 6-Credits **OR** Two courses mentioned below of 4 to 6 credits.

A. After First Year: UG Certificate (Engg.).

The candidate should pass the following two additional courses (ITI Level) **OR** any two suitable skill-based courses to qualify for **UG Certificate (Engg.).**

OR

Equivalent skills-enhancement courses from MOOC/SWAYAM

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	Skill Enhancement	BME-159	Heating, Ventilation and Air Conditioning (HVAC)	2	0	2	3
2.	Skill Enhancement	BME 160	Machinist	2	0	2	3

.

B. After Second Year: UG Diploma (Engg.).

The candidate should pass the following two additional courses (Diploma Level) OR any two suitable skill-based courses to qualify for **UG Diploma (Engg.).**

OR

Equivalent skills-enhancement courses from MOOC/SWAYAM

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	Skill Enhancement	BME 261	Fundamentals of CNC Programming and Operation	2	0	2	3
2.	Skill Enhancement	BME-262	Welding Technology	2	0	2	3

C. After Third Year: B. Voc. (Engg.).

The candidate should pass following additional courses (Degree Level) OR any two suitable skill-based courses to qualify for **B. Voc. (Engg.).**

OR

Equivalent skills-enhancement courses from MOOC/SWAYAM

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	Skill Enhancement	BME-357	Hydraulics and Pneumatics	2	1	0	3
2.	Skill Enhancement	BME-358	Industrial Robotics and Material Handling Systems	2	1	0	3

SYLLABI

First Year

BSM-110 Engineering Mathematics I

Course category	:	Basic Sciences & Maths (BSM)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture : 3, Tutorial : 1 , Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	:	The course is aimed to develop the basic mathematical skills of engineering students that are imperative for effective understanding of engineering subjects.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Use of basic differential operators in various engineering problems.
2. Understand the concepts of limit theory and nth order differential equations and their applications to our daily life
3. Solve linear system of equations using matrix algebra.
4. Know about qualitative applications of Gauss, Stoke's and Green's theorem.
5. To know the applications of double and triple integration in finding the area and volume.
6. To inculcate the habit of mathematical thinking and lifelong learning.

Topics Covered

UNIT-I 9

Differential Calculus: Limit, Continuity and Differentiability, Mean value theorems. Leibnitz theorem, Partial derivatives, Euler's theorem for homogenous function, Total derivative, Change of variable. Taylor's and Maclaurin's theorem. Expansion of function of two variables, Jacobian, Extrema of function of several variables.

UNIT-II 9

Linear Algebra: Symmetric, Skew-symmetric matrices, Hermitian, Skew Hermitian Matrices, orthogonal and unitary matrices and basic properties, linear independence and dependence of vectors, Rank of Matrix, Inverse of a Matrix, Elementary transformation, Consistency of linear system of equations and their solution, Characteristic equation, Eigenvalues, Eigen-vectors, Cayley-Hamilton theorem, Diagonalization of matrices.

UNIT-III 9

Multiple Integrals: Double and triple integrals, change of order of integration, change of variables. Application of multiple integrals to surface area and volume. Beta and Gamma functions, Dirichlet integral.

UNIT-IV 9

Vector Calculus: Gradient, Divergence and Curl. Directional derivatives, line, surface and volume integrals. Applications of Green's, Stoke's and Gauss divergence theorems (without Proofs).

Books & References

1. B.S. Grewal: Higher Engineering Mathematics; Khanna Publishers
2. Erwin kreyszig: Advanced Engineering Mathematics, John Wiley & Sons.
3. R. K. Jain and Iyenger: Advanced Engineering Mathematics, Narosa Publications.
4. B.V. Ramana: Higher Engineering Mathematics, Tata Mc. Graw Hill Education Pvt. Ltd.,

BSM-140/BSM-190	**Environmental Science and Green Chemistry**
Course category:	Basic Sciences & Maths (BSM)
Pre-requisite Subject:	NIL
Contact hours/week	Lecture: 3, Tutorial: 0 , Practical: 2
Number of Credits:	4
Course Assessment methods:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	Understanding the principles and concepts of Chemistry viz. Chemical Bonding, acidity and basicity, Atmospheric Chemistry & Water Chemistry, Spectroscopic analytical methods and Green Chemistry and solving industrial problems using solid foundation in Chemistry.
Course Outcomes:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. To develop the concepts of basic chemistry.
2. To make the students aware of global environmental issues e.g. global warming & Greenhouse effect, Ozone depletion, pollution and its prevention and understand various aspects of atmospheric chemistry.
3. To understand the analytical and conceptual skills required for environmental chemistry research.
4. To understand water treatment for all types of uses and need to protect environment.
5. To understand the specifications of pure water and its purification techniques.
6. To develop the knowledge about Green Chemistry and Green Technology.

Unit 1:

Basic Chemical Concepts

Periodic properties of elements, Ionization potential, electron affinity and electronegativity; mole concept, molarity and normality, Chemical Bonding – MO Theory, MO diagram of diatomic molecules, hydrogen bonding, electrophiles, nucleophiles, inductive effect and mesomeric effect. Reaction Mechanism. Acidity and basicity - Concept of pH.

Unit 2:

Atmospheric chemistry & Water Chemistry

The atmosphere of Earth, layers of atmosphere and temperature inversion, Air pollution, Global warming and Greenhouse effect. Acid rain and Ozone layer depletion. Chemical and photochemical Smog.

Sources of water, conservation of water, impurities in water and their effects. WHO guideline and BIS guideline for drinking water. Hardness of water, Softening of water by Zeolite process, Lime Soda process, Ion exchange process and Reverse osmosis.

Unit 3:

Spectroscopic analytical methods

Absorbance, Transmittance and Beer-lamberts Law. Basic principles of UV-Visible spectroscopy, Fluorescence spectroscopy, Infrared spectroscopy, NMR Spectroscopy. Use of these instrumental techniques for monitoring of environmental pollution.

Environmental problems posed by the use of non-biodegradable polymers widely used in day-to-day life. Incineration as the key method for disposal of polymeric waste. Bio-degradable polymers.

Unit 4:

Green Chemistry

Green Chemistry and Green Technology: New trends in Green chemistry; Green Chemistry Methodologies-Microwave heating, ultrasound technique. Green Chemical Synthesis Pathways; Green reagents, Green solvents.

Experiments:

1. Determination of temporary and permanent hardness in water sample using EDTA as standard solution.
2. Determination of alkalinity in the given water sample.
3. Determination of chloride content in the given water sample by Mohr's method.
4. Determination of percentage of available chlorine in bleaching powder sample.
5. Determination of iron content in the given sample using $K_3[Fe(CN)_6]$ as an external indicator.
6. Determination of Electrical conductivity/TDS of a given water sample using conductivity meter.
7. Determination of dissolved Carbon Dioxide of given water sample.
8. Determination of the biochemical oxygen demand of sewage influent.
9. To calculate the lambda max of the given compound by using UV-Visible spectrophotometer.
10. Determination of nickel / cobalt / copper solutions by UV–visible spectrometry.
11. Examples of Green Synthesis /Reactions.
12. Determination of Turbidity of Water
13. Iodoform test
14. Synthesis of a polymer Bakelite or Polyacrylic acid.

Books & References

1. A Text book of Environment and Ecology, Shashi Chawla, Tata McGraw Hill
2. Environmental Studies, Raj Kumar Singh, Tata McGraw Hill
3. Engineering Chemistry, Wiley India
4. Engineering Chemistry, Tata McGraw Hill
5. Organic Chemistry, Morrison & Boyd, 6th edition, Pearson Education
6. Fundamentals of Environmental Chemistry, Manahan, Stanley E., Boca Raton: CRC Press LLC.
7. Environment and Ecology, R K Khandal, Wiley India

8. An Introductory Text on Green Chemistry: For Undergraduate Students, lndu Tucker Sidhwani, Rakesh K. Sharma, Wiley
9. A textbook of Green Chemistry, Shankar Prasad Deo and Nayim Sepay, Techno World Publication.
10. Introduction to Green Chemistry, John Andraos, Albert S. Matlack, CRC Press

BIT-103 PROGRAMMING IN C

Course category : Engineering Fundamentals (EF)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial: 0, Practical:2
Number of Credits : 4
Course Assessment Methods : Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination

Course Objective: Students will gain an understanding of the fundamentals of computers and programming. The objective is to prepare them for various dimensions of C Programming language.

Course Outcomes: The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Describing the basics of terminologies used in computer programming.
2. Practicing C language programming by writing, compiling and debugging the code.
3. Designing programs involving simple statements, conditional statements, iterative statements, array, strings, functions, recursion and structure.
4. Discussing the dynamic memory allocations and use of the pointers.
5. Applying basic operations on files through programs.
6. Studying and implementing the codes using macros, pre-processor directives and command line arguments

Topics Covered

UNIT-I **9**

Basics of Computers and Programming: Functional diagram of computer; Language Processors; Approaches to problem solving, Concept of algorithm and flow charts. **Simple Statements:** Data types; Tokens and its types; Variable declaration and initialization; User defined type declaration: type def, enum; Comments; Format specifiers; Standard I/O: taking input and displaying output; **Operators:** types, precedence and associativity; Expressions; Type conversion, Cshort-hands.

UNIT-II

9

Conditional Statements: Simple if, if-else, nested if-else, else-if ladder, switch statements, nested switch, advantages of switch over nested if, restrictions on switch values. **Iterative Statements:** Concepts of entry and exit controlled loops; Uses of for, while and do while loops; Nested Loops; Printing various patterns using nested loops; Using break, continue and goto statements.

9

UNIT-III

Arrays: Single-dimensional, multi-dimensional array and their applications; declaration and manipulation of arrays; strings and string handling functions. **Pointers:** Pointer and address arithmetic; dereferencing; pointers and arrays; dynamic memory allocation and de-allocation. **Functions:** Function prototype; Arguments and its types: actual, formal and default arguments; Scope of a variable; Argument passing methods; Passing pointer as the function argument; Recursion: types, advantages and disadvantages; Storage class specifies; Character test functions.

9

UNIT-IV

Structure: Declaring and defining structures; Array within structure; Array of structure; Defining and using some data structures: Stack, Queue, and Linked lists. **File Handling:** Types of files; Text files and different operations on text files, opening a file, closing a file; Data structure of a file; EOF; I/O operations on files; Random access to the files. **Standard C Pre-processors & C Library:** Pre-processor, Directives, Macro, Macro substitution; Conditional Compilation; Command Line Arguments; Standard C Library.

EXPERIMENTS

Implementing programs in following categories using programming language 'C':

1. Programs of simple statements, conditional statements, and iterative statements with the applications.
2. Programs of single and multi-dimensional arrays and their applications.
3. Programs of strings and the applications
4. Programs of pointer and the applications
5. Programs of function and the applications
6. Programs of structure and the applications
7. Codes of file handling and management
8. Codes with Pre-processor, Macro, Conditional Compilation and Command Line Arguments

Textbooks

1. Brian W. Kernighan and Dennis M. Ritchie, "The C programming language", Pearson
2. E. Balagurusamy, "Programming in ANSI C", McGraw Hill Education
3. Yashavant Kanetkar, "Let Us C", bpb publication
4. Jeri R. Hanly, Elliot B. Koffman, "Problem Solving and Program Design in C", Pearson
5. Herbert Schildt,"C: The Complete Reference", McGraw Hill Education

BME 104		**Manufacturing Practice Workshop**
Course Category	:	Professional Skill (PS)
Pre-requisite Subject	:	NIL
Contact Hours/Week	:	Lecture: 2, Tutorial: 0, Practical: 04
Number of Credits	:	04
Course Assessment Method	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objective		This course introduces basic concepts of various manufacturing processes and their applications in production of complex shape andsize products based on the concepts of forming, welding, casting

and machining.

Course Outcomes : After completion of this course the students are expected to be able to demonstrate following knowledge, skills, and attitudes

1. Understand the importance, materials, applications, and safety in different shops for the development of a product/component.
2. The knowledge of tools and processes used in carpentry and foundry shops for the development of products through the casting process.
3. The knowledge of forming process will develop skills for producing products using different tools and processes in the black smithy and sheet metal shops.
4. The knowledge and practical skill of various welding processes and their application.
5. The knowledge and practical skill of various machining processes.
6. The knowledge of non-conventional machining will develop the ability to produce various products.

Unit I **6**

Concept of Manufacturing- Manufacturing definition; Role of materials, processes and systems in manufacturing; Classification and brief introduction of engineering materials such as metals & alloys, Classification and brief introduction of manufacturing processes

Unit II **6**

Sand Casting Process of Metals- Elements of Green Sand Mould; Pattern design and making, Method of Preparation of Green Sand Mould; Casting Defects

Unit III **6**

Metalworking Processes- Classification of Metalworking Processes-brief introduction of bulk and sheet metal processes, Hot Vs Cold Working; Hot and Cold Rolling; Types of Rolling Mills, Forging, Extrusion, Drawing

Fabrication Processes- Classification of Welding Operations, Types of Joints & Welding Positions; Brief description of Arc, Resistance and Gas welding techniques. Brazing and Soldering

Unit IV **6**

Machining Processes: Classification of machining processes & machine tools; Construction, Specification, and operations on Lathe Machine and Drilling machine

List of Practicals

1. **Safety in Workshop (Demonstration)**

Safety precautions and utilization of hand tools and machines of different shops with safe working habits. Introduction to measuring equipment and gauges of different shops.

2. **Carpentry**

Study woodwork, types of hand tools and machine. Making of one job involving wood work joint

3. **Fitting**

Study of different fits and hand tools. Making of one job involving fitting to size, male female fitting with drilling and tapping

4. **Welding**

Study of electric arc welding and gas welding, tools, types of weld joints and safety precaution during welding. Making of one joint using electric and gas welding. Students will be introduced to brazing and soldering (demonstration)

5. **Sheet Metal Work**

Study of different hand tools, machine and sheet metal joints. Making of one utility job in sheet metal

6. **Foundry**

Principles of molding, methods, core & core boxes, preparation of sand mould of given pattern and casting (demonstration)

7. **Black Smithy**

Introduction to hot working and Study of forging hand tools, furnace and machine. Making a job on hot upset forging.

8. **Machining**

Study of lathe machine, cutting tools and turning related operations. Making of one job on lathe machine including facing, step and taper turning, threading operations.

9. **Plastic Processing**

Introduction to plastics and different plastic molding techniques. Study of injection molding process with demonstration.

10. **Computer Numerical Control (CNC)**

Introduction to automation & CNC, Assembly of models of CNC, CNC wood router, engraving and exposure to part programming. Preparation of part program for simple profiles. Making a job on CNC (Demonstration).

11. **Mini Project**

Team activity – Fabrication of prototype model based on above practical.

Text and Reference Books

1.Manufacturing Science: A. Ghosh and A.K. Mallik (East- West Press).

2.Workshop Technology Vol-I: B. S. Raghuvanshi (Dhanpat Rai and Sons)

3.Workshop Technology Vol-II: B. S. Raghubanshi (Dhanpat Rai and Sons)

BHS- 102/152 TECHNICAL WRITING AND PROFESSIONAL COMMUNICATION (TW&PC)

Course Category	: HSS
Prerequisite subject	: None
Number of Credits	: 4
Contact Hours/Week	: Lectures: 2, Tutorial: 1, Practical: 2
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	: The objectives of this course are to: - The course aims- 1. To sensitize the students to understand the role and importance of communication for personal and professional success. 2. To enable the learners to enhance their writing skills in techno-cultural and professional echo-system. 3. To equip learners to differentiate technical writing from general writing. 4. To equip them with technical writing skills. 5. To enable learners to exhibit knowledge, skills, attitude and judgment in and around human communication that facilitate their ability to work collaboratively with others in an interpersonal environment.

Course Outcomes : The students will be able to demonstrate the following knowledge, skills, and attitudes upon completion of the course: -

1. Overcome the problems she/he shall faces in oral and written communication.
2. Acquire knowledge of and methods for using technical communication, such as reports, proposals, technical letters, etc.
3. Use and Practice compositions correctly.
4. Give presentations in different sessions and make self-appraisal.
5. Learn and understand the various facets of Communication Skills, such as (LSRW) Listening, Speaking, Reading, and writing, and identify, formulate, and solve real-life problems with a positive attitude; also inculcate, the habit of learning and developing communication and soft skills.

Unit 1: Language and Communication **6**

Language Vs communication: Communication as coding and decoding – signs, symbols & pictograph – verbal and non–verbal symbols – Language & communication; Types ofCommunication- functional, situational, verbal, and non-verbal, interpersonal, group, interactive, public, Mass Communication. Thinking and Articulation, critical, creative aspects of articulation.

Skills of Language Acquisition: Natural Language Acquisition Skills: Listening, Speaking, Reading & Writing {LSRW}; Language Acquisition Through Training: Listening, Speaking, Reading, Writing, Grammar & Vocabulary {LSRWGV}

Phrase, Clause & Sentence in Professional Drafting-Simplicity, Clarity and Conciseness of a Presentation, Differentiating between Professional and Creative Writing, Blending of Artistic/Professional Writing, Avoiding gender, racial, and other forms of bias in Professional Writing. Pre-writing, Drafting, and Re-writing.

Unit 2: Towards Technical Writing **6**

Technical Paper Writing: Professional Paper Elements-Front Matter of a Paper, Main Text of a Paper, End Matter of a Paper: Organizing References and Bibliography, Order of a thesis and Paper Elements, Concluding Remarks. **Methods of Research Paper Writing:** Identification of Author and His Writing-Author's name and Affiliation, Joint Authorship of a Paper, Identification of Writing- Title, Keywords, Synopsis, Preface and Abstract. Drafting Research Article & Methodology.

Thesis/Dissertation Writing: Thesis Elements-Front Matter of a Thesis, Main Text of a Thesis, End Matter of a Thesis, Specimen—Thesis and Research Paper, Chapters and Sections-Introductory Chapters and Sections, Statement of the Problems, Plan and Scope, Core Chapters and Sections-Theoretical Analysis and Synthesis, Basic Assumption and Hypothesis.

Professional Presentation & Seminar Delivery Tools: Designing the Presentation; Establishing the Objectives. Making Professional PowerPoint Presentations, Signaling Structure of Presentation through Sentences and Crisp Phrases, Preparing Notes for Professional/Technical Presentation, Text Animation, White Board, Flip Charts, Diagrams, Preparing Cards. Seminar Presentations: Purpose modes and methods. Nascent Emerging Platforms for On-line Presentations viz. Zoom, Webex, Team& Meet etc.

Unit 3: Drafting Skills & Career Correspondence **6**

Professional Drafting: Letters vs. e-mails, Formal and Informal emails, Parts of e-mails, Types of e-mails, Managing tone of E-mails and business Letters, Examples of Letters and E-mail, Professional Correspondence through E-mail, Job Applications and cover Letters. Introduction to DOs (Demi-Official Letters)

Career & Correspondence: Developing a Professional C.V, Bio Data & Resume. Report Writing, Kinds of Reports, Length of Report, Parts of a Report, Terms of Reference, Collection of Facts, Outlines of Report, Examples of Report, Technical Proposal, Elements of Proposal, Examples of Proposal, drafting of proposal.

Unit 4: Professional Practices with ICT Interface **6**

Conducting Professional Meeting: Pre-meeting Preparation, During Meeting: Action Taken Report (ATR) & New Agenda Points, Post Meeting Follow ups. Notice, Circular, Agenda & Meeting Minutes. **Introduction to Generation–Z, Cyber Identity & Professional Netiquettes for Netizens:** Drafting E-mails, Blogs on social media, Videoconferencing. Managing Profiles on social media. What to Write and Share on social media. Telephone Etiquettes & Phubbing.

List of Practical:

1. Introduction to Vowel and Consonant Sounds
2. Monophthongs and Diphthongs
3. Syllable, Word Stress & Intonation
4. Harnessing Non-verbal Communication Skills in Cross-Cultural Environment for the establishment of an ideal Ecosystem to ensure Professional Success
5. Developing Speech, and Proofreading the Same
6. Argumentative Skills & Group Dynamics
7. Preparing CV, Biodata & Resume
8. Types of Interview and Interview Skills
9. GD, PI & Telephonic Interview
10. Presentation Skills, Extempore, Debate and Video Conferencing
11. Netiquettes while Writing Blogs on social media.
12. Ethical Usages of Generative AI

Text / Reference Books

1. Acharya Anita. (2012) Interview Skills- Tips & Techniques. Yking Books, Jaipur.
2. Basu, B. N., (2008) Technical Writing. PHI Learning Pvt. Ltd.., New Delhi.
3. Chauhan, N. K & Singh, S. N. (2013) Formal Letters, Pankaj Publication International, New Delhi.
4. Chhabra T.N. (2018) Business Communication. Sun India Publication New Delhi.
5. Dubey Arjun et.al. (2016) Communication for Professionals. Alfa Publications, Delhi.
6. Gibaldi, Joseph (2021). The MLA Handbook for Writers of Research Papers. Ed. IXth, ModernLanguage Association of America, NY, US.
7. Gurumani, N. (2010) Scientific Thesis Writing and Paper Presentation, MJP Publishers, Chennai.
8. Hamilton Richard. (2009) Managing Writers. Penguin, India.
9. Mc Graw S. J. (2008) Basic Managerial Skills for All. Ed. 08th, Prentice Hall of India, New Delhi.
10. Murphy & Hildebrandt. (2008) Effective Business Communication. Tata McGraw Hill New Delhi.
11. Pandey, S.P., Singh, S. N. & Kumar, Raman, (2023) Exploring Digital Humanities: Challenges & Opportunities, MacBrain Publishing House, New Delhi.

BSM-160	**Engineering Mathematics II**
Course category	: Basic Sciences & Maths (BSM)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial: 1 , Practical: 0
Number of Credits	: 4

Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	:	The course is aimed to develop the basic mathematical skills of engineering students that are imperative for effective understanding of engineering subjects.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. To solve the ordinary differential equations.
2. To solve the partial differential equations using Lagrange and charpit's method.
3. To solve and understand the properties of Bessel`s and Legendre`s differential equation.
4. Application of partial differential equation in real life problems
5. To solve ODE and PDE with the help of Laplace transform
6. To inculcate the habit of mathematical thinking and lifelong learning.

Topics Covered

UNIT-I 9

Ordinary Differential Equations I: Linear differential equations with constant coefficients ($n^{th} order$), complementary function and particular integral. Simultaneous linear differential equations, solution of second order differential equations by changing dependent and independent variables, Method of variation of parameters, Applications of differential equations to engineering problems

UNIT-II 9

Ordinary Differential Equations II: Series solution of second order differential equations with variable coefficient (Frobeneous method). Bessel and Legendre equations and their series solutions, Properties of Bessel function and Legendre polynomials.

UNIT-III 9

Partial Differential equations: Partial differential equations of the first order, Lagrange's solution, Charpit's general method of solution, Partial differential equations of the second order: Constant coefficient and reducible to constant coefficient, Classification of linear partial differential equations of second order.

UNIT-IV 9

Laplace Transform: Laplace Transform, Laplace transform of derivatives and integrals. Unit step function, Laplace transform of Periodic function. Inverse Laplace transform, Convolution theorem, Applications to solve simple linear and simultaneous differential equations and Partial Differential Equations.

Books & References

1. B.S. Grewal: Higher Engineering Mathematics; Khanna Publishers
2. Erwin kreyszig: Advanced Engineering Mathematics, John Wiley & Sons.
3. R. K. Jain and Iyenger: Advanced Engineering Mathematics, Narosa Publications.
4. B.V. Ramana: Higher Engineering Mathematics, Tata Mc. Graw Hill Education Pvt. Ltd.
5. M.D. Raisinghania, Ordinary and Partial Differential Equations. S Chand Publications.

BSM-131/181 ENGINEERING PHYSICS

Course category	:	Basic Sciences and Maths (BSM)
Pre-requisite Subject	:	Physics at 12thStandard
Contact hours/week	:	Lecture : 3, Tutorial: 0 , Practical: 2

Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	:	Understanding of the principles and concept of Optics, Quantum Mechanics, Fiber Optics, Electrodynamics and Physics of Advanced Materials.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attributes after completing this course.

1. Understand the basics principles of Optics and its applications in Engineering and Technology.
2. Compare and understand the uses of various lasers in different fields of Engineering.
3. Know the knowledge of Optical Fibre and their applications in Photonics.
4. Understand the principles of Quantum Mechanics and their applications in Engineering and Technology.
5. Know the principles of Electrodynamics and their applications in Engineering and Technology.
6. Understand the basic properties of advanced materials and their engineering applications.

UNIT-I: Optics: 9

Interference: Interference of light, Interference in thin films, Newton's rings. Refractive index and wavelength determination.

Diffraction: Fresnel and Fraunhofer class of diffraction. Resultant of n-hormonic waves, single, double and N- slit diffraction, Diffraction grating, Grating spectra, Dispersive power.

Polarization: Phenomena of double refraction, Nicol prism, Production and analysis of plane, circular and elliptical polarized light, Retardation Plate, Polarimeter.

Laser: Spontaneous and stimulated emission of radiation, Population inversion, Concept of 3 and 4 level Laser, Construction and working of Ruby, He-Ne lasers, and laser applications.

UNIT-II : Quantum Mechanics and Fiber Optics: 9

Quantum Mechanics: de Broglie waves, Davisson-Germer experiment, Concept of Phase and Group velocities, Uncertainty principle and its applications, Derivation of time independent and time dependent Schrodinger wave equations. Postulates of quantum mechanics, Significance of wave function, Application of Schrodinger wave equation for a particle in one dimensional infinite potential well.

Fiber Optics: Fundamentals of optical fiber, Acceptance angle and cone, Numerical aperture, Single and Multi-Mode Fibers, Step index and graded index fiber, Propagation Mechanism in optical fibers.

UNIT-III: Electrodynamics: 9

Scalar and Vector fields, Gradient, Divergence and curl, Concept of displacement current, Maxwell's equation in differential and integral forms, Physical significance of each equation.

Maxwell's equation in free space, Velocity of electromagnetic wave, Transverse nature of the electromagnetic wave, Poynting vector, Maxwell's equations in dielectric and conducting medium, and skin depth.

UNIT-IV: Physics of Advanced Materials: 9

Concept of energy bands in solids, Semiconducting materials**,** Concept of direct and indirect band gap in semiconductors, Carrier concentration and conductivity in semiconductors, Optoelectronic Materials, Superconducting Materials**,** Temperature dependence of resistivity in superconducting materials, Effect of magnetic field (Meissner effect), Type I and Type II superconductors, London Equations, BCS theory (Qualitative), Introduction of nanoscience, Nanotechnology and its applications.

EXPERIMENTS

1. To determine the specific resistance of a given wire using Carrey Foster's Bridge.
2. To determine the wavelength of sodium light using Newton's Ring experiment.
3. To determine the wavelength of spectral lines of white light using plane diffraction grating.
4. To determine the specific rotation of cane sugar solution using polarimeter.
5. To study the variation of magnetic field along the axis of current carrying circular coil.
6. To study the Hall's effect and to determine Hall coefficient in n type Germanium.
7. To study the energy band gap of Germanium using four probe method.
8. To determine the height of Tower by Sextant.

Books & References

1. Optics- Ajoy Ghatak, Tata McGraw-Hill
2. Optics- N. Subrahmanyam, Brij Lal, M.N. Avadhanulu, S. Chand
3. Quantum Mechanics: Theory and Applications- Ajoy Ghatak, Tata McGraw-Hill
4. Fiber optics and laser Principles and Applications-Anuradha De, New Age International
5. Optical Fibers and its application as sensors by R. K. Shukla, New Age International.
6. Introduction to Electrodynamics by David J. Griffiths, Pearson
7. Physics of Semiconductor Devices, by S. M. Sze, Wiley
8. Concepts of Modern Physics by Arthur Beiser, Tata MCGraw Hill.
9. Introduction to Solid State Physics by C. Kittel, Wiley.
10. Engineering Physics by B. K. Pandey and S. Chaturvedi, 3e Cengage Learning Pvt. Limited, India.
11. Engineering Physics by H. K. Malik and A. Singh Tata MCGraw Hill.
12. Advanced Practical Physics Vol. I and Vol. II by D. K. Dwivedi, Victorius Publishers, New Delhi.

BEE-110/160 Basic Electrical Engineering

Course category	:	Engineering Fundamentals (EF)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	:	4

Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	:	**1.** To demonstrate and understand the basic knowledge of electrical quantities such as current, voltage, power, energy, and frequency to understand the impact of technology in a global and societal context. **2.** To demonstrate and understand the basic concepts of analysis of simple DC and AC circuits used in electrical engineering and apply the basic concepts in Electrical engineering for multi-disciplinary tasks.

Course Outcomes: The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course:

1. Understand the basic properties of electrical elements, and solve problem based on basic electrical circuits & DC network theorems.
2. Understand the fundamental behaviour of AC circuits and solve AC circuit problems.
3. Apply the knowledge gained to explain the behaviour of the circuit at series & parallel resonance of circuit & the effect of resonance.
4. Classify different electrical measuring equipment's and understanding their principles.
5. Understand the basic concepts of magnetic circuits.
6. Explain construction and working principle of transformer.

Topic Covered

UNIT I

D C Circuit Analysis and Network Theorems: **9**

Circuit Concepts: Concepts of network, Active and passive elements, Voltage and current sources, Concept of linearity and linear network, Unilateral and bilateral elements, R, L and C as linear elements, Source transformation, Kirchhoff's laws, Loop and nodal methods of analysis, Star-delta transformation, Network theorems: Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem.

UNIT II

Introduction to AC Circuits: **9**

AC fundamentals, Analysis of single phase series, parallel and series-parallel RLC Circuits, Resonance in series and Parallel circuit.

Three Phase AC Circuits: Three phase system-its necessity and advantages, Star and delta connections, Balanced supply and balanced load, Line and phase voltage/current relations, three-phase power, and its measurement.

UNIT III

Measuring Instruments: **9**

Fundamentals of measurement & instrumentation, Units, Dimensions and Standards. Error Analysis, types of errors & its analysis. Measuring instruments, construction and working principles of PMMC, Moving Iron and Electro-dynamometer type voltmeters & ammeters, Use of shunts and multipliers.

UNIT IV **9**

Magnetic Circuits and Transformers:

Magnetic circuit concepts, analogy between electric & magnetic circuits, B-H curve, Hysteresis, and eddy current losses.

Single Phase Transformer: Principle of operation, Construction, EMF equation, Power losses, Efficiency, O.C & S.C Test and Introduction to auto transformer.

EXPERIMENTS

1. Verification of Kirchhoff's Law.
2. Verification of Norton's Theorem.
3. Verification of Thevenin's Theorem.
4. Verification of Superposition Theorem.
5. Verification of Maximum Power Transfer Theorem.
6. Verification of Series R-L-C circuit.
7. Verification of Parallel R-L-C circuit.
8. Measurement of Power and Power factor of three phase inductive load by two wattmeter method.
9. To perform O.C. and S.C. test of a single-phase transformer.

Textbooks:

1. Fundamentals of Electric Circuits, C.K. Alexander and M.N.O. Sadiku; TATA McGraw-Hill.
2. Principles of Electrical Engineering, V. Del Toro; Prentice Hall International.
3. Electrical and Electronics Technology, Edward Hughes; Pearson.
4. Basic Electrical Engineering, D P Kothari, I.J. Nagarath; Tata McGraw Hill
5. Electrical Technology, B. L. Thareja and A. K. Thareja; S. Chand.

BME-157		**Engineering Graphics with AutoCAD**
Course category	:	Professional Skill
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 2, Tutorial: 0, Practical: 4
Number of Credits	:	4
Course Assessment Methods		Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objective	:	This course aims at the following educational objectives: Comprehend general projection theory, with emphasis on orthographic projection to represent three- dimensional objects in two-dimensional views (principal, auxiliary, sections). Dimension and annotate two-dimensionalengineering drawings.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. How Engineering Drawing helps to sketch the imagination?
2. Able to effectively practice the different scales for drawings.
3. Effectively analyze the geometrical shapes and to be able to draw.
4. Know about out solids and discuss about their classification.
5. How to implement the different views for a solid placed in 3dspace.
6. Construction of the object from different perspective.

Topics Covered

UNIT-I 6

Conic Sections and Orthographic Projections Introduction

Introduction to Engineering Drawing covering, Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales.

Orthographic Projections

Orthographic Projections covering Principles of Orthographic Projections- Conventions Projections of Points and lines inclined to both planes; Projections of planes inclined Planes -Auxiliary Plane

UNIT-II **6**

Projection of Regular Solids

Projections of Regular Solids covering those inclined to both the Planes- Auxiliary Views

UNIT-III **6**

Sections and Sectional Views of Right Angular Solids

Sections and Sectional Views of Right Angular Solids covering, Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid,Cylinder and Cone.

UNIT-IV **6**

Isometric Projections

Isometric Projections covering, Principles of Isometric projection – Isometric Scale,Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions. Overview of computer graphics, demonstrating knowledge of the theory of CAD software.

List of experiments

1. To perform lettering practice using BIS standards, including capital letters, small letters, and numerals
2. To construct a Cycloid, Epicycloid, Hypocycloid, and Involute of a Circle for the given dimensions.
3. To draw the orthographic projections of a regular solid (Prism, Pyramid, Cylinder, or Cone) inclined to both HP and VP using the auxiliary view method.
4. To obtain the auxiliary view of a given regular solid and show its true shape and dimensions.
5. To draw the sectional views of a cylinder or cone using the auxiliary view method.
6. To develop the lateral surface of a Prism, Pyramid, Cylinder, or Cone for the given dimensions.
7. To draw the development of a truncated solid after sectioning by an inclined plane.
8. To draw the isometric projection and isometric view of the given simple or compound solid using an isometric scale.
9. To explain the principles of computer graphics and the theory of CAD software, and prepare a simple engineering drawing using CAD tools.

10. To convert the given orthographic views into an isometric view and vice versa.

Text & Reference books:

1. Engineering Drawing-Bhat, N.D.& M. Panchal, Charotar Publishing House, 2008
2. Engineering Drawing and Computer Graphics- Shah, M.B. & B.C. Rana, Pearson Education,2008
3. A Textbook of Engineering Drawing-Dhawan, R.K., S. Chand Publications,2007
Textbook on Engineering Drawing-Narayana, K.L. & P Kannaiah, Scitech Publishers, 2008

BHS- 101/151 Universal Human Values: Understanding Harmony

Course Category	: HSS
Prerequisite subject	: None
Number of Credits	: 4
Contact Hours/Week	: Lectures: 3, Tutorial: 1, Practical: 0
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	: The objectives of this course are to: -

1. Develop a holistic perspective in students based on self-exploration about themselves (human being), family, society and nature/existence.
2. Develop understanding (or developing clarity) in students about harmony in the human being, family, society and nature/existence.
3. Strengthen self-reflection in students.
4. Develop commitment and courage in students to act.

Course Outcomes : The students will be able to demonstrate the following knowledge, skills, and attitudes upon completion of the course: -

1. Ability to understand the interconnectedness of humanity and nature as well as the importance of values in interpersonal relationships.
2. Ability to recognize their role as global citizens and understand the importance of actively contributing to the betterment of society through responsible actions.
3. Ability to engage in critical reflection on their own values and beliefs, challenging assumptions and biases to foster personal growth and development.
4. Ability to appreciate and respect diversity thereby promoting communication and conflict resolution skills, promoting dialogue and understanding in resolving interpersonal and intergroup conflicts.

Unit 1 **9**

Introduction to Values: origin, definition, meaning, and types of values; Values in Education System; difference between Values, Morals, and Ethics; Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and 'Experiential Validation' as the process for self-exploration; Continuous Happiness and Prosperity- A look at basic human aspirations; Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority; Understanding Happiness and Prosperity correctly- A critical appraisal of the current

scenario; Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Unit 2 **9**

Understanding human being as a co-existence of the sentient 'I' and the material 'Body'; Understanding the needs of Self ('I') and 'Body' - happiness and physical facility; Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer); Understanding the characteristics and activities of 'I' and harmony in 'I'; Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail; Programs to ensure Sanyam and Health.

Unit 3 **9**

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship; Understanding the meaning of Trust; Difference between intention and competence; Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship; Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals; Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Unit 4 **9**

Understanding the harmony in the Nature; Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature; Understanding Existence as Co-existence of mutually interacting units in all-pervasive space; Holistic perception of harmony at all levels of existence; Natural acceptance of human values; Definitiveness of Ethical Human Conduct; Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order; Competence in professional ethics.

Text & Reference Books:

1. Andrews, C. (2006). *Slow is beautiful*. New Society Publishers.
2. Gandhi, M. K. (1909). *Hind Swaraj or Indian Home Rule*. Navjeevan Trust.
3. Gandhi, M. K. (2009). *An Autobiography or The Story of My Experiments with Truth* (Mahadev Desai, Trans.). Navjeevan Mudranalay. (Original work published 1925).
4. Gaur, R. R., Sangal, R., & Bagaria, G. P. (2010). *A Foundation Course in Human Values and Professional Ethics*. Excel Books.
5. Govindrajan, M., Senthilkumar, S., & Natarajan, M. S. (2013). *Professional Ethics and Human Values*. Prentice Hall India.
6. Kumarappa, J. C. (2017). *Economy of Permanence.* Sarva Seva Sangh Prakashan.
7. Naagarazan, R. S. (2022). *A Textbook on Professional Ethics and Human Values*. New Age International.
8. Rolland, R. (2010). *Life of Vivekanad* (4th Ed.). Advait Ashram.
9. Schumacher, E. F. (1973). *Small is beautiful. A study of Economics as if people mattered*. Blond & Briggs.
10. Suresh, J., & Raghavan, B. S. (2003). *Human Values and Professional Ethics*. S Chand.

BHS- 102/152 TECHNICAL WRITING AND PROFESSIONAL COMMUNICATION (TW&PC)

Course Category	: HSS
Prerequisite subject	: None
Number of Credits	: 4
Contact Hours/Week	: Lectures: 2, Tutorial: 1, Practical: 2
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	: The objectives of this course are to: -

The course aims-

1. To sensitize the students to understand the role and importance of communication for personal and professional success.
2. To enable the learners to enhance their writing skills in techno-cultural and professional echo-system.
3. To equip learners to differentiate technical writing from general writing.
4. To equip them with technical writing skills.
5. To enable learners to exhibit knowledge, skills, attitude and judgment in and around human communication that facilitate their ability to work collaboratively with others in an interpersonal environment.

Course Outcomes : The students will be able to demonstrate the following knowledge, skills, and attitudes upon completion of the course: -

1. Overcome the problems she/he shall faces in oral and written communication.
2. Acquire knowledge of and methods for using technical communication, such as reports, proposals, technical letters, etc.
3. Use and Practice compositions correctly.
4. Give presentations in different sessions and make self-appraisal.
5. Learn and understand the various facets of Communication Skills, such as (LSRW) Listening, Speaking, Reading, and writing, and identify, formulate, and solve real-life problems with a positive attitude; also inculcate, the habit of learning and developing communication and soft skills.

Unit 1: Language and Communication **6**

Language Vs communication: Communication as coding and decoding – signs, symbols & pictograph – verbal and non–verbal symbols – Language & communication; Types ofCommunication- functional, situational, verbal, and non-verbal, interpersonal, group, interactive, public, Mass Communication. Thinking and Articulation, critical, creative aspects of articulation.

Skills of Language Acquisition: Natural Language Acquisition Skills: Listening, Speaking, Reading & Writing {LSRW}; Language Acquisition Through Training: Listening, Speaking, Reading, Writing, Grammar & Vocabulary {LSRWGV}

Phrase, Clause & Sentence in Professional Drafting-Simplicity, Clarity and Conciseness of a Presentation, differentiating between Professional and Creative Writing, Blending of Artistic/Professional Writing, Avoiding gender, racial, and other forms of bias in Professional Writing.

Pre-writing, Drafting, and Re-writing.

Unit 2: Towards Technical Writing **6**

Technical Paper Writing: Professional Paper Elements-Front Matter of a Paper, Main Text of a Paper, End Matter of a Paper: Organizing References and Bibliography, Order of a thesis and Paper Elements, Concluding Remarks. **Methods of Research Paper Writing:** Identification of Author and His Writing-Author's name and Affiliation, Joint Authorship of a Paper, Identification of Writing- Title, Keywords, Synopsis, Preface and Abstract. Drafting Research Article & Methodology.
Thesis/Dissertation Writing: Thesis Elements-Front Matter of a Thesis, Main Text of a Thesis, End Matter of a Thesis, Specimen—Thesis and Research Paper, Chapters and Sections-Introductory Chapters and Sections, Statement of the Problems, Plan and Scope, Core Chapters and Sections-Theoretical Analysis and Synthesis, Basic Assumption and Hypothesis.
Professional Presentation & Seminar Delivery Tools: Designing the Presentation; Establishing the Objectives. Making Professional PowerPoint Presentations, Signaling Structure of Presentation through Sentences and Crisp Phrases, Preparing Notes for Professional/Technical Presentation, Text Animation, White Board, Flip Charts, Diagrams, Preparing Cards. Seminar Presentations: Purpose modes and methods. Nascent Emerging Platforms for On-line Presentations viz. Zoom, Webex, Team& Meet etc.

Unit 3: Drafting Skills & Career Correspondence **6**

Professional Drafting: Letters vs. e-mails, Formal and Informal emails, Parts of e-mails, Types of e-mails, Managing tone of E-mails and business Letters, Examples of Letters and E-mail, Professional Correspondence through E-mail, Job Applications and cover Letters. Introduction to DOs (Demi-Official Letters)

Career & Correspondence: Developing a Professional C.V, Bio Data & Resume. Report Writing, Kinds of Reports, Length of Report, Parts of a Report, Terms of Reference, Collection of Facts, Outlines of Report, Examples of Report, Technical Proposal, Elements of Proposal, Examples of Proposal, drafting of proposal.

Unit 4: Professional Practices with ICT Interface **6**

Conducting Professional Meeting: Pre-meeting Preparation, During Meeting: Action Taken Report (ATR) & New Agenda Points, Post Meeting Follow ups. Notice, Circular, Agenda & Meeting Minutes.
Introduction to Generation–Z, Cyber Identity & Professional Netiquettes for Netizens: Drafting E-mails, Blogs on social media, Videoconferencing. Managing Profiles on social media. What to Write and Share on social media. Telephone Etiquettes & Phubbing.

List of Practical:

1. Introduction to Vowel and Consonant Sounds
2. Monophthongs and Diphthongs
3. Syllable, Word Stress & Intonation
4. Harnessing Non-verbal Communication Skills in Cross-Cultural Environment for the establishment of an ideal Ecosystem to ensure Professional Success
5. Developing Speech, and Proofreading the Same
6. Argumentative Skills & Group Dynamics
7. Preparing CV, Biodata & Resume
8. Types of Interview and Interview Skills

9. GD, PI & Telephonic Interview
10. Presentation Skills, Extempore, Debate and Video Conferencing
11. Netiquettes while Writing Blogs on social media.
12. Ethical Usages of Generative AI

Text / Reference Books

1. Acharya Anita. (2012) Interview Skills- Tips & Techniques. Yking Books, Jaipur.
2. Basu, B. N., (2008) Technical Writing. PHI Learning Pvt. Ltd, New Delhi.
3. Chauhan, N. K & Singh, S. N. (2013) Formal Letters, Pankaj Publication International, New Delhi.
4. Chhabra T.N. (2018) Business Communication. Sun India Publication New Delhi.
5. Dubey Arjun et.al. (2016) Communication for Professionals. Alfa Publications, Delhi.
6. Gibaldi, Joseph (2021). The MLA Handbook for Writers of Research Papers. Ed. IXth, ModernLanguage Association of America, NY, US.
7. Gurumani, N. (2010) Scientific Thesis Writing and Paper Presentation, MJP Publishers, Chennai.
8. Hamilton Richard. (2009) Managing Writers. Penguin, India.
9. Mc Graw S. J. (2008) Basic Managerial Skills for All. Ed. 08th, Prentice Hall of India, New Delhi.
10. Murphy & Hildebrandt. (2008) Effective Business Communication. Tata McGraw Hill New Delhi.
11. Pandey, S.P., Singh, S. N. & Kumar, Raman, (2023) Exploring Digital Humanities: Challenges & Opportunities, MacBrain Publishing House, New Delhi.

BME - 158	**Engineering Innovation & Design**
Course category:	Engineering Fundamental (EF)
Pre-requisite Subject:	NIL
Contact hours/week:	Lecture: 0, Tutorial: 0, Practical: 2
Number of Credits:	1
Course Assessment methods:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination

Course Objectives

1. To familiarize product design process
2. To introduce the basics of design thinking
3. To bring awareness on idea generation
4. To familiarize the role of design thinking in services design

Course Outcomes: The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

1. Students will be able to visualize the need for engineering for serving the society better
2. To explain the concept of design thinking for product and service development
3. To explain the fundamental concept of innovation and design thinking
4. To discuss the methods of implementing design thinking in the real world.
5. Students will be able to identify needs and be able to suggest different alternative solutions considering cost constraints.
6. Students will enhance the possibility of taking up entrepreneurship activity, possibility of coming up with new ideas leading to IPR.

UNIT-I

Introduction Design & innovation, Who designs & develops products, Industrial & Practical examples. Projects.

UNIT-II

Creative thinking- Invention- innovation & inventiveness in a society.

UNIT-III

A Generic Development Process & Concept Development. Identifying Customer Needs, Concept Generation, Concept Selection

UNIT-IV

Product Architecture, Industrial Design, Intellectual Property Rights

Textbooks

1. Product Design & Development- Karl T. Ulrich, Steven D Eppinger, McGraw Hill
2. Publishers.
3. Gerard Voland, Engineering by Design, Pearson,
4. Human Factors in Engineering Design- Mark S sanders & Ernst J. Mc Cornick McGraw Hill
5. Publishers.
6. https://ocw.mit.edu/courses/esd-051j-engineering-innovation-and-design-fa

B.Tech Second year

BSM-214/264		**Numerical Methods**
Course category	:	Basic Sciences & Maths (BSM)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial : 0 , Practical: 2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and One Minor tests and One Major Theory & Practical Examination.
Course Objectives		The objective of this course is to introduce a broad range of numerical methods for solving mathematical problems that arise in science and engineering.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.
2. To find the root of a function using Bisection, Regula falsi, Newton's Method, Aitken's method.
3. To interpolate a curve using Gauss, Newton's interpolation formula.
4. To solve the first order boundary value problem.
5. To develop an understanding of the fundamentals in finding the numerical solutions of the system of equations and to find the eigen value of the matrix.
6. Demonstrate the concepts of numerical methods used for different applications.

Topics Covered

UNIT-I 9

Roots of equation: Bisection method, Regula Falsi Method, Secant Method, Fixed point Iteration Method, Newton Raphson Method, Modified Newton Raphson Method for Multiple roots, derivation of rate of convergence, Aitken Method.

UNIT-II 9

Solutions of system of Linear equations and Eigen Value problem: Linear equations: Direct method for solving systems of linear equations (Gauss elimination, Gauss Jordan, LU Decomposition, Cholesky Decomposition), Iterative methods (Jacobi, Gauss Seidel, Relaxation method). Algebraic Eigen value problem: Power method, Jacobi's method, Given's method.

UNIT-III 9

Interpolations, and Numerical Integration: Relationship in various difference operators, Newton`s Forward and Backward Interpolation, Lagrange and Newton divided difference interpolation, Newton`s Cotes Formula, Trapezoidal Rule, Simpson's 1/3 and 3/8 rule, Gauss Quadrature Formula, Chebyshev's Formula, Piecewise Linear Interpolation, Cubic Spline Interpolation.

UNIT-IV 9

Numerical solution of Ordinary differential equations, and Difference Equation: Single Step Methods: Taylor, Picard, Euler, Modified Euler, and Runge-Kutta Fourth Order Methods. Multistep methods: Milne's and Adam's predictor and corrector methods. Difference equations and their solutions, Rules for finding the particular integral.

EXPERIMENTS

1. To implement Regula-Falsi method to find root of algebraic equation.
2. To implement Newton-Raphson method to find root of algebraic equation.
3. To implement Newton's Divided Difference formula to find value of a function at a point.
4. To implement Numerical Integration by using Simpson's one-third rule.
5. To implement numerical solution of differential equation by Picard's method.
6. To implement numerical solution of differential equation by using Euler's method.
7. To implement numerical solution of differential equation by using Runge – Kutta Method.

Books & References

1. M.K. Jain, S.R.K. Iyenger and R.K. Jain, Numerical Methods:, New Age Publishers.
2. P. *Kandasamy*, K.Thilagavathi, K.Gunavathi , *Numerical Methods*., S. Chand & Company.
3. B.S. Grewal; Higher Engineering Mathematics, Khanna Publishers, Delhi.
4. B.V. Ramana; Higher Engineering Mathematics, Tata Mc. Graw Hill Education Pvt. Ltd., New Delhi.
5. Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, Asia, New Delhi

BME-205 Basics of Mechanical Engineering

Course category : Engineering Fundamental (EF)

Pre-requisite Subject : NIL

Contact hours/week : Lecture: 3, Tutorial: 0, Practical: 2

Number of Credits : 4

Course Assessment methods : Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and One test examinations and One Major Theory & Practical Examination

Course Objectives : The objective of this course is to provide the student with knowledge of concepts of basic mechanical engineering in the field of mechanics of forces along with heat transfer and their applications.

Course Outcomes : Upon completion of this course, the student will demonstrate the ability to:

- Understand the laws of mechanics, two-dimensional force systems, equivalent force system, types of friction and its application in belt drives.
- Determine centroid of plane composite surfaces and moment of inertia of composite bodies.

- Understand the relationships of kinematic quantities of rigid bodies involving linear, curvilinear and angular motions and the applications of force in kinetics of rigid bodies.
- Understand the nature of the thermodynamic processes for pure substances as well as ideal gases and ability to demonstrate the Zeroth law and First Law of Thermodynamics.
- Apply the First Law of Thermodynamics for control surface and control volume systems and demonstrate the Second Law of Thermodynamics and its application to various systems.
- Demonstrate the use of Second Law of Thermodynamics for entropy balance analysis of different Thermodynamics processes of systems.

Topics Covered

UNIT-I 9

Two-dimensional Force Systems: Basic Concepts, Laws of Mechanics, System of forces, Equivalent force system, Resultant of concurrent and non-concurrent force system, Free body diagrams, Equations of equilibrium, Applications; Trusses and frames

Friction and its Applications: Types of friction, Laws of Coulomb friction, Basics terminologies; Friction applications including rolling friction, belt-pulley; brakes and clutches, screw jack & wedge, vehicles, etc.; Centrifugal tension, Initial tension.

UNIT-II 9

Properties of Plane Surfaces

First moment of area, Centroid of a plane and composite bodies joined by different surfaces, Moment of Inertia of area, Parallel axis theorem, Perpendicular axis theorem, Moment of inertia of composite bodies.

Kinematics of a rigid body

Introduction, Plane motion of a rigid body, Linear motion, Translation of a point with constant acceleration, Equation of motion due to gravity, Angular motion, Curvilinear motion of a particle, General plane motion, Concept of virtual work.

Kinetics of rigid body

Introduction, Kinetics of rigid bodies, Motion on inclined rough surface, Analysis of lift motion, Work and energy, Impulse and momentum, D'Alembert's principle.

UNIT-III 9

Fundamental Concepts and Definitions:

Introduction and definition of thermodynamics, Microscopic and Macroscopic approaches, Systems, surroundings and universe, Control system boundary, control volume and control surface, Properties and state, Thermodynamic properties, Thermodynamic path, process and cycle, Thermodynamic equilibrium, Reversibility and irreversibility, Quasi static process, Work and heat, Gas laws, Ideal gas, Real gas.

Zeroth law of thermodynamics

Zeroth law of thermodynamics, Temperature and its measurement, Temperature scales.

First law of thermodynamics I

Thermodynamic definition of work, Thermodynamic processes, Calculation of work in various processes and sign convention, non-flow work and flow work, Joule's experiment, First law of thermodynamics, Internal energy and enthalpy.

UNIT-IV 9

First law of thermodynamics-II

First law of thermodynamics applied to open systems, Steady flow systems and their analysis, Applications, Limitations of first law of thermodynamics, PMM-I.

Second law of Thermodynamics

Introduction, Thermal reservoir, Kelvin Planck and Clausius statement, Concepts of Heat engines, heat pump and refrigerator, Reversible and irreversible processes, Carnot cycle and Carnot engine, Carnot theorem and it's corollaries, PMM-II.

Entropy

Clausius inequality, Concept of Entropy, Entropy change in different thermodynamic processes, TdS equation, Principle of entropy increase, T-S diagram, Statement of the third law of thermodynamics.

List of Practical:

1. Static experiments on equilibrium
2. Experiment on jib and tie.
3. Friction experiments on an inclined plane
4. Experiments on friction between belt and pulley
5. Experiment on moment of inertia
6. Experiments on flywheel
7. Study of Fire Tube boiler
8. Study of Water Tube boiler
9. Study of Steam Engine model
10. Study of Gas Turbine Model

Textbooks and References:

1. Engineering Mechanics: Principles of Statics and Dynamics R. C. Hibbler, (Pearson Press).
2. Engineering Mechanics: Statics and dynamics - I.H. Shames (PHI)
3. J. L. Meriam and L. G. Kraige, Engineering Mechanics, Vol I – Statics, Vol II –Dynamics, J. L. Meriam and L. G. Kraige (John Wiley).
4. Engineering Mechanics -S S Bhavikatti (New Age International)
5. Engineering Mechanics - D S Kumar (Katson)
6. Engineering Thermodynamics - P.K. Nag (Tata McGraw Hill)
7. Thermodynamics - J.P. Holman (McGraw Hill)
8. Engineering Thermodynamics - Jones and Dugans (PHI Learning Pvt. Ltd)

BME-206	**Mechanics of Solids**
Course category	: PC
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	: 4
Course Assessment methods	: Continuous assessment through attendance, home assignments, quizzes, practical work, record, viva voce and Minor test and One Major Theory & Practical Examination
Course Objectives	: To develop skills for analyzing solid mechanics problems and to provide with fundamental knowledge of the strength of materials.

Course Outcomes : Upon completion of this course, the student will demonstrate the ability to:

1. Understand the concept of internal forces and moments, stress, strain, deformations in members subjected to axial, bending and torsional loads.
2. Apply the concepts of Solid Mechanics on application based combined mode of loading.
3. APPLY the concept of principal stresses and theories of failure to determine stresses on a 2-D element
4. Apply the concepts to calculate stress, strain, and displacements in mechanical structures and components containing the fundamental elements such as beams.
5. Apply the concepts to calculate stress, strain, and displacements in mechanical structures and components containing the fundamental elements such as shafts, shells and springs
6. Analyze the mechanical engineering structures and components for safer mechanical design by considering appropriate failure criteria and the design requirements.

Topics Covered

UNIT-I: **Analysis of Stress and Strain** 9

Uniaxial Stress and Strain, Hooke's Law, Stress-Strain Curves, Elastic Constants, Strain Energy, Statically Indeterminate Problems, Thermal Effects, Impact Loading. Biaxial Stress and Strain: Stress at a Point, Stress Transformation, Analysis of Strain, Strain-Displacement Relations, Strain Transformation, Principal Stresses and Strain, Mohr's Circle

UNIT-II Deflection of Beams 9

Bending and Shear Stresses: Shear Force and Bending Moment Diagrams, Pure ending, Normal Stress and Shear Stresses in beams, Composite Beams, Deflections of Beams: Equation of Elastic Curve, Methods for Determining Deflections: Double Integration, Macaulay's Method, Moment-Area Method, Castigliano's Theorem

UNIT-III Torsion of Shaft, Springs 9

Torsion of Circular Shaft, Power transmitted by a Shaft, Compound Shaft, Combined Loadings, Springs (Open and Closed Coils), Columns: Euler's Theory for Long Columns, Rankine-Gordon Formula, Eccentrically Loaded Columns

UNIT-IV Theories of failure and Pressure Vessels 9

Thin cylindrical and spherical shells: Hoop and Longitudinal stresses and strain, cylindrical shell with hemispherical ends, Volumetric strain, Wire wound cylinders, spherical shell.

Thick cylindrical shell: Stresses in thick cylinders subjected to internal or external pressures, Compound cylinders, Stresses due to interference fits.

Columns and Struts: Classification, Euler's theory for long column for different end conditions, Limitations, Rankine formulae for struts/columns. Introduction to other theories.

List of Practical:

1. Deflection test on Cantilever beam
2. Deflection test on simply supported beam
3. Torsion test

4. Spring test
5 Izod Impact test
6. Tensile test using UTM
7. Charpy impact test on a metal specimen
8. Flexural strength of a beam
9. Compressive Test on Cube
10. Brinell hardness test
11. Rockwell hardness test

Textbooks and References:

1. Mechanics of Materials, F. P. Beer, E. R. Johnston, John T. Dewolf, David F. Mazurek, Sixth Edition
2. Mechanics of Materials - E. J. Hearn, Third Edition
3. Strength of Materials-S Timoshenko
4. Mechanics of Materials-J.M Gere and B J Goodno.
5. Engineering Mechanics of Solids – Egor P. Popov (Pearson)
6. Advanced Mechanics of Materials, A.P. Boresi & R J Schmidt (Wiley)
7. Strength of Materials-R. K. Rajput (S. Chand)
8. Strength of Materials-R.K. Bansal (Laxmi Publications)
9. Strength of Materials-S S Ratan (McGraw Hill Education)

BME-207 **Material Science & Engineering**

Course category : **Professional Core (PC)**

Pre-requisite Subject : NIL

Contact hours/week : Lecture: 3, Tutorial: 0, Practical: 2

Number of Credits : 4

Course Assessment methods : Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and one Minor tests and One Major Theory & Practical Examination

Course Objectives : This course introduces basic concepts of material and their applications for engineering problems based on the concepts of crystallography, mechanical properties and testing. This course also introduces the concept of microstructural examination and various heat treatment processes.

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course:

1. Understand the various types of materials with their basic concepts including crystallography and imperfections.
2. The understanding of the various mechanical properties and testing by different testing methods such as strength, hardness, fatigue, etc.
3. The knowledge of Phase diagrams and equilibrium diagram.
4. The knowledge of different heat treatment processes, TTT diagram, and their application.
5. The knowledge of metallography, NDT and corrosion
6. The knowledge of different ferrous, non-ferrous metals and advanced materials & their applications.

Topics Covered

UNIT-I 9

Classification and Structure of Materials

Introduction, Classification of materials, Concept of unit cell, space lattice, Bravais lattices, common crystal structures, atomic packing factor and density. Miller indices, **i**mperfections, Defects & Dislocations in solids

Mechanical Properties and Testing

Stress strain diagram, Ductile and brittle materials, strength, toughness, hardness, fracture, fatigue and creep. Testing, such as Strength test, Hardness test, Impact test, Fatigue test & Creep test.

UNIT-II 9

Phase Diagram and Equilibrium Diagram

Unary and Binary diagrams, Phase rules, Types of equilibrium diagrams: solid solution type, eutectic type and combination type, Iron-carbon equilibrium diagram.

Heat Treatment: various types of heat treatment, such as Annealing, Normalizing, Quenching, Tempering and Case hardening. Time Temperature Transformation (TTT) diagrams. Recovery, Recrystallization and Grain Growth

Strengthening mechanisms: strain hardening, grain size hardening, solid solution hardening and age hardening.

UNIT-III 9

Metallography:

Microscope principle and methods, Sample preparation, microstructure examination, grain size determination, comparative study of microstructure of various metals and alloys, such as Mild steel, Cast Iron, Brass etc., Electron Microscopy, X-ray crystallography techniques Non-destructive testing (NDT)

Corrosion and its prevention.

UNIT-IV 9

Ferrous metals

Iron and steel, various types of steels and cast irons, its properties and applications.

Non-ferrous metals,

Copper and its alloys, Aluminum and its alloys, Nickel, Zinc, Tungsten, Titanium etc.

Advanced materials

Composite materials, Biomaterials, Optical materials, Smart materials & Nanomaterials

EXPERIMENTS

Minimum Eight experiments are to be conducted from the following:

1. Tensile test on universal testing machine
2. Compression test on universal testing machine
3. Impact test of given specimen on impact testing machine
4. Hardness test of given specimen on hardness testing machine
5. Study of corrosion and its effects.
6. Study of Metallurgical microscope.
7. To practice the techniques of sample preparation for microscopy.
8. To observe the microstructure of ferrous metal (mild steel and cast iron).
9. To observe the microstructure of non-ferrous metal (Aluminum, copper, brass etc.)
10. Comparative study of microstructures of different specimens of different materials (mild steel, gray C.I., brass, copper etc.)

11. Heat treatment experiments such as annealing, normalizing, quenching and comparison of hardness before and after heat treatment.
12. To perform nondestructive testing methods such as ultrasonic flaw detector

Text & Reference books:

1. Materials Science and Engineering: An Introduction by William D. Callister Jr., David G. Rethwisch (Wiley India Pvt. Ltd.)
2. Materials Science and Engineering: A First Course by Raghavan V. (Prentice Hall of India)
3. Mechanical Metallurgy by George E. Dieter (McGraw Hill Education)
4. Elements of Material Science and Engineering by Lawrence H. Van Vlack (Pearson)
5. Material Science and Engineering – Smith, Hashemi and Moreno (McGraw Hill)

BME-208		**Theory of Machines**
Course category	:	PC
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through attendance, home assignments, quizzes, practical work, record, viva voce and Minor test and One Major Theory & Practical Examination
Course Objectives	:	To develop skills for analyzing linkages, cams, gears and other mechanisms and to provide with fundamental knowledge of dynamics of machines so that students can appreciate problems of dynamic force balance.
Course Outcomes	:	Upon completion of this course, the student will demonstrate the ability to:

1. Apply the graphical methods and analytical Computations involved in the mechanisms to analyze the position, velocity and acceleration of a mechanism.
2. Draw velocity and acceleration diagrams for cams and followers executing various kinds of motions for various configuration of followers.
3. Analyse the gyroscopic effects on disks, airplanes, stability of ships.
4. Select gear and gear trains for a particular application in automobile and various industries employing gears as power transmission tools.
5. Mathematically model and analyze the effects of the static and dynamic forces that mechanisms/machines may experience commonly and work upon the control of fluctuations of energy
6. Solve the problems associated with the unbalance present in rotating and reciprocating masses.

Topics Covered

UNIT-I: **Velocity and Acceleration in Mechanism** 9

Introduction to Kinematic Links and Pairs, Inversion of Mechanism, Velocity of a Link, Relative Velocity Method, Instantaneous Center Method, Kennedy's Theorem for Three Centers, Acceleration Diagram, Coriolis Component of Acceleration.

UNIT-II Cams and Gyroscope 9

Classification of Cams and Followers, Nomenclature, Types of Follower Motion, Generation of Cam Profile with Uniform Velocity, SHM, Uniform Acceleration and Retardation, Cycloidal Motion of The Follower.

Gyroscopic Motion Principles, Gyroscopic torque, Effect of gyroscopic couple on the stability of aero planes & automobiles

UNIT-III Gear and Gear Trains 9

Types. Terminology, Fundamental Law of Gearing, Gear Profiles, Undercutting, Gear Trains: Simple, Compound, Reverted and Epicyclic Gear Trains.

UNIT-IV Force Analysis and Balancing 9

Static and Dynamic Force Analysis-Static Force Analysis of Planar Mechanisms, Dynamic Force Analysis Including Inertia and Frictional Forces of Planar Mechanisms, Turning Moment Diagram for Engines and Speed Fluctuation, Flywheel. Balancing of Rotating and Reciprocating Masses- Static Balance, Dynamic Balance, Balancing of Rotating Masses

List of Practical:

1. Study of simple linkage models/mechanisms
2. Study of inversions of four bar linkage
3. Study of inversions of single/double slider crank mechanisms
4. Experiments on friction
5. Experiment on gyroscope
6. Experiment on Gear trains
7. Experiment on Gears tooth profile, interference etc.
8. Experiment on static/dynamic balancing

Textbooks and References:

1. Kinematics & Dynamics of Machinery by R. L. Norton, McGraw Hill
2. Kinematics, Dynamics and Design of Machinery by K.J. Waldron & G. L. Kinzel, Wiley
3. Theory of Machines and Mechanisms by John J. Uicker, Jr. Gordon R. Pennock& Joseph E. Shigley, Oxford University Press.
4. Theory of Machines by S.S. Ratan, Tata McGraw-Hill.
5. Theory of Machines by Thomas Bevan, CBS Publishers & Distributors.
6. Kinematics and Dynamics of Machines by George H. Martin, Overseas Press Pvt. Ltd., India
7. Theory of Mechanisms and Machines by Amitabha Ghosh &Asok Kumar Mallik, Affiliated EastWest Press

BME-256		**Software Applications for Mechanical Engineering**
Course category	:	EF
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 2, Tutorial: 0, Practical: 4
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through attendance, home assignments, quizzes, practical work, record, viva voce and Minor test and One Major Theory & Practical Examination

Course Objectives : To develop skills for using different software's for solving mechanical engineering problems.

Course Outcomes : Upon completion of this course, the student will demonstrate the ability to:

1. Understand the concept of EES software for mechanical engineering applications
2. Understand the concept of MATLAB software for mechanical engineering applications
3. Understand the concept of ANSYS software for mechanical engineering applications
4. To analyze the mechanical engineering problems using different software's.
5. Ability to analyze structural problems using ANSYS
6. Acquire ability to analyze fluid flow problems using EES

Topics Covered

UNIT-I: 6

Introduction to EES and Its applications for Integration, Differential Equations and Thermal Problems

UNIT-II 6

Introduction to MATLAB and its applications for Engineering mechanics and Vibration problems.

UNIT-III 6

Introduction to ANSYS Workbench, Types of analysis that can be done using ANSYS.

UNIT-IV 6

Structural Analysis, Thermal and Fluid Flow Analysis

List of Practical:

1. To find out the integration with Runga-Kutta method using EES
2. To use the Integral function with parametric Table using ES
3. To determine the thermal efficiency of vapor power cycle using EES.
4. To determine the diagram efficiency of impulse steam turbine using EES.
5. To write a MATLAB program to determine the magnitude and direction of the resultant of 3- coplanar forces.
6. To write a MATLAB script for plotting the non-dimensional response magnitude for a system with harmonically moving base
7. To Find the deflection of simply supported beams using ANSYS
8. To Find the deflection of cantilever beams using ANSYS
9. To find out the velocity and pressure variations in pipe flow using ANSYS.
10. To perform analysis on duct flow using ANSYS

Textbooks and References:

1. MATLAB: An Introduction with Applications by Rao V Dukkipati New Age International Pvt Ltd
2. Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers by Rudra Pratap, Oxford; Edition (1 January 2010)
3. ANSYS Manual
4. EES Manual

BME-257		**Fluid Mechanics and Hydraulic Machines**
Course category	:	Professional Core (PC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through attendance, home assignments, quizzes, practical work, record, viva voce and One Minor test and One Major Theory & Practical Examination
Course Objectives	:	The objective of this course is to understand fundamental concepts, different laws, Fluid flow behavior and application of different laws in different Fluid Mechanics problems. Students will learn about the working and performance evaluation of different fluid flow systems such as impulse turbine, reaction turbine, centrifugal pump and reciprocating pump etc.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course: The students should be able to understand the fundamental concepts, different laws of fluid Mechanics and its application in different fluid flow problem. 1. The students should be able to understand fluid statics, pressures on submerged planes and curved surface and stability of immersed and floating bodies. 2. The students should be able to understand the various aspects of Laminar, Turbulent Flow and other types of flow over different types of bodies. 3. The student be able to develop understanding about Dimensional Analysis, different types of flows and losses in a flow system 4. The student should be able to develop basic knowledge of hydraulic machines and their applications 5. The student should be able to understand the performance parameters of turbine and Pumps

Topics Covered

UNIT-I 9

Introduction to Fluid Mechanics

Statics and Kinematics: Physical properties of fluids, Rheology of fluids, Hydrostatic pressure on plane and curved surfaces, centre of pressure, Kinematics of Fluid flow: Types of fluid flows, Description of motion, continuity equation, stream function and velocity potential function.

UNIT-II 9

Dynamics of Fluid Flow and Dimensional Analysis

Euler's Equation of motion, Bernoulli's equation and its applications, Pitot tube, Orificemeter, Venturimeter, nozzle and bend meter., Momentum equation (Navier-Stokes equation). Dimensional Analysis and similarity, Buckingham's Pi theorem, Important dimensionless numbers and their physical significance.

UNIT-III 9

Laminar and Turbulent Flows

Equation of motion for laminar flow through pipes, Stokes law, intensity of turbulence, eddy viscosity, Prandtl's mixing length theory, velocity distribution in turbulent flow over smooth and rough surfaces, minor losses, pipe in series and parallel. Boundary layer flow.

UNIT-IV 9

Introduction to Hydraulic Machines:

Hydraulic Turbines: Introduction to Hydroelectric power station and its components, Classification of turbines, Heads and efficiencies, Pelton wheel, Francis and Kaplan turbines, specific speed and unit quantities, Characteristic curves. Pumps: Centrifugal Pumps, specific speed, priming, Characteristic curves, Reciprocating pumps, Comparison between Centrifugal and Reciprocating pumps. Cavitation in pumps and turbines.

EXPERIMENTS

Minimum Eight experiments are to be conducted from the followings:

1. To verify the momentum equation using the experimental set-up on impact of jet.
2. To determine the coefficient of discharge, coefficient of velocity and coefficient of
3. Contraction of an orifice of a given shape.
4. To determine the coefficient of discharge of an orifice meter and study the variation of the
5. Co-efficient of discharge with the Reynolds number.
6. To study the transition from laminar to turbulent flow by using Reynold's Apparatus.
7. To determine Meta-centric height of a given ship model.
8. To determine the surface tension of the given Fluid.
9. To study and calculate the efficiency of Pelton wheel.
10. To study and calculate the efficiency of Francis turbine.
11. To study and calculate the efficiency of Kaplan turbine.
12. To study and Conducting experiments on Reciprocating pump.
13. To study and Conducting experiments on centrifugal pump.
14. To study the model of different types of blades / Vanes of Hydraulic Machine.
15. To determine the head loss for a sudden enlargement.
16. To determine the head loss for a sudden Contraction.

Books & References

1. Introduction of Fluid mechanics & Fluid Machines - Som, S.K. & Biswas G. (TMH Pub)
2. Fluid Mechanics &Hydraulic Machines by -R K Bansal (Laxmi publications))
3. Fluid Mechanics & Machinery - S.K. Agarwal (TMH Pub.)
4. Fluid Mechanics through Problems - Garde, R.J. (New Age International Pvt. Ltd, 2e)
5. Fluid Mechanics and hydraulic machines by R K Rajput (Kataria publications)
6. Hydraulics and Fluid Mechanics by Modi and Seth (Rajsons Publications PVT. LTD)

BME-258 **Metrology and Quality Engineering**

Course category : Professional core (PC)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits : 4

Course Assessment methods	:	Continuous assessment through attendance, home assignments, quizzes, practical work, record, viva voce and One Minor test and One Major Theory & Practical Examination
Course Objectives	:	To impart the concept of measurement standards, measuring instruments and their construction, working and applications. This subject also exposes the students to the principles of measurement, gauges and concepts of quality control and assurance for industrial applications
Course Outcomes	:	After learning this subject, the student will: 1. Ability to learn about selective assembly for different types of fits and design of limit gauges 2. Ability to learn various linear, angular, form and finish measuring devices as well as able to distinguish various comparators and interferometers 3. To learn special measuring devices for gears, screw threads and machine tools 4. Evaluate the surface quality of a given specimen which is important in all kinds of manufacturing 5. Able to use various control charts and various quality assurance tools 6. To acquire knowledge of various quality standards and their implementations in industries

Topics Covered

UNIT-I 9

Introduction to Metrology: Fundamental Definitions, Types of Standards, Precision and Accuracy, Measurement Errors; Statistical concepts in metrology

System of Limits, Fits and Tolerance: Concept of Interchangeability and selective assembly; Tolerances-concept and classification; Types of Fits; Allowance and Width of Tolerance Zone; Tolerance Sink; Design of limit gauges-Types, Materials, and Taylor's principle of design

Linear, Angular and Form Measurements: Linear measurements by Scaled instruments, Vernier instruments, Micrometre instruments, and Slip gauges; Angular measurement by Bevel Proctors**(**Universal and Optical), Sine bar & Angle gauges, Clinometers and Autocollimator; Form Measurement for Straightness, Flatness, Squareness, Parallelism, Roundness and Cylindricity

UNIT-II 9

Comparators and Interferometers: Functional requirements and classification of Comparators; Working principle of Mechanical, Opto-mechanical, Pneumatic and Electrical/Electronic comparators with advantages, limitations and uses; Concept of optical interference and its application for measurement; Working principle of Optical flat and Laser interferometers

Metrology of Surface Texture: Surface metrology and terminology; Concept of Waviness & Roughness and Lay & Flaw; M-system and E-system of datum; Numerical representation of surface roughness such as Rz, RMS and Ra; Working of Stylus instruments, Probe instruments and Profilometer

Metrology of Gears, Threads and Machine Tools : Measurement of Gear Elements-Runout, pitch, profile, lead, backless and tooth thickness; Working of Parkinson gear tester; Measurement of Screw Thread Elements-Measurement of relevant diameters (major, minor and effective) and pitch**;** Alignment and testing methods of machine tools; Concepts of coordinate-measuring machine (CMM)

UNIT-III 9

Statistical Quality Control: Meaning of Quality, Concept of Cost of Quality and Value of Quality; benefits and limitation of SQC; Process capability analysis

Quality Control for Variables: Theory and uses of control charts; Control chart for variables – X chart, R chart and (P & C) chart; Six sigma concept

Process Control for Attributes: Control chart for fraction defectives – p chart and np chart – control chart for defects – C and U charts, State of control and process out of control identification in charts

UNIT-IV 9

Acceptance Sampling Plan: OC Curves and Sampling Plans; Producer's risk and consumer's risk; Process Capability Index (PCI); AQL, LTPD, AOQL concepts-standard sampling plans for AQL and LTPD- uses of standard sampling plans

Quality Assurance and Certification: Comparison of Inspection, Quality control and Quality assurance; Seven quality control tools and its application; Seven quality improvement tools and its application; ISO 9000 and ISO14000 series of standards their interpretation and implementation

List of Practical

1. To measure the amount of clearance provided in the given fit with the help of dial calliper
2. To measuring the included angle of given hexagonal/ octagonal piece with the help of venire bevel protractor and to verify the same using the formula.
3. To measure the taper angle of given with the help of slip gauges and sine bar.
4. To measure the effective diameter of a screw thread using three wire method of a 1‖ BSW tap and find the flank angle.
5. Use of gear teeth, Vernier calipers and checking the Chordal Addendum and Chordal Height of spur gear
6. To study and sketch of tool mater microscope for measurement of dimensional parameters of the given work piece
7. Gear tooth measurement using Gear tooth Vernier and Parkinson Gear Tester
8. Surface topology measurement using Surface Roughness Tester & Surface defects ,profile measurement using Vision system
9. Machine tool Alignment of test on the lathe
10. Estimation of Process Capability of a Machine Lathe and Use of Attribute Chart

Textbooks and References:

1. A Text book of Engineering Metrology by I.C. Gupta, Dhanpat Rai and Sons
2. Engineering Metrology and Measurements by NV Raghavendra and L Krishnamurthy, Oxford publishers
3. Engineering Metrology by KL Narayana, Scitech publishers
4. Introduction to Statistical Quality Control by Douglas C. Montgomery, John Wiley & Sons, Inc.
5. Statistical Quality Control by Grant, E.L, Tata McGraw-Hill
6. Juran's Quality Planning and Analysis, by Frank. M.Gryna Jr. McGrawHill

BME-259	**Energy Conversion Technologies**
Course category	: Professional Core
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial: 0 Practical: 2
Number of Credits	: 4
Course Assessment methods	: Continuous assessment through attendance, home assignments, quizzes, practical work, record, viva voce and One Minor test and One Major Theory & Practical Examination

Course Objectives : The objective of this course is to provide the student with basic knowledge in energy scenario, types of fuels, vapor power cycles, gas power cycle and renewable energy, as practiced in the field of Mechanical Engineering

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course:

1. Understand the energy scenario, environmental aspects, types of fuel, combustion analysis and related calculations.
2. Attain the knowledge of different types of boilers, their mountings and accessories and draught.
3. Ability to gain the knowledge of vapor power cycles and perform the first law and second law analyses and steam & gas nozzles.
4. Understand the knowledge of steam turbines with related parameter calculations.
5. Ability to gain the knowledge of gas power cycles with related calculations and the principle of aircraft propulsion.
6. Understand the knowledge of renewable energy sources for sustainable energy generation.

Topics Covered

UNIT-I 9

Introduction: Basics of energy, primary and secondary energy sources, Global and Indian Scenario of conventional and non-conventional energy sources, Environmental aspects of energy utilisation.

Fuels and combustion: Introduction to solid, liquid and gaseous fuels, Fuel properties, Combustion analysis, Air requirement, Air/Fuel ratio, Diesel power, Biodiesel.

Boilers: Classifications and working of boilers, boiler mountings and accessories, air pre-heater, feed water heater, super heater, Boiler efficiency, Draught and its calculations.

UNIT-II 9

Vapour Power Cycle: Carnot vapour power cycle, Rankine cycle, reheat cycle, Regenerative cycle, Organic Rankine cycle, Binary cycle, Cogeneration & Combined cycles, Exergy analysis.

Steam Nozzles: Flow through Convergent and convergent-divergent nozzles, Variation of velocity, throat area, Nozzle efficiency, Effect of friction on nozzle.

UNIT-III 9

Steam Turbines: Classification of steam turbine, Impulse and Reaction turbines, Stage and Overall efficiency, Reheat factor, Bleeding, Velocity diagrams, blade efficiency of impulse & reaction turbines, Losses and Governing.

Gas Power Cycle: Gas turbine classification, Principles of gas turbine, Brayton cycle, Gas turbine cycles with intercooling, reheat and regeneration and their combinations, Combined cycles. Introduction to the principles of jet propulsion.

UNIT-IV 9

Renewable Energy: Solar energy and collectors, geothermal, wind, biomass, ocean, fuel cells, unique features of decentralized systems. Cogeneration and multigeneration systems. Environmental issues, Sustainability and future scenarios.

EXPERIMENTS

Minimum Eight experiments are to be conducted from the followings:

1. Study and working of two stroke and four stoke petrol Engine.
2. Study and working of two stroke and Four stoke Diesel Engine.
3. Study of Fire Tube and Water tube boiler.
4. Study of Lancashire, Cochran and Babcock-Wilcox boiler.
5. Study of steam Turbine Model.
6. Study of Velocity compounded steam turbine.
7. Study of Pressure compounded steam turbine.
8. Study of Impulse & Reaction turbine.
9. Study of Gas Turbine Model.
10. To determine the thermal efficiency of flat plate collector.
11. To determine the thermal efficiency of evacuated tube collector.
12. To determine the thermal efficiency of PV collector.
13. Any other experiment on wind turbine.
14. To determine the BSFC, BTE and EGT of single cylinder 4-stroke Diesel Engine.
15. Visit of thermal power plant.

Books & References

1. Basic and Applied Thermodynamics - P.K. Nag (TMH)
2. Applied thermodynamics - Onkar Singh (New Age International)
3. Fuels and Combustion- S. Sarkar (CRC Press)
4. Thermodynamics: An Engineering Approach – Cengel and Boles (TMH)
5. Gas turbine Theory & Practice - Cohen & Rogers (Pearson Education)
6. Mechanics and Thermodynamics of Propulsion - Hill and Peterson (Pearson Education)
7. Non-Conventional Energy Resources – B.H. Khan (TMH)
8. Renewable Energy Resources – J. Twidell & T. Weir (Routledge)

BME-260	**Fundamentals of Mechanical Engineering**
Course category	: Engineering Fundamentals (EF)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	: 4
Course Assessment methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and one Minor tests and One Major Theory & Practical Examination
Course Objectives	: This course introduces fundamentals of mechanical engineering and their applications in solving engineering problems based on the concepts of thermodynamics, engine, measurement, engineering materials, mechanical properties and testing etc.

Topics Covered

UNIT-I 9

Thermodynamics

Thermodynamics laws, Enthalpy, Entropy, Steam properties, Steam processes at constant pressure, volume, enthalpy and entropy, Classification of steam boilers, boiler mounting and accessories, Refrigeration, Basics of Vapour compression and vapour absorption system, Coefficient of performance (COP), Refrigerants properties.

Reciprocating Machines

Carnot cycle, Otto and Diesel cycles, Working of two and four strokes petrol and diesel engines.

UNIT-II 9

Measurement & Metrology

Introduction to measurement and measuring instruments, Types of sensors and transducers and their characteristics, measuring error uncertainty analysis, Temperature, pressure, velocity, flow, strain, force and torque introduction of dial gauges, slip gauges and sine bar

Engineering Materials

Classification of materials, Ferrous and nonferrous metals, Composition of cast iron, carbon steel, alloy steel and their applications, Non-ferrous metals such as Cu, Al, Zn, Cr, Ni etc. properties and its applications.

UNIT-III 9

Simple Stress and Strain

Introduction, Normal and shear stresses, Poisson's ratio, Elastic constants and their relationships, Hooke's law, Deflection of bars of uniform and varying cross-sections, Strain energy in due to static loading, Stress-strain diagrams for ductile and brittle materials

Mechanical Properties and Testing

Strength, Stiffness, Malleability, Ductility, Brittleness, Toughness, Hardness, Fracture, Fatigue & creep.

UNIT-IV 9

Beams

Introduction, Classification of beams, types of loading, Free body diagram, Shear force and bending moment, Analysis of beams, Shear force and bending moment diagrams for statically determinate beams, Simple bending theory, Stress of beams of different cross sections

Torsion of Circular shafts

Introduction, Torsion of circular shafts, Shear stress due to torsion, Polar modulus, Power transmission.

List of Experiments:

(Note: Minimum 8 experiments are to be performed)

1. Tensile strength test on universal testing machine.
2. Compressive strength test on universal testing machine.
3. Impact test on Impact testing machine.
4. Hardness testing on Vicker/Brinell hardness testing machine.
5. Stiffness test on spring testing machine.
6. Study of two stroke engine models.
7. Study of four stroke engine model.
8. Deflection on bending of simple supported and cantilever beams.
9. Determination of COP of vapour absorption system.
10. Determination of COP of vapour compression refrigeration system.
11. Study of steam boilers models.
12. Study of domestic refrigerators

Textbooks and References:

1. Basic and Applied Thermodynamics-P. K. Nag (Tata McGraw Hill)
2. Basic Thermodynamics- Cengel(Tata McGraw Hill).
3. Applied Thermodynamics-Onkar Singh (New Age International)
4. Material Science-V. Raghvan (Prentice Hall India Limited)
5. Elements of Materials science and Engineering-Van Vlash (Jhon Wiley & Sons)
6. Mechanical Measurement-G. Beckwith Thomas (Narosa Publishing House)
7. Mechanical Measurement – Sirohi (New Age Publications)
8. Strength of Materials-S. Ramamurtham (Dhanpat rai Publishing Co.)
9. Strength of Materials-R. K. Rajput (S. Chand)

B.Tech Third Year (3 & 4 Year)

BME-305 Design of Machine Elements

Course category	:	Professional Core (PC)
Pre-requisites	:	----
Contact Hours/Week	:	Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through practical, attendance, home assignments, quizzes, one minor tests and one major theory.
Course Objectives	:	To impart fundamental knowledge of design principles, material selection, and, safety standards to analyze and design safe, efficient mechanical components like shafts, gears, and bearings.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge and skills after completing this course

1. The understanding of design of mechanical components/systems, associated design parameters and standards, and knowledge of engineering materials and their properties.
2. The ability to design mechanical components under the static loads and dynamic loads based on different criteria.
3. Demonstrate the ability to design cotter and knuckle joints and its engineering applications.
4. The ability to design temporary and permanent joints such as riveted, bolted and welded joints as well as
5. The knowledge of design of circular shafts under the combined loadings,
6. Demonstrate the ability to design different types of keys, rigid & flexible couplings.

Topics Covered

UNIT-I

Introduction 9

Definition, Design requirements of machine elements, General design procedure, Introduction to Design for Manufacturing, Interchangeability, Limits, Fits and Tolerances, Standards in design, Selection of preferred sizes

Engineering materials and their properties

Classification, Mechanical properties, Ferrous and non-ferrous metals, Non-metallic materials, Indian Standards designation of carbon & alloy steels, Selection criteria of materials.

UNIT-II

Design under Static Load 9

Modes of failure, Factor of safety and basis of determination, Principal stresses, Torsional and bending stresses, Principal stresses in design of machine element, Theory of failure, Eccentric loading

Design under Variable Loads

Cyclic stresses, Fatigue and endurance limit, Factors affecting endurance limit, Stress concentration factor, Stress concentration factor for machine components, Notch sensitivity, Design for finite and infinite life, Soderberg, Goodman & Gerber criteria

UNIT-III

Design of Joints 9

Types of cotter joints, Design of socket and spigot cotter joint, Gib and cotter joint, Design of knuckle joint, Design of threaded joints, Preload on the bolt, stiffness of bolt and members, efficiency of joints; Design of weld joints, Specification of welds, weld design under different loading conditions, Design of riveted joints.

UNIT-IV

Design of Shafts 9

Cause of failure in shafts, Materials for shaft, Stresses in shafts, Design of shafts subjected to twisting moment, bending moment and combined twisting and bending moments, Shafts subjected to fatigue loads, Design for rigidity

Keys and Couplings

Types of keys, splines, Selection of square & flat keys, Strength of sunk key, Couplings-Design of rigid and flexible couplings

Note: Design data book is allowed in Minor/Major/Practical Examinations

EXPERIMENTS

Note: Minimum Eight experiments are to be performed from the following. Students are advised to use design data book for the design. Drawing shall be made wherever necessary on small drawing sheets

1. Design of machine components subjected to steady loads
2. Design of machine components subjected combined steady and variable loads
3. Design of boiler riveted joint
4. Design of eccentrically loaded riveted joint
5. Design & drawing of Cotter joint
6. Design & drawing of Knuckle joint
7. Design of shaft for combined constant twisting and bending loads

8. Design of shaft subjected to fluctuating loads
9. Design and drawing of flanged type rigid coupling
10. Design and drawing of flexible coupling

Textbooks

1. Design of Machine Elements-V.B. Bhandari (Tata McGraw Hill)
2. Mechanical Engineering Design – Joseph E. Shigely (McGraw Hill)
3. Mechanical Design of Machine Components – Norton (Prentice Hall)
4. Fundamentals of Machine Components Design – Juvinall (Wiley)

Reference books

1. Design of Machine Members - Alex Valance and VI Doughtie (McGraw Hill)
2. Machine design-M.F. Spott (Prentice Hall India)
3. Machine Design-Maleev and Hartman (CBS)

BME-306 Heat Transfer

Course category	:	Professional Core (PC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and one minor tests and one major theory & practical examination
Course Objectives	:	To enable students to understand, analyze, and design systems that involve the transfer of thermal energy via conduction, convection, and radiation. Key goals include solving engineering problems involving heat exchangers, fins, and boiling/condensation, while distinguishing between steady and unsteady state processes
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understand the governing laws of heat transfer and general differential heat conduction equation in different coordinate system.
2. Ability to solve steady state one-dimensional heat conduction problems for plate, cylinder, and sphere.
3. Understand the basic of fins and their application in various equipment's for enhancing the heat transfer and estimation of heat transfer for free convection problems.
4. Understanding of concepts and estimation of heat transfer for forced convection problems.
5. Understanding of condensation and boiling phenomenon on surfaces and able to design the different types of heat exchanger.
6. Understanding the basic concepts, analysis of thermal radiation and its numerical solutions and introduction to mass transfer.

Topics Covered

UNIT-I

Introduction to Heat Transfer Modes of heat transfer; Governing law of conduction, convection, and radiation; Effect of temperature on thermal conductivity of materials; Combined modes of heat transfer mechanism. 9

Conduction General differential heat conduction equation in the cartesian, cylindrical and spherical coordinate systems; Initial and boundary conditions.

Steady state one-dimensional heat conduction in different coordinates with and without energy generation and variable thermal conductivity; Composite Systems; Analogy between heat and electricity flow; Thermal resistance networks; Concept of overall heat transfer coefficients; Critical thickness of insulation.

UNIT-II

Fins Different fin geometries; Heat transfer from extended surfaces of uniform cross-sectional area; Fin efficiency and effectiveness; Transient conduction; Lumped system analysis. 9

Natural Convection Physical mechanism of natural convection; Empirical heat transfer correlations for natural convection over horizontal/vertical plates & cylinders and sphere; Combined free and forced convection.

UNIT-III

Forced Convection Basic concepts; Hydrodynamic boundary layer; Thermal boundary layer; Approximate integral boundary layer analysis; Analogy between momentum and heat transfer in turbulent flow over a flat surface; Mixed boundary layer; Flow over a flat plate; Empirical heat transfer relations; Flow inside pipes; Relation between fluid friction and heat transfer. 9

Boiling and Condensation Classification of boiling; pool boiling; Empirical correlations for boiling heat transfer; Introduction to condensation phenomena; Heat transfer relations for laminar film condensation on vertical plate; Film condensation outside and inside of horizontal tube.

Heat Exchanger Classification of heat exchangers; Overall heat transfer coefficient; Fouling factor; Heat exchanger analysis using LMTD method and Effectiveness-NTU method; Compact heat exchangers.

UNIT-IV

Thermal Radiation Basic radiation concepts; Radiation properties of surfaces; Concept of black body; Stefan-Boltzmann law and its quasi-linearization; Planck's law; Wein's displacement law; Kirchhoff's law; Shape factor algebra; Radiation exchange between black and nonblack bodies; Radiation shields; Radiation from gases, vapours and flames; Solar radiation. 9

Introduction to Mass Transfer Fick's law of diffusion; Steady state equimolar counter diffusion; Steady state diffusion though a stagnant gas film.

EXPERIMENTS

Minimum Eight experiments are to be conducted from the followings:

1. Conduction - Determination of thermal conductivity of fluids.
2. Conduction - Composite wall experiment
3. Conduction - Composite cylinder experiment
4. Conduction - Thermal Contact Resistance Effect.
5. Convection - Heat transfer through fin-natural convection.
6. Convection - Heat transfer from vertical cylinder-natural convection.
7. Convection - Heat transfer through fin-forced convection.
8. Convection - Heat Pipe experiment.
9. Boiling - Pool boiling experiment.
10. Condensation- Film-wise condensation.
11. Condensation- Drop-wise condensation.
12. Heat exchanger - Parallel flow experiment.
13. Heat exchanger - Counter flow experiment.
14. Heat exchanger – Shell and tube experiment.
15. Experiment on Stefan's Law on radiation determination of emissivity.
16. Any experiment on solar collector.

Books & References

1. Fundamentals of heat transfer – F. P. Incropera & D. P. Dewitt (Wiley)
2. Elements of Heat Transfer - Bayazitouglu & Ozisik (McGraw-Hill)
3. Heat Transfer - J. P. Holman (McGraw-Hill)
4. Principles of Heat Transfer - Frank Kreith & M. S. Von (McGraw-Hill)
5. Heat Transfer – S. P. Sukhatme (Universities Press)
6. Heat Transfer -Y. V. C. Rao (University Press)
7. Heat Transfer - R. Yadav (Central Publishing House)

BME-307 Manufacturing Science & Technology-I

Course category	:	Professional Core (PC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test, practical examination and one major theory examination
Course Objective	:	To provide foundational and advanced knowledge of material processing, covering casting, forming, machining, and joining techniques.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Apply the law of physics and engineering fundamentals to classify and analyze the different forming processes like forging, rolling, etc.
2. Analyze the state of stress and metal deformation in different sheet metal and drawing operation.
3. Identify and analyze the suitability of different welding processes.
4. Design of patterns and gating systems for defect-free casting
5. Conduct experiments to demonstrate and correlate the theory of metal forming, casting and welding with the actual processes
6. Prepare report based on observation and interpretation of experimental results.

Topics Covered

UNIT-I

Introduction 9

Importance of manufacturing, economic & technological considerations in manufacturing, classification of manufacturing processes, materials & manufacturing processes for common items

Metal forming processes-I

Elastic & plastic deformation, Yield criteria, Hot & cold working processes. Analysis of the forging process for load estimation of the slab and disc. Hand, power & drop Forging. Analysis of Rolling Process. Rolling mills & rolled sections

UNIT-II

Metal forming processes-II 9

Analysis of Wire/strip drawing, Tube drawing, Extrusion and its application. Design, lubrication and defects in metal forming processes.

Sheet metal working:

Presses and their classification, Die & punch assembly, Cutting/Punching mechanism, Blanking & piercing. Compound & progressive dies. Analysis of the forming process, such as cup/deep drawing, Bending & spring-back.

Unconventional metal forming processes

Unconventional metal forming or High Energy Rate Forming (HERF) processes - Explosive forming, electromagnetic, and electro-hydraulic forming.

UNIT-III

Welding: 9

Survey of welding and allied processes. Gas welding and cutting, process and equipment.

Arc welding: Power sources and consumables. TIG & MIG processes and their parameters.

Resistance welding, other welding processes - atomic hydrogen, submerged arc, electroslag, friction. Thermodynamic and Metallurgical aspects in welding. Defects in welds and their remedies. Soldering & Brazing.

UNIT-IV

Casting 9

Basic principle & survey of casting processes. Types of patterns and allowances. Types and properties of moulding sand, sand testing. Design considerations for elements of mould Gate, Riser, Runner & Core. Solidification of casting. Sand casting— defects, remedies.

Other casting processes-Die Casting, Centrifugal casting, Investment casting, Continuous casting and CO_2 casting etc.**,** Powder Metallurgy.

List of Experiments

Minimum eight experiments are to be conducted from the following:

1. Experiment on Design and Pattern Making
2. Study of the Sieve Shaker and to find the Grain Fineness Number
3. Making a mould (with core) and casting.
4. Study & operation of hand & power forging.
5. Press work experiments, such as blanking/piercing, washer, making, etc.
6. Wire drawing/extrusion on soft material.
7. To prepare a Lap or butt joint using gas welding.
8. To prepare a butt joint using electric arc welding.
9. To prepare a Lap joint using electric arc welding.
10. To prepare a butt joint using the TIG welding process
11. To prepare a butt joint using the MIG welding process
12. To prepare a Lap joint using the resistance welding technique

Books & References

1. Manufacturing Science -Ghosh and Mallik (EWP)
2. Manufacturing Engineering & Technology- Kalpakjian (Pearson)
3. Materials and Manufacturing - Paul Degarmo. (TMH)
4. Manufacturing Technology – Foundry, Forming and Welding- P. N. Rao (TMH).
5. Manufacturing Processes Vol I – H. S. Shan (Pearson)
6. Fundamental of Modern Manufacturing – M. P. Groover (PHI)
7. Workshop Technology Vol1-B. S. Raghubanshi (Dhanpat Rai and Sons)

BMS-301	**Principles of Industrial Management**
Course category	: Management (M)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	: 4
Course Assessment methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes and one Minor Test and one Major Theory Examination.
Course Objectives	To enable students to develop operational skills and analyzing different situations in the industrial scenario having limited resources and obtain the optimal solution with and without constraints.
Course Outcomes	: The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Students should be able to become efficient and acquire acumen for more profitable business practices.
2. Students should be able to understand the importance of better customer service and product quality.

3. Students should be able to make work safer, faster, easier, and more rewarding.
4. Students should be able to help the industry in the production of more products that possess all utility factors
5. Students should be able to reduce costs associated with new technologies.
6. Students should be able to understand different principle of Industrial Management.

Topics Covered

UNIT-I

Introduction of Industrial Management: Definition, Nature and Scope of Management, Process of management, Elements of management, Definition of industrial management, Scope and Application of industrial management.

Plant Location and Layout: Factors affecting Plant Location, Objectives and Principles of Plant Layout, Types of Plant-Layout

UNIT-II

Work Analysis and Measurement: Design of work study, steps involved in work-study process, Definition and Concept of Method study, Procedure involved in Method study, Objectives and techniques of Work Measurement, worksampling and its application, Selection of Personnel and wage payment plans.

UNIT-III

Material Management: Meaning of Inventory management, Economic Order Quantity Model, ABC analysis, Just-in-time, Minimum Safety Stock

Industrial Safety: Occupational safety, safety programs; Safety aspects in work system design

UNIT-IV

Project Management: Meaning, Features, Project management life cycle, Project cost control System, Project planning and control, Project scheduling and techniques.

Text & Reference books:

1. Joseph Russell Smith, "The Elements of Industrial Management", Hard Press
2. Gavriel Salvendy, "Handbook of Industrial Engineering: Technology and Operations Management", John Wiley & Sons, Inc.
3. S. N. Chary, "Production and Operations Management", Tata McGraw Hill
4. R. Paneerselvam, "Production and Operations Management", PHI
5. E. S. Buffa and R. K. Sarin, Modern Production/ Operations Management, Wiley.

BME-354	**Refrigeration & Air Conditioning**
Course category	Professional Core (PC)
Pre-requisite Subject	NIL
Contact hours/week	Lecture : 3, Tutorial : 0, Practical: 2
Number of Credits	4
Course Assessment methods	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva-vice and one test examination and one Major Theory & Practical Examination
Course Objective	The objective of this course is to provide students with a fundamental understanding of refrigeration and air-conditioning principles, various refrigeration cycles, system components, psychrometric principles and cooling load calculations, with emphasis on energy efficiency and environmental considerations.
Course Outcomes	Upon completion of this course, the student will demonstrate the ability: 1. To understand the basics of refrigeration principles, various air refrigeration cycles and concept of different refrigerants. 2. To apply the fundamental knowledge of refrigeration in single stage and multi-stage vapour compression refrigeration system for analyzing the performance parameters.

3. To understand the elementary knowledge of vapour absorption refrigeration systems along with system performance.
4. To understand the basics of psychrometry of air used in air conditioning systems.
5. To evaluate various heat loads for designing of air conditioning systems by analysing different parameters based on psychrometry.
6. To understand various system equipment and various applications of refrigeration and air conditioning

Topics Covered

UNIT-I 9

Refrigeration

Introduction to refrigeration system, Methods of refrigeration, Unit of refrigeration, Refrigeration effect, COP, Carnot refrigeration vapour cycle.

Air Refrigeration cycle

Open and closed air refrigeration cycles, Reversed Carnot gas cycle, Bell Coleman air refrigeration cycle, Introductory knowledge of aircraft refrigeration system.

Refrigerants

Classification of refrigerants, Nomenclature, Desirable properties of refrigerants, Common refrigerants, secondary refrigerants, ODP and GWP, CFC free refrigerants

UNIT-II 9

Single stage vapour compression system

Performance analysis of vapour compression cycle, Use of T-S and p-h charts, Effect of suction pressure, discharge pressures, subcooling, and superheating of refrigerant on performance of the cycle, Actual vapour compression refrigeration cycle, Performance aspects and cycle modifications.

Multistage vapour compression system

Requirement, Different configurations based on flash gas removal and flash intercooling.

Multi-evaporator and cascade refrigeration systems: Requirement, Different configuration of Multi-evaporator refrigeration systems, principle of cascade refrigeration system.

UNIT-III 9

Vapour Absorption system

Working Principle of vapour absorption refrigeration system, Comparison between absorption & compression systems, Elementary idea of refrigerant absorbent mixtures, Ammonia - Water vapour absorption system, Effect of absorbent entered in evaporator, Lithium- Bromide water vapour absorption system.

Air Conditioning-I

Introduction to air conditioning, Psychometric properties: definitions and relations, Psychometric chart, Calculation of various psychrometric properties, Different Psychometric processes, Thermal analysis of human body, Effective temperature and comfort chart.

9

UNIT-IV

Air Conditioning-II

Cooling and heating load calculations, Selection of inside & outside design conditions, Heat transfer through walls & roofs, Infiltration & ventilation, Internal heat gain, Sensible heat factor, By pass factor, Apparatus dew point (ADP). Analysis of different configurations of summer air conditioner and winter air conditioner, Introduction to desiccant cooling.

Refrigeration Equipment & Applications

Elementary knowledge of refrigeration & air conditioning equipments, e.g., compressors, condensers, evaporators & expansion devices, Air washers, Cooling towers, Food preservation, Cold storage, Refrigerates Freezers, Ice plant, Water coolers, Elementary knowledge of transmission and distribution of

air through ducts.

List of experiments

Minimum eight experiments are to be conducted from the following list

1. To study domestic refrigerator based on its principle and components.
2. Experiment on vapour compression refrigeration test rig and calculation of various performance parameters.
3. Experiment on vapor absorption refrigeration test rig and analysis of various performance parameters.
4. Experiment on water to water heat pump and analysis of various performance parameters.
5. Experiment on Refrigeration circuit with variable load
6. Experiment on refrigeration system with two-stage compression.
7. Experiment on cascade refrigeration test rig and analysis of various performance parameters.
8. Experiment on air-conditioning test rig & calculation of various performance parameters.
9. Experiment on Recirculating air conditioning test rig.
10. Experiment on Air conditioning and ventilation system.
11. Experiment on Air conditioning system with chamber.
12. Experiment on Vehicle air conditioning used in automobiles.
13. Experiment on Adsorptive air drying for understanding adsorption and desorption.
14. To study different types of expansion devices used in refrigeration system.
15. To study air washers.

Books & References

1. Refrigeration and Air conditioning - Stoecker & Jones (McGraw-Hill Education India Pvt. Ltd -New Delhi).
2. Principle of Refrigeration - Roy J. Dossat (Pearson).
3. Refrigeration and Air conditioning - C.P Arora (Tata McGraw Hill).
4. Refrigeration and Air conditioning - Manohar Prasad (New Age International (P) Ltd)
5. Refrigeration and Air conditioning - Arora & Domkundwar (Dhanpat Rai & Co.(p) Ltd, Delhi).
6. Refrigeration and Air conditioning - P.L. Baloney (Khanna).
7. Thermal Environment Engineering - Kuhen, Ramsey & Threlkeld (Prentice Hall)
8. Performance studies of desiccant cooling systems - P. Rai, S.K. Shukla (Lambert publication Germany)

BME-355	**CAD/CAM**
Course category	: Professional Core (PC)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	: 4
Course Assessment methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva-vice and one test examination and one Major Theory & Practical Examination
Course Objectives	To equip students with the skills to design, analyze, and manufacture mechanical components using computer technology, covering 3D geometric modeling, CNC programming, and

industrial automation. It emphasizes integrating design (CAD) with manufacturing (CAM) for optimized, efficient production.

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Students will be able to create 2D/3D geometric models, surface models, and solid models using CAD software for various engineering components.
2. Ability to develop mathematical models to represent curves, surfaces, and solids
3. Develop CNC programs to manufacture industrial components
4. Understand the elements of an automated manufacturing environment
5. Apply CAD/CAM tools for the given engineering application

Topics Covered

UNIT-I 9

Introduction to CAD/CAM: Introduction to CAD/CAM/CIM, Design Process, Product Lifecycle Management (PLM), CAD/CAM Input and Output Devices, Software Tools for CAD/CAM.

Geometric Transformations

2D Geometric Transformations - Translation, Scaling, Shearing, Rotation & Reflection Matrix representation-homogeneous coordinates, Rotation and scaling about arbitrary point, Reflection through arbitrary line, Composite transformation, 3 D transformations, multiple transformation.

UNIT-II 9

Planar Curves

Curves representation, Interpolation vs approximation, Classical representation of curves, Parametric analytic curves-lines, circles, ellipses, parabolas, and hyperbolas

Space Curves

Properties for curve design, Parametric continuity, Parametric representation of synthetic curves, Spline curves and specifications, Parametric representation of synthetic curves, Hermite curves-Blending functions formulation, shape control, properties, Bezier curves-Blending functions formulation, properties, Non-rational B-spline curves- Blending functions formulation, knot vector, B-spline blending functions, properties

UNIT-III 9

Computer Aided Manufacturing (CAM): Introduction to Computer Numerical Control (CNC), Designation of Axes, Drives and Actuation Systems, Feedback Devices, CNC Tooling and Work Holding Devices, CNC Control Systems, Adaptive Control, DNC.

CNC Programming: Part Programming Fundamentals, Developing Manual Part Programming, APT Programming, Geometric and Motion Commands, Post Processor Commands, Practice using Software Tools.

UNIT-IV 9

Group Technology and Computer Aided Process Planning (CAPP): Group Technology (GT), Part Classification and Coding Systems, CAPP Methods, Advantages of CAPP.

Flexible Manufacturing System (FMS): Components of FMS, FMS Equipment and Control, FMS Case Studies.

Robotics: Types and generations of Robots, Structure and operation of Robot, Robot applications.

CAD/CAM Applications: Reverse Engineering, Virtual Prototyping, Rapid Prototyping, Additive Manufacturing, Integration of CAD/CAM Tools with Industry 4.0 Technologies. Practice using Software Tools.

EXPERIMENTS

Minimum ei:ght experiments are to be conducted from the following list

1. To write Manual part program for a job for turning operation and prepare the component.

2. To prepare Manual part program for a job for drilling operation.
3. To write Manual part program for a job for milling operation and prepare the component
4. Write a program for a pick and place robot to shift the work piece from one location to another.
5. To prepare a part program in APT for drilling operation.
6. To prepare a part program in APT for milling operation
7. Simulation of tool path for turning and milling operations
8. Development of part drawings for various components in the form of orthographic view
9. Generation of various 3D models through protrusion, revolve, shell, sweep commands
10. Feature based and Boolean based solid modelling
11. Study of different file formats like DXF, IGES and STL
12. Assembly modelling and creation of exploded views.

Books & References

Text Books:

1. Ibrahim Zeid and Sivasubramanian, R., CAD/CAM Theory and Practice, TataMcGraw Hill Publications, New Delhi, 2009.
2. P.N. Rao, CAD/CAM: Principles and Applications, Tata McGraw Hill, 2002.
3. Vikram Sharma, Vikrant Sharma and Om Ji Shukla, Principles and Practices of CAD/CAM, CRC Press, 2024.

Reference Books:

1. David F. Rogers, J. A. Adams, Mathematical Elements for Computer Graphics, Tata McGrawHill, 2008.
2. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, Prentice-Hall, 2003.
3. Chang, T.C, Wysk, R.A. and Wang, H.P, Computer Aided Manufacturing, Prentice Hall, 2006.
4. Michael E. Mortenson, Geometric Modelling, McGrawHill, 2013.
5. Anupam Saxena and Birendra Sahay, Computer Aided Engineering Design, Springer, 2005.

BME-356 Manufacturing Science and Technology II

Course category	:	Professional Core (PC)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes and one Minor test, practical examination and one Major Theory Examination
Course Objectives	:	To provide a comprehensive understanding of how raw materials are converted into finished parts through material removal processes. The main goals are to teach the mechanics of cutting, the operation of machine tools, tool geometry, and advanced manufacturing techniques.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Apply the law of physics and engineering fundamentals to compute cutting forces and related parameters during metal cutting.
2. Discuss the mechanism and construction of different machine tools to assess its suitability
3. Discuss and analyze different grinding/ finishing processes for sustainable machining
4. Assess the suitability of advanced machining processes for different materials
5. Conduct experiments to demonstrate and correlate the theory of metal cutting with the actual processes
6. Prepare report based on observation and interpretation of experimental results

Topics Covered

UNIT-I

Metal Cutting 9

Mechanics of metal cutting. Geometry of tool and nomenclature. ASA system. Orthogonal/ Oblique cutting. Mechanics of chip formation, types of chips. Shear angle relationship. Merchant's force circle diagram. Cutting forces & power required. Cutting fluids/lubricants. Tool materials. Tool wear and tool life. Machinability. Dynamometer. Economics of metal cutting

UNIT-II

Machine Tools: 9

Lathe: Principle, construction, types, operations, Turret/capstan, semi/Automatic, Tool layout. Specification of the lathe

Milling: Construction, milling cutters, up & down milling, milling operations, Dividing head & indexing. Max chip thickness & power required, Specification of the milling

Reciprocating Machine: Shaper, slotter, planer: Construction, operations & drives. Drilling, boring & reaming operation tools. Geometry of twist drills.

Introduction to machine tool vibration and surface finish.

UNIT-III

Grinding & Super finishing 9

Grinding: Grinding wheels, abrasives (bonds & cutting action). Grinding wheel specification. Wear of grinding wheel, dressing & truing, Max. chip thickness, Surface and cylindrical grinding, Centerless grinding.

Super finishing: Honing, lapping, and polishing.

Jigs & Fixtures

Locating & Clamping devices & principles. Jigs and fixtures and their applications.

Standardization & Interchangeability

Limits, Fits, Tolerance and Surface Roughness

UNIT-IV 9

Unconventional Machining

Introduction. Limitations of conventional machining processes, need for unconventional machining processes & their classifications. Principles, working and applications of Abrasive Jet Machining (AJM), Ultrasonic Machining (USM), Electro discharge machining (EDM), Electrochemical Machining (ECM), & Electron beam machining (EBM)**.**

List of Experiments

Minimum eight experiments are to be conducted from the following:

1. Preparation of a single-point cutting tool model as per the given tool specification.
2. Shear-angle determination (using formula) with tube cutting (for orthogonal) on lathe machine.
3. Bolt (thread) making on Lathe machine.
4. Study of Indexing Mechanism for Horizontal Milling Machine.
5. Gear cutting on milling machine.
6. Machining a block on shaper machine.
7. Study of constructional details and working of Planer.
8. Study of constructional details and working of Slotter.
9. To make a job as per drawing using Radial Drilling Machine.
10. To make a job as per drawing using Surface Grinding Machine.
11. Study of different types of tools and its materials.
12. Experiment on tool wear and tool life.

13. Experiment on unconventional machining.

Books & References

1. Manufacturing Science - Ghosh and Mallik (EWP)
2. Manufacturing Technology: Metal Cutting & Machine Tools- P. N. Rao (TMH)
3. Advanced Machining Process - VK Jain (Allied Publisher)
4. Fundamentals of Metal Cutting & Machine Tools – Juneja & Shekhon (New Age International)
5. Production Technology – P. C. Sharma (S. Chand)
6. Introduction to Machining Science – G. K. Lal (New Age Publisher)
7. Modern Machining Processes - P.C. Pandey & H.S. Shan (TMH)
8. Manufacturing Engineering & Technology- Kalpakjian (Pearson)
9. Materials and Manufacturing - Paul Degarmo (TMH)
10. Workshop Technology Vol. II-B. S. Raghubanshi (Dhanpat Rai and Sons)

BHS-351 Engineering and Managerial Economics

Course category : Humanities & Social Science Elective (HSSE)

Pre-requisite Subject : NIL

Contact hours/week : Lecture : 3, Tutorial : 1, Practical: 0

Number of Credits : 4

Course Assessment methods : Continuous assessment through tutorials, attendance, home assignments, quizzes and one minor test and one major TheoryExamination

Course Objectives

1. To make fundamentally strong base for decision making skills by applying the concepts of economics.
2. Educate the students on how to systematically evaluate the various cost elements of a typical manufactured product or service, with a view to determining the price offer.
3. Prepare engineering students to analyse profit/revenue data and carry out make economic analysis in the decision-making process to justify or reject alternatives/projects.
4. Be equipped with the tools necessary in forecasting product demand.
5. Understand and analyze the macro environment affecting the business decision making.
6. To make students understand basic elements of Indian Economy.

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.
Upon completion of this course, the student will demonstrate the ability:

1. Students will acquire basic knowledge in Engineering & managerial economics, which allows students to gain theoretical and empirical skill of economics.
2. To make Engineering students prepared for economic empowerment so that they could manage their wealth, help them in starting their own business or during managerial period.
3. Students will develop Interdisciplinary skills which can help them to thrive in the life- long changing environment in various fields of Industry of Economics.
4. Students will acquire practical knowledge of economics, the kind of markets, costtheory, various issues of demand and other major economic concepts.
5. Able to explain succinctly the meaning and definition of managerial economics; elucidate on the characteristics and scope of managerial

economics.

6. Able to describe the techniques of managerial economics.
7. Able to explain the applications of managerial economics in various aspects.
8. To learn about the management and economics of the industrial environment.

Topics Covered

UNIT-I 9

Introduction to the Managerial Economics- Economics and Managerial economics, Review of Economic Terms and Economic Rationality, Law of diminishing marginal utility, Theories of Profit, Decision making Process with reference to Managerial economics, Managerial Economics and its application in engineering perspective

UNIT-II 9

Theory of Demand: Law of Demand, Demand Function, Types of Demand, Demand Schedule, Demand Curve, Shift in Demand Curve, Factors affecting Demand, Elasticity of Demand, Theory of consumer behaviour.

Theory of Supply: Law of Supply, Supply Function, Supply Schedule, Supply Curve, Factors, affecting Supply

UNIT-III 9

Demand Forecasting: Meaning, significance and methods of demand forecasting, production function, Laws of returns to scale & Law of Diminishing returns scale. An overview of Short and Long run cost curves – fixed cost, variable cost, average cost, marginal cost, Opportunity cost.

UNIT-IV 9

Market Structure: Perfect Competition, Imperfect competition – Monopolistic, Oligopoly, duopoly sorbent features of price determination and various market conditions.
National Income, Inflation and Business Cycles: Concept of N.I. and Measurement. Meaning of Inflation, Type causes & prevention methods, Phases of business cycle

Books & References

1. Mote, Paul and Gupta, Managerial Economics, T M H, New Delhi.
2. H L Ahuja, Managerial Economics, S Chand & Co. New Delhi
3. P.L. Mehta, Managerial Economics, Analysis, Problems and Cases, Sultan Chand Sons, NewDelhi.
4. Prof. D.N. Kakkar , Managerial Economics for Engineering, PHI publication, New Delhi
5. Varshney and Maheshwari, Managerial Economics, Sultan Chand and Sons, New Delhi.Thermal Environment Engineering - Kuhen, Ramsey & Threlkeld (Prentice Hall)
6. Performance studies of desiccant cooling systems - P. Rai, S.K. Shukla (Lambert publicationGermany)

BME-390 Minor Project -1

Course category	:	Minor Project (P)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 0, Tutorial: 0 , Practical: 0
Number of Credits	:	0
Course Assessment methods	:	Continuous assessment through three viva voce/presentation, final project report, contribution made to literary world and Major examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Able to design the various component/subsystem of project using basic and advanced knowledge of science and engineering courses.
2. Able to analyze the various components/process of project problem.
3. Able to fabricate the hardware through different fabrication techniques available.
4. Able to make computer programme to design and analyze different components of product.
5. Able to make conclusion of given project.

BME-490 Minor Project-2

Course category	:	Minor Project (P)
Pre-requisite Subject	:	Minor Project -I (BME-390)
Contact hours/week	:	Lecture : 0, Tutorial : 0 , Practical: 12
Number of Credits	:	6
Course Assessment methods	:	Continuous assessment through viva voce/presentation, final project report, contribution made to literary world and Major examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Able to design the various component/subsystem of project using basic and advanced knowledge of science and engineering courses.
2. Able to analyze the various components/process of project problem.
3. Able to fabricate the hardware through different fabrication techniques available.
4. Able to make computer programme to design and analyze different components of product.
5. Able to make conclusion of given project.

SKILLS-ENHANCEMENT COURSES FOR EXIT MECHANICAL ENGINEERING

BME-159		Heating Ventilation and Air Conditioning (HVAC)
Course category	:	Skill Enhancement
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 2, Tutorial: 0 , Practical: 2
Number of Credits	:	3
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	:	This course is designed to provide occupational and technical information related to the safety, fundamentals of refrigeration, electrical circuits and controls, installation and service of residential hermetic units, and basic sheet metal fabrication.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Thorough understanding and increased knowledge of HVAC systems, including their installation, operation, maintenance and repair.

2. Increased confidence and experience to troubleshoot for any issues with HVAC systems in the least time possible
3. Greater skill and understanding to work with HVAC systems and ensure proper maintenance to reduce shutdowns or downtimes.
4. Increased confidence and experience to guide other professionals regarding all critical aspects of HVAC systems.
5. Better strategic skills and foresight to predict possible challenges and hindrances and address these in time, before they have grave impact
6. Enhanced skills and capabilities to work and assume higher roles and responsibilities related to HVAC systems across any organization, thereby increasing avenues for growth and progression

Topics Covered

UNIT-I 6

I**ntroduction to HVAC:** Fundamental and scope of HVAC, Mode of heat transfer , Standards Refrigeration cycle Component of A/C, Refrigerants and types

Classification of Air-Conditioning System: Window Air Conditioning Systems, Split Air Conditioning Systems, Central Air Conditioning Systems, Package Air Conditioning Systems.

Fundamental and scope of HVAC: Air cooled system of air conditioning, Chilled water system of air conditioning, Air water system of air conditioning, Direct refrigerant system of air conditioning.

UNIT-II 6

Study of Psychometric: Properties of Air (DBT, %RH, WB, DPT, enthalpy).

Load Calculation: Orientation of Building, To Read Latitude of Location of building, Calculation of U factor for wall, glass, Roof and Partition, Calculation of Equivalent Temp. Difference for wall, glass, Roof and Partition, Cooling and Heat Load Calculation using ASHRAE Standards, Calculation Of sensible Heat Factor, ADP and Dehumidified CFM

UNIT-III 6

Chilled water system: Definition of STHE, Study about Chilled Water Systems, Types & Application of Chillers, Open loop & Closed loop system- Chilled water pipe sizing, Types of Valves & Its Connection, Valve Authority, Primary and Secondary pump system, Hydraulic Calculation for Pump Selection

Expansion Tank Sizing, Air Separator, Pump Cavitations, Pump Curves, NPSH Calculation for Pumps, Advance Psychrometric Analysis, Determine Mix Air

Temperature, Calculate the Flow of Air, ESHF, Ton of Refrigeration, Design of CAV & VAV System. Components of Chilled Water system, Heat Gain Calculation, Manual Calculation, Hour analysis Program, Cooling and Heating Load calculation using Hourly Analysis Program (HAP)

UNIT-IV 6

Duct Designing:

Calculation of duct sizes by Mc-Quay Duct Sizer; Equipment and Air Terminal:
Cold storage selection. Selection of Materials of Ducts, Primary and secondary pump selections, Duct material selection, Selection of cooling tower, Selection of Chillers, AHU and FCU classification and selection, Package unit selection DX unit selection Section dwg, Pipe Designing, Air terminal selection.

Pipe Designing Refrigerant Pipe sizing. Chilled water pipe sizing, Calculation of Chilled water pipe sizes by Mc-Quay pipe Sizer Software, Static Pressure Calculation: Selection of Motor HP, Selection Fan/Blower RPM.

List of Experiments

1. Study of components and working of a Window Air Conditioner.
2. Performance analysis of a Vapor Compression Refrigeration System.
3. Identification and properties of different refrigerants used in HVAC systems.
4. Measurement of psychrometric properties of air (DBT, WBT, RH, DPT).
5. Calculation of sensible heat factor (SHF) and apparatus dew point (ADP).
6. Cooling load estimation for a room using ASHRAE procedures.
7. Selection and performance evaluation of cooling towers.
8. Refrigerant piping design and sizing calculations.
9. HVAC system layout and ducting design for a building.

Books & References

1. HVAC Fundamentals Volume-l / James E. Brumbou / Audel / 4th Edition
2. Fundamentals of HVAC Systems / Robert Mcdowall / Academic Press / 2007
3. Home Heating & Air Conditioning systems / James Kittle / MGH
4. HVAC Fundamentals / Samuel C. Sugarman / Fairmont Press / 2005.
5. Principles of Refrigeration – Dossat, Pearson 6. R&AC Handbook by ISHRAE

BME-160	**Machinist**
Course category	: Skill Enhancement
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 2, Tutorial: 0 , Practical: 2
Number of Credits	: 3
Course Assessment methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test and one Major Theory Examination
Course Objectives	: The objective of this course is to provide the student with knowledge in the areas of industrial safety, machining and machine tools as practiced in the field of Mechanical Engineering Technology
Course Outcomes	: Upon completion of this course, the student will demonstrate the ability to:

- Identify and remediate unsafe work practices within a shop environment.
- Perform a variety of machining operations on both an engine lathe and vertical milling machine.

- Apply tolerances, fits, surfaces finish requirements, and material selection to a given part or assembly.
- Determine machine tool speeds, feeds, and depth of cuts for a variety of machining applications.
- Understand machine code (G&M code) for (CNC) machine tools.

Topics Covered

UNIT-I 6

Plan & identify tools, instruments and equipment for marking and make this available for use in a timely manner. Identify hand tools for different fitting operations and make these available for use in a timely manner, Check for dimensional accuracy as per standard procedure. Plan and organize for fitting job.

Marking and Marking tools, Measuring instruments. Linear measurements - Steel rule – Marking media – Calipers – Dividers – Marking punches – Scriber – Hammer – Marking off table – Surface plate –vices – Angle plate – Try square – Combination set – Marking block – Parallel block.

UNIT-II 6

Precision measuring instruments: Micrometer (different types, parts, graduation, reading) – Vernier caliper – Dial Test Indicator- Bore dial gauge – Vernier height gauge –Vernier bevel protractor – Gear tooth caliper.

Hand tools: Hacksaw frame and blade – Saw setting – Files (types, uses, cut, grade, specification) – convexity of file – Pinning of file – Taps and Dies – Die nut – Chisel – Reamer

UNIT-III 6

Drilling: Lubricants and Cutting fluids, Maintenance, Drilling machines – types – various operations in drilling machine – Drill – Drill holding devices – work holding devices – tap drill size – Cutting speed, feed and depth of cut in drilling – Drilling defects and causes. Types of cutting fluids and purpose – Lubricants classification and properties – Lubricating system – Maintenance – Machine tool inspection

Lathe: Parts and functions – Types –Specification – Operations – Lathe accessories and attachments – Cutting speed, feed, RPM – Lathe tools and angles – Driving mechanism – Chip breaker – Taper turning methods – Taper and its types – Taper calculation – Sine bar and slip gauges – Screw thread and elements – Forms of screw threads – Lathe centre's – Mandrel – Thread cutting – Single and multi-start threads – Simple gear train and compound gear train – Lathe dogs – Driving plate – Face plate – Rests.

UNIT-IV 6

Milling: Milling machine – classification – specification – parts, functions – Application – cutter holding devices – milling cutters – cutter material – types of cutters – Nomenclature of milling cutter – Different milling operations – Up milling and down milling – Straddle milling – Gang milling – Cutting speed, feed and machining time – Dividing head types and uses – Types of indexing and calculations – Types of gears and uses – Elements of spur gear – Spur gear calculation – Selection of gear cutter – Helix and spiral elements, applications – Difference between helix and spiral – Methods of checking gear and its parts – Rack elements, application – Cam types and applications – Jigs and fixtures – Gauges material and purpose – Different types of gauges.

Grinding: Types of grinding machines – parts and functions of each types – Different grinding operations – Construction of grinding wheel – Standard marking system of grinding wheels – Glazing and loading – Dressing and truing – Cutting speed, feed and depth of cut – Shapes of grinding wheel and applications – Selection of grinding wheel – Wheel balancing – Wet grinding and dry grinding – Tool and cutter grinder attachments and their uses.

List of Practical:

1. Plan and organize the work to make job as per specification applying different types of basic fitting operation and check for dimensional accuracy.
2. Produce components by different operations and check accuracy using appropriate measuring instruments.
3. Make different fit of components for assembling as per required tolerance observing principle of interchange ability and check for functionality.
4. Set different shaped jobs on different chuck and demonstrate conventional lathe machine operation observing standard operation practice.
5. Set different components of machine & parameters to produce taper/ angular components and ensure proper assembly of the components.
6. Set the different machining parameters and cutting tool to prepare job by performing different slotting operation.
7. Set the different machining parameters and cutters to prepare job by performing different milling operation and indexing.
8. Set the different machining parameters to produce square & "V'' threaded components applying method/ technique and test for proper assembly of the components.
9. Produce components of high accuracy by different operations using grinding.
10. Read and apply engineering drawing for different application in the field of work.
11. Set different machining parameters and cutters to prepare job by different milling machine operations.
12. Set the different machining parameters and cutters to prepare components by performing different milling operations and indexing.
13. Plan and perform simple repairs, overhauling of different machines and check for functionality.

Textbooks and References:

1. Manufacturing Science: A. Ghosh and A.K. Mallik (East- West Press).
2. Workshop Technology Vol-I: B. S. Raghuvanshi (Dhanpat Rai and Sons)
3. Workshop Technology Vol-II: B. S. Raghubanshi (Dhanpat Rai and Sons)
4. A Textbook of Workshop Technology: Manufacturing Processes
5. Mechanical Workshop Practice, John K C, PHI

BME-261 FUNDAMENTALS OF CNC PROGRAMMING AND OPERATION

Course category : Skill Enhancement
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 2, Tutorial: 0, Practical: 2
Number of Credits : 3

Course Assessment Methods : Continuous assessment through class test, attendance, home assignments, quizzes, practical work, record, viva voce, and Two Minor tests and One Major Theory & Practical Examination

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understand the concept and requirements of Design and Manufacturing.
2. Knowledge of the components and working principle of the CNC Lathe.
3. Understand the components and working principle of CNC Vertical Machining Centre.
4. Learn the programming methods for typical components for CNC Lathe and CNC Vertical Machining Centre.
5. The knowledge of machining components with different materials.
6. Able to understand the machining concept, CNC programming codes, and operate the machine tools independently.

Topics Covered

UNIT-I

Introduction to Computer Numerical Control (CNC): 6

Introduction to Manual, Numerical Control, Computer Numerical Control and Direct Numerical Control Machine Tools, General Safety & Maintenance – Typical applications of CNC – Advantages and limitations of CNC – Classification of CNC machine tools.

UNIT-II

Programming fundamentals: 6

Procedure for manual NC programming – Structure of a program –Programming methods – Data input, Axes Designation for various CNC machine tools- Zero and Reference points on CNC Machine Tools.

UNIT-III

Part Programming for CNC Turning Centre: 6

G codes and M codes for CNC turning Centre-Introduction to Fanuc simulation software, Part programming practice-simple turning, facing, step turning, taper turning, circular interpolation. Part programming practice - thread cutting, grooving cycle, multiple turning cycle and multiple facing cycle, Internal operations-drilling and peck drilling.

UNIT-IV

Part Programming for CNC Vertical Machining Centre: 6

Co-ordinate system – absolute and incremental co-ordinate system, G-codes and M codes for CNC VMC, Part Programming practice – linear Interpolation. Part Programming practice circular interpolations, Program using subroutines, Program for cutter radius compensation.

EXPERIMENTS

Minimum Eight experiments are to be conducted from the followings:

1. To draw the CAD files as per design for machining of component.
2. Measurement dimensions of machined components using vernier calliper and other tools.
3. Proving the training for CNC Lathe on FANUC simulation software.
4. To determine the Tool Offset and Part programming in CNC Lathe for typical components.
5. Proving the training for CNC Vertical Machining on FANUC simulation software.
6. To determine the Tool Offset and Part programming in CNC Vertical Machining for typical components.
7. Study on the different Tool and Work holding devices and different types of cutting Tools used in machining.
8. Study on the cutting tool specification and tool selection, Tool offset setting, Work piece datum setting and Cutting parameters effect on MRR.
9. Write G-codes for machining of a cylindrical rod having threads with multiple turning steps.

10. Write G-codes for machining of a rectangular workpiece with internal pocketing operation.

Books & References

1. CAD/CAM/CIM- R. Radhakrishnan, S. Subramanian (New Age International Pvt. Ltd., New Delhi, 3rd Edition 2008)
2. CAD/CAM- Mikell P. Groover Emory Zimmers Jr (Pearson Education, New Delhi. 2002)
3. Computer control of manufacturing systems - Yoram Koren (McGraw Hill book company, USA)
4. CAD/CAM Principles and Applications -Dr. P.N. Rao (Tata Mc Graw Hill Publishing Company Ltd., New Delhi.2002)
5. Computer Aided Design and Manufacturing -Khushdeep Goyal (S.K. Kataria & Sons Educational Publisher, reprint 2021, New Delhi – 100 002.)
6. Production Management - Dr. A.P. Varma (S.K. Kataria & Sons, 5th edition 2020, New Delhi – 110 002.)
7. Geometric Dimensioning and Tolerancing- P.S. Gill (S.K. Kataria & Sons, 5th edition 2020, New Delhi – 100 002.)

BME-262 Welding Technology

Course category		Skill Enhancement
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 2, Tutorial: 0, Practical: 2
Number of Credits	:	3
Course Assessment methods	:	Continuous assessment through class test, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test, and one Major Theory & Practical Examination
Course Outcomes	:	After completing this course, students are expected to be able to demonstrate the following knowledge, skills, and attitudes.

CO1: Understand the fundamentals of the welding process and its classification.
CO2: Explain the working principles and applications of gas welding and cutting.
CO3: The knowledge of various arc & resistance welding processes and their applications.
CO4: Understand the fundamentals of pressure welding processes.
CO5: The ability to understand weld testing and inspection.
CO6: The knowledge of thermal and metallurgical considerations

Topics Covered

UNIT-I

Introduction: 6

Importance and application of welding, classification of welding process. Selection of the welding process. Brief review of conventional welding process.
Survey of welding and allied processes. Gas welding and cutting, process and equipment.

UNIT-II

Arc welding: Power sources and consumables, shielded metal arc, flux cored arc, submerged arc welding-consideration of shielding gases, electrode polarity. TIG & MIG processes and their parameters. 6

Resistance welding - spot, seam, projection etc.

UNIT-III

Introduction to pressure welding processes - friction welding, friction stir welding, ultrasonic welding, explosive welding, diffusion bonding and adhesive bonding. 6

Welding Mild Steel, Cast Iron, Aluminum, Stainless steel, Welding of pipelines and pressure vessels. Maurer/Schaeffler Diagram.
Soldering & Brazing

UNIT-IV

Weld Design: Welding machines/equipment and its characteristics and arc-stability, Weld defects and distortion and its remedies, Inspection/testing of welds, Life prediction. 6

Thermal and Metallurgical considerations: Thermal considerations for welding, temperature distribution, heating & cooling curves. Metallurgical consideration of weld, HAZ and Parent metal, micro & macro structure. Solidification of weld and properties

List of Experiments:
(Note: Minimum 8 experiments are to be performed)

1. Study the different types of welds and weld positions.
2. To weld metals using an oxyacetylene welding setup.
3. To prepare a butt joint using MMAW technique.
4. To prepare a Lap joint using MMAW technique.
5. To prepare a Lap and butt joint using Shielded metal arc welding process
6. To understand the working principle of submerged arc welding and its various parameters.
7. To prepare a Lap and butt joint using various GMAW welding parameters.
8. To study and understand the various non-destructive tests for welded joints.
9. To understand the effect of different welding parameters on the weld bead profile.
10. To prepare a butt joint with mild steel strips using brazing technique.

Textbooks and References:

1. Welding Processes and Technology – Dr. R. S. Parmar (Khanna Publication)
2. Manufacturing technology – Foundry, Forming and Welding- P. N. Rao (Tata McGraw Hill).
3. Welding and Welding Technology – Richard L. Little (Tata McGraw Hill).
4. Workshop Technology Vol1-B. S. Raghuvanshi (Dhanpat Rai and Sons)

BME-357 Hydraulics and Pneumatics

Course category	:	Skill Enhancement
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 2, Tutorial: 1, Practical: 0
Number of Credits	:	3
Course Assessment methods	:	Continuous assessment through class test, attendance, home assignments, quizzes, viva voce, one Minor test, and one Major Theory Examination
Course Outcomes	:	After completing this course, students are expected to be able to demonstrate the following knowledge, skills, and attitudes

CO1. Understand the working principle of various components used for hydraulic & pneumatic systems.
CO2. Identify various components of hydraulic Pumps systems, Hydraulic Actuators and Valve.
CO3. Explain the design pneumatic system for industrial applications.
CO4. Understand industrial applications of hydraulic and pneumatic system
CO5. Design of hydraulic and pneumatic circuits

Topics Covered

UNIT-I

Introduction- Need, scope and importance of hydraulic and pneumatic, Hydrostatic and Hydrodynamic definitions, properties of fluid, Pascal's law, Continuity equation and Bernoulli's equation. 6

Advantages and limitations of hydraulic and pneumatic systems

UNIT-II

Hydraulic Elements-Construction, working applications and selection criteria of pumps, Power packs, Other Elements such as filters, manifold, receivers, coolers and connecters. Hydraulic Actuators- Type, working and applications. Control Valves- Type, designation, symbols, working and applications, 6

Hydraulic Pipes- Type, materials, designations, pressure ratings and selection criteria. Piping Layout, Concept, rules/norms

UNIT-III

Fundamentals of Pneumatics and elements-Compressible fluid flow, mass flow rate, compressible fluid- Type, Properties and applications. Pipes- Type, designations, applications and properties. Air Compressor- Type (Reciprocating and rotary), working and selection, Pneumatic Cylinders- Type, symbol, cushion, assemblies, mounting and, Pneumatic Valves- Type, symbols, working, applications and selection, Air Motors- Type, working and applications. Installation. Other Elements - Air receivers, filters, pressure regulator, lubricator 6

UNIT-IV

Hydraulic and Pneumatic Circuits- Concept, Meaning and ISO symbols, Brief on the designing of hydraulic and pneumatic circuits. Applications. 6

Books & References

1. Fluid Mechanics & Hydraulic Machines by R K Bansal
2. Hydraulics and Pneumatics by A.Parr
3. Anthony Esposito," Fluid Power with Applications", PHI / Pearson Education, 2005
4. Shanmugasundaram.K, "Hydraulic and Pneumatic controls", Chand & Co, 2006. Credit Hours Marks 03 45 I E To 15 35 50 Reference Books:
5. Majumdar, S.R., "Pneumatic Systems – Principles and Maintenance", Tata McGraw Hill, 2007.
6. Srinivasan. R, "Hydraulic and Pneumatic Control", IInd Edition, Tata McGraw - Hill Education, 2012.

BME-358 Industrial Robotics and Material Handling Systems

Course category	:	Skill Enhancement
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 2, Tutorial: 1, Practical: 0
Number of Credits	:	3
Course Assessment methods	:	Continuous assessment through class test, attendance, home assignments, quizzes, viva voce, one Minor test, and one Major Theory Examination
Course Outcomes	:	After completing this course, students are expected to be able to demonstrate the following knowledge, skills, and attitudes

CO1. Explain the basic concepts, parts of robots and types of robots.

CO2. Discuss the various drive systems for robot, sensors and their applications in robots and programming of robots.

CO3. Illustrate the various applications of robots, justification and implementation of robot.

CO4. Design automatic manufacturing cells with robotic control

Topics Covered

UNIT-I

Introduction: Types of industrial robots, Load handling capacity, general considerations in Robotic material handling, material transfer, machine loading and unloading, CNC machine tool loading, Robot centered cell. 6

UNIT-II

Robots for Inspection: Robotic vision systems, image representation, object recognition and categorization, depth measurement, image data compression, visual inspection, software considerations 6

UNIT-III

Other Applications: Application of Robots in continuous arc welding, Spot welding, Spray painting, assembly operation, cleaning, robot for underwater applications. 6

UNIT-IV

End Effectors and Material Handling: Gripper design, degrees of freedom. Types of end effectors & their uses. Concepts of material handling, principles and considerations in material handling systems design, conventional material handling systems - industrial trucks, monorails, rail guided vehicles. 6

Books & References

1. Richaerd D Klafter, Thomas Achmielewski and Mickael Negin, “Robotic Engineering – An integrated Approach” Prentice HallIndia, New Delhi, 2001.
2. Mikell P. Groover,”Automation, Production Systems, and Computer Integrated Manufacturing“, 2nd Edition, John Wiley & sons, Inc, 2007
3. James A Rehg, “Introduction to Robotics in CIM Systems”, Prentice Hall of India, 2002.
4. Deb S R, "Robotics Technology and Flexible Automation", Tata McGraw Hill, New Delhi, 1994

Mechanical Engineering Department

Madan Mohan Malaviya University of Technology, Gorakhpur

Syllabus for Professional Elective -1

EME-101 INTRODUCTION TO ROBOTICS

Course category	:	Professional Elective (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment is done through tutorials, attendance, home assignments, quizzes, a minor test, and a major theory.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. The students should be to classify the manipulators and understand the specification.
2. The students should be able to understand the mechanical engineering concepts used for robotics.
3. The students should be able to perform a simple kinematics analysis of the manipulator.
4. The students should understand the concept of control techniques.
5. The students should be able to write a computer program for the robot.
6. The students should be able to understand the application of robots in different fields.

Topics Covered

UNIT-I

Introduction 9

Definition, Classification of Robots, Geometric classification and control classification, Robot Components, manipulator, controller and its elements, sensory devices, Functions of a robot system, and Robot specifications and applications.

Robot Sensors

Introduction, Classification, position sensors, velocity sensors, acceleration sensors, and proximity sensors. Developments in sensor technology using sensory control Vision.

UNIT-II

Mechanical Components 9

Introduction, Linear motion, Rotational motion, Moment of Inertia-calculation and measurement, Mechanical work and power, Motion conversion, Rotary-to-rotary motion, Rotary-to-linear motion.

Manipulator Kinematics

Position and orientation of a rigid body, Coordinate transformations-translational, rotational, Matrix operators, Coordinate reference frames, Homogeneous coordinates, Homogeneous transformations, manipulator forward solution, inverse solution,

UNIT-III

Robot Control 9

Control Techniques, Dynamics Systems, Transfer Function and State-Space Representation, Performance and stability of Feedback Control, Closed-loop control in position servo, Effect of friction and gravity, DC servomotor, PID Control, Multivariable Robot Control, Stability of Multi-DOF Robot, PD Position Control, Inverse Dynamic Control, Force control

UNIT-IV

Programming Language 9

Industrial robot programming languages examples, VAL language, robot programming for welding, machine tools, material handling etc.

Robot applications

Application of robots in surgery, manufacturing industries, space and underwater. Mobile robots, obstacle avoiding systems, walking devices.

Books & References

1. Introduction to Robotics – J.J. Craig, Pearson Education
2. Introduction to Robotics, S.K.Saha, McGraw Hill Publication
3. Robot Dynamics and Control, Mark W. Spong, M. Vidyasagar, John Wiley & Sons
4. Robotic Engineering-R.D. Klafter, T.A. Chmielewski and M. Negin, Prentice-Hall International
5. Robotics – K.S. Fu, R.C. Gonzalez & CSG Lee, McGraw Hill International
6. Robotics Engineering-an Integrated Approach - Richard D, Klafter, Thomason A Chmiel Owski, Michel Nagin, PHI
7. Robotics & Control- R.K. Mittal & I.J. Nagrath, TMH
8. Industrial Robotics, Technology, Programming, and Application-Groover. M.P. Mc-Graw Hill
9. Robotics Technology and Flexible Automation, S.R. Deb and S. Deb, McGraw Hill Education

EME-102 Fundamentals of Renewable Energy Sources

Course category : Professional Elective (PE)
Pre-requisite Subject : NIL
Contact hours/week : Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits : 4
Course Assessment Methods : Continuous assessment is done through tutorials, attendance, home assignments, quizzes, a minor test, and a major theory.
Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. Explain the principles of renewable energy conversion processes and analyze the global and Indian renewable energy availability.
2. Introduction of various renewable energy sources with its social as well as environmental implications and the concept of the Internet of Energy (IoE).
3. Fundamentals of solar energy with its characteristics as well as measurements and various hydraulic energy systems.
4. Principles, characteristics and limitations of wind and tidal energy.
5. Introduction to biomass energy with its conversion technologies and various practical applications.
6. Principles, limitations, and applications of geothermal energy.

Topics Covered

UNIT-I

Introduction to Renewable Energy 9

Principles of renewable energy and sustainable development, Global and Indian renewable energy availability and potential, Overview of solar, wind, hydraulic, tidal, wave, ocean thermal, biomass, geothermal, and oil shale energy, Social and environmental implications of renewable energy, Introduction to the Internet of Energy (IoE) and its applications.

UNIT-II

Solar and Hydraulic Energy Fundamentals 9

Solar radiation: Characteristics, estimation on horizontal and inclined surfaces, Solar radiation measurement: Pyrheliometers, Pyrometers, Sunshine Recorders, Solar photovoltaic systems: Principles, advantages, and limitations, Hydraulic energy: Principles of hydropower, types of turbines (Pelton, Francis, Kaplan), and small-scale hydropower systems.

UNIT-III

Wind and Tidal Energy 9

Wind energy: Properties, availability in India, wind velocity, and power estimation. Wind Energy Conversion Systems (WECS): Components, classification (Horizontal axis: single, double, multi-blade; Vertical axis: Savonius, Darrieus).

Tidal energy: Mechanics, characteristics, and harnessing methods, Advantages and limitations of tidal energy systems.

UNIT-IV

Biomass and Geothermal Energy 9

Biomass energy: photosynthesis, biofuels, and biomass resources; Biomass conversion technologies: fixed dome, urban waste to energy, gasification; Geothermal energy: Principles, availability, and extraction methods; Challenges and opportunities in biomass and geothermal energy utilization.

Books & References

1. Duffie, J. A., & Beckman, W. A. (2013). *Solar Engineering of Thermal Processes*, Fourth Edition, Wiley.
2. Tiwari, G. N., & Ghosal, M. K. (2007). *Fundamentals of Renewable Energy Sources*. Alpha Science International Limited.
3. Mukherjee, D., & Chakrabarti, S. (2004). *Fundamentals of Renewable Energy Systems*. New Age International.
4. Kothari, D. P., Singal, K. C., & Ranjan, R. (2011). *Renewable Energy Sources and Emerging Technologies*. PHI Learning Pvt. Ltd.
5. Paish, O. (2002). *Small Hydropower: Technology and Current Status*. Renewable and Sustainable Energy Reviews.

EME-103 Smart Manufacturing

Course category	:	Professional Electives (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, one Minor test and one Major Theory
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Discuss the importance and be able to critically discuss the role of smart manufacturing systems in industry.
2. To understand basic concept of Smart Manufacturing/Industry-4.0.
3. To proficient with various hardware and software used in Advanced Automation, and Smart Manufacturing systems.
4. To build and assess cyber security enabled applications for manufacturing and supply chain.
5. To provide consulting services in the field of Smart Manufacturing Systems.
6. To pursue higher education in advancements in the field of Smart Manufacturing Systems.

Topics Covered

UNIT-I

Introduction to Smart Manufacturing 9

Introduction to smart manufacturing, difference from conventional/legacy manufacturing; Smart Manufacturing Processes Dimensions: Demand Driven and Integrated Supply Chains; Dynamically Optimized Manufacturing Enterprises (plant + enterprise operations); Real Time, Sustainable Resource Management (intelligent energy demand management, production energy optimization and reduction of GHG).

UNIT-II

Smart Design/ Fabrication 9

Smart Design/Fabrication - Digital Tools, Product Representation and Exchange Technologies and Standards, Agile (Additive) Manufacturing Systems and Standards. Mass Customization, Smart Machine Tools, Robotics and Automation (perception, manipulation, mobility, autonomy), Smart Perception – Sensor networks and Devices.

UNIT-III

Smart Communication system 9

Information, Mobility, Communication Technologies, Protocols, Cyber Physical Systems – the next generation of Embedded Systems and Networks, IT and OT convergence, co-creation and collaboration enablement. Smart Cloud- Hyper scale Computing; Application Delivery.

UNIT-IV

Smart Applications 9

Online Predictive Modeling, Monitoring and Intelligent Control of Machining/Manufacturing and Logistics/Supply Chain Processes; Smart Energy Management of manufacturing processes and facilities.

Books & References

1. Bahga and V. Madisetti, Internet of Things, A hands-on approach, CreateSpace Independent Publishing Platform, 1st edition, 2014, ISBN: 978-0996025515.
2. R. Zurawski, Integration Technologies for Industrial Automated Systems, 1st edition, CRC Press, 2006, ISBN: 9780849392627
3. S. Jeschke, C. Brecher, H. Song, and D. B. Rawat, Industrial Internet of Things: Cybermanufacturing Systems, Springer, 1st edition, 2017, ISBN: 978-3319425580.
4. D. Boswarthick, O. Elloumi, and O. Hersent, M2M communications: A systems approach, Wiley, 1st edition, 2012, ISBN: 978-1119994756.
5. Anton-Haro and M. Dohler, Machine-to-machine (M2M) Communications: Architecture, Performance and Applications, Woodhead Publishing, 1st edition, 2015, ISBN: 978-1782421023.
6. G. Alciatore and M. B. Histand, Introduction to Mechatronics and Measurement Systems, McGraw-Hill, 4th edition, 2014, ISBN: 978-9339204365.

EME-104 Numerical Methods for Engineers

Course category	:	Professional Electives (PEs)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, viva voce, one Minor tests and One Major Theory exam.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understanding of fundamentals and errors in numerical methods and their application in engineering.
2. Ability to solve linear and nonlinear algebraic equations using numerical methods.
3. Knowledge of interpolation, curve fitting, numerical differentiation and integration techniques.
4. Ability to solve ordinary and partial differential equations numerically.

5. Develop algorithms and code using MATLAB/Python to solve practical engineering problems.
6. Critical comparison of methods with respect to accuracy, efficiency and convergence.

Topics Covered

UNIT-I

Fundamentals of Numerical Methods 9

Introduction to numerical computation, sources of error, error propagation and stability.
Solution of algebraic and transcendental equations: Bisection, Regula-Falsi, Newton-Raphson methods.
Linear system of equations: Gauss Elimination, Gauss-Seidel, LU Decomposition.

UNIT-II

Interpolation and Curve Fitting 9

Finite difference operators, Newton's forward, backward and central difference interpolation, Lagrange interpolation.
Curve fitting: Least squares method, Linear and polynomial regression.
Numerical Differentiation and Integration: Finite difference approximations, Trapezoidal rule, Simpson's rules. Thermometers, bimetallic thermocouples, thermistors, and pyrometers

UNIT-III

Ordinary Differential Equations 9

Euler's method, Modified Euler's, Runge-Kutta methods of 2nd and 4th order, Predictor-Corrector methods.
Boundary Value Problems and Applications in Engineering.

UNIT-IV

Partial Differential Equations and Advanced Applications 9

Finite difference methods for PDEs: Elliptic, Parabolic and Hyperbolic equations., Stability and convergence of numerical schemes.
Introduction to numerical linear algebra and eigenvalue problems.

Books & References

1. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI.
2. Steven C. Chapra & Raymond P. Canale, Numerical Methods for Engineers, McGraw-Hill.
3. Jain, Iyengar & Jain, Numerical Methods for Scientific and Engineering Computation, New Age International.
4. Balagurusamy E, Numerical Methods, Tata McGraw-Hill.
5. Mathews J.H. & Fink K.D., Numerical Methods Using MATLAB, Pearson Education.

Syllabus for Professional Elective -2

EME-201		**Additive Manufacturing Technology**
Course category	:	Professional Electives (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and one Minor tests and One Major Theory
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

CO1: Understand the fundamental principles and historical evolution of Additive Manufacturing (AM) technologies
CO2: Analyze and resolve data-related issues in AM including STL file errors, digital inspection, and network-based operations
CO3: Demonstrate knowledge of materials used in AM and understand the impact of solidification, microstructure, and material properties on part performance
CO4: Compare and contrast various AM processes based on materials and working principles (e.g., powder-based, solid-based, droplet-based)
CO5: Apply concepts of monitoring, control, and defect mitigation in AM to enhance product quality
CO6: Integrate the knowledge of reverse engineering and traditional manufacturing with AM for applications like rapid prototyping and tooling

Topics Covered

UNIT-I

Introduction to Additive Manufacturing (AM) 9

Historical developments, Fundamentals of RP/AM Systems and their Classification, Rapid prototyping process chains, 3D modelling and mesh generation, Data conversion and transmission.

UNIT-II

Additive manufacturing Data base 9

Rapid prototyping data formats, STL format, STL file problems, STL file repair, Network based operations, Digital inspection, Data warehousing and learning from process data; Types of curves and its application in AM.

UNIT-III

Materials and Mechanics for AM 9

Discussion on different materials, multifunctional and graded materials in AM, Role of solidification rate, Evolution of non-equilibrium structure, Structure property relationship, Grain microstructure.

UNIT-IV

Processing and Aapplications of different AM Techniques 9

Powder-based AM processes involving sintering and melting (selective laser sintering, shaping, electron beam melting. involvement). Printing processes (droplet based 3D Solid-based AM processes, extrusion based fused deposition modeling, Stereolithography, Micro- and nano-additive. Discussion on the applications of various additive manufacturing (AM) processes.
Monitoring and control of defects. Introduction to reverse engineering Traditional manufacturing via AM, Direct processes – Rapid Prototyping, Rapid Tooling.

Books & References

1. Rapid Manufacturing: An Industrial Revolution for the Digital Age. Neil Hopkinson, Richard Hague, Philip Dickens (Editors); Wiley; Jan., 2006; ISBN: 10: 0470016132; 13: 978-0470016138.
2. Additive Manufacturing Technologies; Rapid Prototyping to Direct Digital Manufacturing. Ian Gibson, David W. Rosen, Brent Stucker; Springer; January, 2010; ISBN: 978-1-4419-1119-3.
3. Rapid Prototyping: Principles and Applications. Rafiq I. Noorani; Wiley; Oct., 2005; ISBN: 10: 0471730017; 13: 978-0471730019.
4. User's Guide to Rapid Prototyping. Todd Grimm; Society of Manufacturing Engineers; February, 2004; ISBN: 0-87263-697-6.
5. Rapid Prototyping - Laser-based and Other Technologies. Patri K. Venuvinod and Weiyin Ma; Kluwer Academic Publishers; October, 2003; ISBN: 1-4020-7577-4.

EME-202 Energy Conservation and Waste Heat Recovery

Course category : Professional Elective (PE)

Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one Minor test, and one Major Theory.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Realize energy resources, their usage patterns, and effective conservation strategies.
2. Apply thermodynamic principles to evaluate and improve energy systems.
3. Design, operate, and optimize waste heat recovery technologies.
4. Select and implement suitable energy storage solutions.
5. Create innovative energy systems and comprehensive business plans.
6. To acquire knowledge about various energy storage systems and its optimization

Topics Covered

UNIT-I

Energy Resources, Conservation, and Utilization 9

Energy Resources and Use: Overview of global energy resources, Patterns of energy consumption Potential for Energy Conservation Optimal Utilization of Fossil Fuels: Techniques for improving fossil fuel utilization, Environmental and economic impacts Total Energy Approach Coupled Cycles and Combined Plants.

UNIT-II

Cogeneration Systems and Exergy Analysis: Cogeneration Systems Exergy Analysis Utilization of Industrial Waste Heat. 9

UNIT-III

Heat Recovery Systems and Technologies: Heat Exchangers: Recuperators and regenerators, Shell and tube heat exchangers, Spiral tube and plate heat exchangers Waste Heat Boilers Heat Pipes Prime Movers: Sources and uses of waste heat, Fluidized bed heat recovery systems. 9

Advanced Waste Heat Recovery Applications: Waste Heat in HVAC Systems Thermoelectric Systems Heat Pumps for Energy Recovery and Heat Recovery from Incineration Plants

UNIT-IV

Energy Storage, Optimization, and Advanced Applications 9

Energy Storage Systems: Importance and need for energy storage, Thermal storage systems (sensible and latent), Electrical storage systems, Thermo-Chemical storage systems Utilization of Low-Grade Reject Heat Thermo-Economic Optimization

Books & References

1. Mehta, C. R., & Sontakke, N. K. (2020), Waste Heat Recovery: Principles and Industrial Applications, Springer
2. Vanek, F. M., Albright, L. D., & Angenent, L. T. (2021), Energy Systems Engineering: Evaluation and Implementation, McGraw-Hill Education.
3. Mehta, C. R., & Sontakke, N. K. (2020), Waste Heat Recovery: Principles and Industrial Applications, Springer
4. Fuller, T. F. (2017), Cogeneration and Combined Heat and Power (CHP): Thermodynamics and Economics (Reprint), Elsevier

EME- 203		**GAS DYNAMICS**
Course category	:	
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	3
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Two Minor tests and One Major Theory.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understand the basics of thermodynamic cycles for Jet engines.
2. The knowledge of compressible fluid flow at inlets, the compressor, and the turbine.
3. The understanding of concepts and analyzing jet engines, determining propulsion efficiency, and designing inlets and nozzles.
4. The understanding of concepts of Combustion Physics in the combustion chamber.
5. To understand the Gas Dynamics of Combustors
6. To understand the design and analysis of various types of compressors

Topics Covered

UNIT-I

Introduction, Early aircraft engines, Types of aircraft engines, Reciprocating internal combustion engines, Concept of gas turbine, Analysis of turbine stages, Gas Turbine engines, Turbo jet Engines, Turbo fan engine, Turbo-prop engine, Rocket propulsion. Aircraft propulsion theory: Thrust, Thrust power, Propulsive and Overall efficiencies, Problems. 9

UNIT-II

Thermodynamic Analysis of Turbo-jet Engine- Study of subsonic and supersonic engine models- Identification and selection of optimal operational parameters. Need for further development- Analysis of Turbojet with after burner. 9

Thermodynamics Analysis of Turbofan Engine- Study of subsonic and supersonic engine models- Identification and selection of optimal operational parameters. Design of fuel-efficient engine, Mixed flow turbo fan engine, Analysis of Turbofan with after burner.

Thermodynamics Analysis of Turboprop Engine- Study of subsonic and supersonic engine models- Identification and selection of optimal operational parameters.

UNIT-III

Fundamentals of Gas dynamics- Energy Equation for a non-flow process and Energy Equation for a flow process, Adiabatic energy equation, Momentum Equation-Moment of momentum equation, Stagnation Velocity of Sound, Stagnation Pressure, Stagnation Density, Stagnation state – Velocity of Sound, critical states, Mach number, Critical Mach number, Various regions of flow. 9

Analysis of Diffusers and Nozzles- Introduction- Study of intakes for subsonic and supersonic engines, Comparison of Isentropic and adiabatic processes, Mach number variation, Area ratio as function of Mach numbers, Impulse function, Mass flow rates- Flow through nozzles, Flow through Diffusers, Effect of friction- Analysis of Intakes for supersonic engines, Intakes with normal shock- Oblique shocks.

UNIT-IV

Gas Dynamics of Combustors – Stoichiometry of combustion, calculation of air-fuel ratio, gas dynamics of combustors, thermal loading factors- design and selection of combustors. 9

Study of Compressor- Design and analysis of compressors, Classification, Analysis of centrifugal compressors, velocity triangles, Analysis of axial flow compressor, analysis of stage, characterization of stage, Performances analysis of centrifugal and axial flow compressors.

Books & References

1. . Ahmed F. El-Sayed, Aircraft Prpoulsion and Gas Turbine Engines, CRC Press, 2008.
2. Gas Dynamics and Jet Propulsion by Dr. S. Senthil from Lakshmi Publications, CME386
3. H.S. Mukunda, "Understanding Aerospace Chemical Propulsion", Interline Publishing,2004.
4. Hill P. and Peterson C., Mechanics & Thermodynamics of Propulsion, Addison Wesley,1992.

EME- 204 Fundamentals of EV and HEV

Course category	:	
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and one Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. To understand upcoming technology of electric and hybrid electric vehicles
2. Learn different energy management strategies
3. To understand the performance and configuration of HEVs
4. To understand different challenges and technologies of Hybrid electric vehicles
5. Explain the concept of vehicle-to-grid configurations
6. Analyze different aspects of drive train topologies.

Topics Covered

UNIT-I

Introduction to EV 9

Current demand in EV industry and opportunities of skilled EV engineers, History and evolution of electric vehicles, Components of an electric vehicle, EV classification and their electrification levels

UNIT-II

Vehicle Fundamentals 9

Battery technology, Motor and controller systems, EV numerical calculation, EV charging infrastructure, Electrical requirement, Power distribution specifications, Electronic component system, EV standard specifications, Selection of electrical and electronic component

UNIT-III

Hybrid Electric Vehicles 9

HEVs Fundamentals, Vehicle performance, Configuration of HEV (Series, Parallel, Series-parallel &Complex), Power Flow control, Operation of HEVs, Challenges and key technology of HEVs. Basics of Hybrid Electric Vehicle (HEV), Basics of plug-in Hybrid Electric Vehicles(PHEV) Basics of Fuel Cell Vehicles (FCVs). Vehicle to grid technology

UNIT-IV

Electric Drive-trains 9

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis

Books & References

1. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2nd Edition, 2003.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004
3. James Larminie, John Lowry, "Electric Vehicle Technology", Wiley publications, 1st Edition, 2003.
4. B D McNicol, D A J Rand, "Power Sources for Electric Vehicles", Elsevier publications, 1st Edition, 1998 .

Syllabus for Professional Elective -3

EME-301 **SMART MATERIALS FOR MECHATRONICS**

Course category	:	Professional Elective (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, one Minor test and one Major Theory
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understand the fundamentals, classification, and mechatronic integration of smart materials, comparing them with traditional materials.
2. Analyze piezoelectric materials and their constitutive behavior for sensing, actuation, and precision control applications.
3. Evaluate the properties and actuation mechanisms of shape memory alloys for smart structures and adaptive systems.
4. Examine different types of electro-active polymers and their use in biomimetic and medical device applications.
5. Understand magnetostrictive materials, their design, and their application in active vibration control systems.
6. Compare smart material-based actuators and explore current trends and future applications in smart systems.

Topics Covered

UNIT-I

Introduction: Introduction to Smart Materials, Definition and classification, Comparison with conventional materials, Applications in mechatronics, Material selection criteria, Smart materials and their application for sensing and actuation, Mechatronics aspects. 9

UNIT-II

Piezoelectric materials: Piezoelectricity and piezoelectric materials, Piezoelectric actuator types, Actuation and sensing applications, Applications of piezoelectric actuators for precise positioning and scanning, Design considerations and limitations. 9

UNIT-III

Shape memory alloys (SMA): Properties of shape memory alloys, Shape memory effects, Pseudo-elasticity in SMA, Thermomechanical behavior, Applications in actuators and self-healing structures, Applications of SMA in precision equipment. 9

UNIT-IV

Electro-active polymers (EAPs): Basics of anelectro-active polymers, Ionic polymer metal composites (IPMC), Conductive polymers, Carbon nanotubes, Dielectric elastomers, Applications of EAP. 9

Magnetostrictive materials: Basics of magnetostrictive materials, Types of magnetostrictive materials, Applications of magnetostrictive materials for active vibration control. Future research trend and applications trends of smart materials.

Books & References

1. Smart Materials and Structures, M. V. Gandhi & B. S. Thompson,Springer Dordrecht.
2. Smart Material Systems and MEMS: Design and Development Methodologies, V. K. Varadan, K. J. Vinoy, & K. A. Jose, John Wiley & Sons.
3. Smart Sensors and MEMsStoyanNihtianov and Antonio Luque, Woodhead Publishing Series in Electronic and Optical Material.
4. Mechatronics: Principles and applications, Onwubolu, Godfrey C, Amsterdam; Boston: Elsevier Butterworth-Heinemann.
5. Mechatronics Integrated Mechanical Electronic System, K.P. Ramachandran, G.K. Vijayaraghavan, and M.S.Balasundaram, Wiley Publication.

EME-302 Renewable Energy Technologies

Course category	:	Professional Elective (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment is done through tutorials, attendance, home assignments, quizzes, a minor test, and a major theory.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course.

1. Design solar thermal and photovoltaic systems for energy generation.
2. Analyze wind energy conversion technologies for efficiency.
3. Evaluate hydraulic and ocean energy systems for practical applications.
4. Apply biomass conversion technologies for energy production.
5. Develop hybrid renewable energy systems for decentralized power.
6. Integrate renewable technologies into existing energy infrastructure.

Topics Covered

UNIT-I

Advanced Solar Energy Technologies 9

Solar thermal power plants: Parabolic trough, solar tower, and dish systems.

Photovoltaic systems: Module efficiency, balance of systems, and performance analysis.

Energy storage for solar: Batteries, thermal storage, and emerging technologies. Applications of solar energy in rural and urban settings.

UNIT-II

Wind and Hydraulic Energy Systems 9

Aerodynamics of wind turbines: Blade design and performance optimization.

Hydropower technologies: Large-scale dams, run-of-river, and micro-hydropower systems.

Hydraulic Turbine Design and Efficiency: Selection Criteria for Turbines.

Wind farm planning: Site selection, layout, and grid integration.

UNIT-III

Ocean and Tidal Energy Technologies 9

Ocean Thermal Energy Conversion (OTEC): Principles, types, and global installations.
Wave energy converters: Oscillating water columns, point absorbers, attenuators.
Tidal barrages and tidal stream systems: Design and environmental considerations. Future prospects of ocean energy technologies.

UNIT-IV

Biomass and Hybrid Systems 9

Advanced biomass conversion: Anaerobic digestion, pyrolysis, and co-firing.
Hybrid renewable energy systems: Solar-wind, solar-hydraulic, and multi-source integration.
Energy management in decentralized power systems, Case studies on renewable energy technology implementations.

Books & References

1. Sukhatme, S. P. (2005). *Solar Energy: Principles of Thermal Collection and Storage*. Tata McGraw Hill.
2. Sørensen, B. (2017). *Renewable Energy: Physics, Engineering, Environmental Impacts, Economics and Planning*. Academic Press.
3. Boyle, G. (2012). *Renewable Energy: Power for a Sustainable Future*. Oxford University Press.
4. Kalogirou, S. A. (2013). *Solar Energy Engineering: Processes and Systems*. Academic Press.
5. Dixon, S. L., & Hall, C. A. (2014). *Fluid Mechanics and Thermodynamics of Turbomachinery*. Butterworth-Heinemann.

EME 303	**Additive Manufacturing**
Course category	: Professional Electives (PE)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	: 4
Course Assessment methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes, one Minor test and one Major Theory
Course Outcomes	: The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

CO1: Understand the fundamental principles and historical evolution of Additive Manufacturing (AM) technologies
CO2: Analyze and resolve data-related issues in AM including STL file errors, digital inspection, and network-based operations
CO3: Demonstrate knowledge of materials used in AM and understand the impact of solidification, microstructure, and material properties on part performance
CO4: Compare and contrast various AM processes based on materials and working principles (e.g., powder-based, solid-based, droplet-based)
CO5: Apply concepts of monitoring, control, and defect mitigation in AM to enhance product quality
CO6: Integrate the knowledge of reverse engineering and traditional manufacturing with AM for applications like rapid prototyping and tooling

Topics Covered

UNIT-I

Introduction to Additive Manufacturing (AM) 9

Historical developments, Fundamentals of RP/AM Systems and their Classification, Rapid prototyping process chains, 3D modelling and mesh generation, Data conversion and transmission.

UNIT-II

Additive manufacturing Data base 9

Rapid prototyping data formats, STL format, STL file problems, STL file repair, Network based operations, Digital inspection, Data warehousing and learning from process data; Types of curves and its application in AM.

UNIT-III

Materials and Mechanics for AM 9

Discussion on different materials, multifunctional and graded materials in AM, Role of solidification rate, Evolution of non-equilibrium structure, Structure property relationship, Grain microstructure.

UNIT-IV

Processing and Applications of different AM Techniques 9

Powder-based AM processes involving sintering and melting (selective laser sintering, shaping, electron beam melting. involvement). Printing processes (droplet based 3D Solid-based AM processes, extrusion based fused deposition modeling, Stereolithography, Micro- and nano-additive. Discussion on applications of different AM processes.

Monitoring and control of defects. Introduction to reverse engineering Traditional manufacturing via AM, Direct processes – Rapid Prototyping, Rapid Tooling.

Books & References

1. Rapid Manufacturing: An Industrial Revolution for the Digital Age. Neil Hopkinson, Richard Hague, Philip Dickens (Editors); Wiley; Jan., 2006; ISBN: 10: 0470016132; 13: 978-0470016138.
2. Additive Manufacturing Technologies; Rapid Prototyping to Direct Digital Manufacturing. Ian Gibson, David W. Rosen, Brent Stucker; Springer; January, 2010; ISBN: 978-1-4419-1119-3.
3. Rapid Prototyping: Principles and Applications. Rafiq I. Noorani; Wiley; Oct., 2005; ISBN: 10: 0471730017; 13: 978-0471730019.
4. User's Guide to Rapid Prototyping. Todd Grimm; Society of Manufacturing Engineers; February, 2004; ISBN: 0-87263-697-6.
5. Rapid Prototyping - Laser-based and Other Technologies. Patri K. Venuvinod and Weiyin Ma; Kluwer Academic Publishers; October, 2003; ISBN: 1-4020-7577-4.

EME-304 **Software Applications for Engineering Problems**

Course category	:	Professional Electives (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 2, Tutorial: 0, Practical: 4
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through attendance, home assignments, quizzes, practical work, record, viva voce and one minor test and one major theory & practical examination
Course Objectives	:	To develop skills for using different software's for solving mechanical engineering problems.
Course Outcomes	:	Upon completion of this course, the student will demonstrate the ability to:

1. Understand the concept of EES software for mechanical engineering applications
2. Understand the concept of MATLAB software for mechanical engineering applications
3. Understand the concept of ANSYS software for mechanical engineering applications
4. To analyze the mechanical engineering problems using different software's.
5. Ability to analyze structural problems using ANSYS
6. Acquire ability to analyze fluid flow problems using EES

Topics Covered

UNIT-I: 6
Introduction to EES and Its applications for Integration, Differential Equations and Thermal Problems

UNIT-II 6
Introduction to MATLAB and its applications for Engineering mechanics and Vibration problems.

UNIT-III 6
Introduction to ANSYS Workbench, Types of analysis that can be done using ANSYS.

UNIT-IV 6
Structural Analysis, Thermal and Fluid Flow Analysis

List of Practical:

1. To find out the integration with Runga-Kutta method using EES
2. To use the Integral function with parametric Table using ES
3. To determine the thermal efficiency of vapor power cycle using EES.
4. To determine the diagram efficiency of impulse steam turbine using EES.
5. To write a MATLAB program to determine the magnitude and direction of the resultant of 3-coplanar forces.
6. To write a MATLAB script for plotting the non-dimensional response magnitude for a system with harmonically moving base
7. To Find the deflection of simply supported beams using ANSYS
8. To Find the deflection of cantilever beams using ANSYS
9. To find out the velocity and pressure variations in pipe flow using ANSYS.
10. To perform analysis on duct flow using ANSYS

Textbooks and References:

1. MATLAB: An Introduction with Applications by Rao V Dukkipati New Age International Pvt Ltd
2. Getting Started with MATLAB: A Quick Introduction for Scientists & Engineers by Rudra Pratap, Oxford; Edition (1 January 2010)
3. ANSYS Manual
4. EES Manual

Syllabus for Professional Elective -4

EME-401	**Design for Additive Manufacturing**
Course category	: Professional Electives (PE)
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	: 4
Course Assessment methods	: Quiz, Tutorials, and Exam
Course Outcomes	: The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

CO1: Understand the principles, constraints, and considerations that distinguish design for additive manufacturing (DfAM) from traditional manufacturing design approaches.

CO2: Apply process-specific design rules and guidelines to create manufacturable 3D models suitable for various additive manufacturing technologies.

CO3: Analyze and optimize designs for support structures, build orientation, and material usage to improve printability and performance.

CO4: Utilize design tools and software to create complex geometries such as lattice structures and perform topology optimization for lightweight and functional designs.

CO5: Evaluate multi-material and functionally graded designs for engineering applications using simulation and design validation techniques.

CO6: Develop and present real-world DfAM case studies and projects, demonstrating the ability to redesign existing parts or systems for AM-based production.

EME-402 Bioenergy

Course category :

Pre-requisite Subject : Nil

Contact hours/week : Lecture: 3, Tutorial: 1, Practical: 0

Number of Credits : 4

Course Assessment : Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, and One Mid Term Test and One Major Theory.

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Explain the fundamental concepts of bioenergy and its role in the global and national energy landscape.
2. Identify and classify different biomass resources and evaluate their potential for energy production.
3. Analyse the processes for producing biofuels such as biogas, ethanol, and biodiesel, and evaluate their applications and limitations.
4. Design or assess bioenergy systems such as biogas plants or biomass gasifiers for rural or industrial applications.
5. Evaluate the environmental and economic impacts of bioenergy systems using tools like Life Cycle Assessment (LCA) and carbon footprint analysis.
6. Interpret and apply current government policies, incentives, and international trends in bioenergy development.

Topics Covered

UNIT-I

Introduction to Bioenergy: 9

Definition, Scope, Importance of renewable energy, Comparison with other renewable sources (solar, wind, hydro), Global and national bioenergy scenario

Biomass Resources:

Types of biomass: wood, agricultural residues, energy crops, algae**,** Availability and characteristics**,** Biomass collection, handling, and storage**,** Biomass energy potential and conversion efficiency

UNIT-II

Biomass Conversion Technologies: 9

Thermochemical conversion: Combustion, Pyrolysis, Gasification, Liquefaction

Biochemical conversion:

Anaerobic digestion, Fermentation, Enzymatic hydrolysis

Mechanical extraction:

Oil extraction techniques, Biodiesel production

UNIT-III

Biofuels: 9

First-generation biofuels: ethanol, biodiesel, Second-generation biofuels: cellulosic ethanol, advanced biodiesel, Third-generation biofuels: algal biofuels, Fuel properties and standards, Applications in transportation and industry.

Bioenergy Systems and Applications:

Bioenergy power plants, Combined heat and power (CHP) systems, Domestic and rural applications, Waste-to-energy systems

UNIT-IV

Environmental and Economic Aspects: 9

Emissions and pollution control, Life Cycle Assessment (LCA) of bioenergy systems, Carbon footprint and climate change mitigation, Cost analysis and economic feasibility, Government policies, incentives, and international cooperation (IEA Bioenergy, MNRE India)

Recent Advances and Case Studies:

UNIT-I

Fundamentals of Design for Additive Manufacturing 9

Define DfAM, Difference between traditional design and DfAM, Process-structure-property relationship in AM, Key design constraints in AM (overhangs, minimum feature size, layer orientation), Design challenges: warping, residual stress, anisotropy, AM design workflow, Introduction to designing software.

UNIT-II

Design Guidelines and Strategies for AM 9

General design guidelines: Self-supporting features, hole sizes, escape holes, Material-specific design: Polymers, metals, composites, Support structures: Design, optimization, and removal, Assembly consolidation and multi-part designs.

UNIT-III

Advanced Design Concepts in AM 9

Topology Optimization (TO) concepts, software tools (Fusion 360, ANSYS, nTopology), Lattice Structures: Types, unit cells, applications in lightweighting, multi-material and functionally graded design.

UNIT-IV

Applications, Tools, and Case Studies 9

Industrial applications: aerospace, automotive, biomedical, tooling, Design for specific AM processes: SLS, FDM, SLA, DMLS, Software tools: nTopology, Fusion 360, and Autodesk Netfabb, Case studies: 3D printed implants, aerospace brackets, lattice helmets, heat exchangers, Emerging trends: 4D printing, bio-inspired design,

Books & References

1. **Ian Gibson et al.**, *Additive Manufacturing Technologies* (Springer)
2. **Steafan Walsh et al.**, *Design for Additive Manufacturing: A Guide* (SpringerBriefs)

Emerging technologies, Innovations in bioenergy conversion, Global bioenergy projects, Role of bioenergy in sustainable development.

Books & References

1. Prabir Basu, "Biomass Gasification and Pyrolysis", Elsevier Inc., 2010.
2. Sunggyu Lee and Y. T. Shah, "Biofuels and Bioenergy: Processes and Technologies", CRC Press, Taylor & Francis Group, 2013.
3. Erik Dahlquist, "Biomass as Energy Source Resources, Systems and Applications", CRC Press, Taylor & Francis Group, UK, 2013.
4. G N Tiwari, M K Ghosal, "Fundamentals of Renewable Energy Sources", Narosa Publishing House, 2005.

EME-403 Alternate Fuels

Course category	:	Professional Elective (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Two Minor tests and One Major Theory.
Course Objectives	:	To provide a comprehensive understanding of sustainable energy sources, focusing on their production, properties, and applications to meet decarbonization goals. Key objectives include evaluating alternative fuels (e.g., hydrogen, ammonia, biofuels) for transportation and industrial use, assessing safety, and environmental impact.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understand the basics of alternative fuels and their properties
2. The knowledge of biogas and alcohol fuels as an alternate fuel in IC engines
3. Understand the concepts of hydrogen production and its application as alternate fuel.
4. The understanding of different emissions and methods to reduce harmful pollutants

Topics Covered

UNIT-I

Introduction: SI and CI engines, Classification of alternative fuels, Estimate of petroleum reserve, Need for alternate fuel, Availability and comparative properties of alternate fuels, CNG, LNG, LPG, Alcohol, Vegetable oil and Bio-gas. 9

UNIT-II

Properties and production of Biogas, classification of biogas plants, Storage, Handling and dispensing, Safety aspects, merits and demerits, Manufacture of alcohols, properties, blending of methanol and ethanol, Performance and emission characteristics, Durability, Types of vegetable oils for engine application, Biodiesel application. 9

UNIT-III

Hydrogen production methods, Properties, Storage and handling, Safety aspects, Advantages and disadvantages of hydrogen, use of Hydrogen in SI and CI engines. Working principle, Classification, Description of fuel cell systems, Fuel cell components, Properties of fuel cell, General performance characteristics, Emission characteristics, Merits and demerits, Vehicle design and layout aspects. 9

UNIT-IV

Emissions, Hydrocarbons, carbon monoxide, carbon dioxide, NOx, Particulates, Smoke opacity, Effects of design and operating variables on emission formation, Controlling of pollutant formation in engines, Methods to reduce engine emissions, Thermal reactors, Catalytic converters, Pollutant formation on incomplete combustion, Exhaust gas recirculation, Air injection, Cetane number effect. Introduction to electric vehicles**.** 9

Books & References

1. Internal Combustion Engines, Ganesan.V, Tata McGraw Hill.
2. Alternative fuels guide. R. Bechtold SAE 2005.
3. Alternative Fuel. S .S. Thipse JAICO. Publishing House 2015.
4. Automotive Emission Control, Crouse. W.M, Anglin. A.L, McGraw Hill.
5. Engine Emissions & pollutant formation, G.S, Patterson. D.J, Plenum Press.
6. Alternative Fuel: Emission, Economic and Performance, Maxwell et al, SAE.

EME-404 EV and HEV for Power Trains

Course category	:	Professional Electives (PEs)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Two Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

- Recognize the basic layouts of modern drivetrains for EVs and HEVs
- To understand the electric drive-train topologies and their analysis.
- Evaluate a powertrain architecture for a certain HEV
- To understand the energy storage requirements in Hybrid and Electric vehicles
- To understand the energy management strategies in hybrid and electric vehicles.
- Design of Hybrid and battery electric vehicle

Topics Covered

UNIT-I

Introduction to Electric Vehicles 9

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Advantages and disadvantages over conventional vehicles, Life cycle assessment

UNIT-II

Electric drive-trains 9

Basic concept of hybrid traction, introduction to various hybrid and electric drive-train topologies, power flow control in hybrid and electric drive-train topologies, fuel efficiency analysis, electric components used in hybrid and electric vehicles, Configuration and control of switch reluctance motor drives, drive system efficiency

UNIT-III

Energy storage 9

Introduction to energy storage requirements in Hybrid and Electric vehicles, Battery-based energy storage and its analysis, Fuel cell-based energy storage and its analysis, Super capacitor based energy storage and its analysis, Flywheel-based energy storage and its analysis, Hybridization of different energy storage devices

UNIT-IV

Energy management strategies 9

Introduction to energy management strategies in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, Issues of energy management strategies,

Design of a hybrid electric vehicle (HEV), Design of a battery electric vehicle (BEV)

Books & References

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Syllabus for Professional Elective -5

EME-501 SENSORS AND ACTUATORS

Course category	:	Professional Elective (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment is done through tutorials, attendance, home assignments, quizzes, a minor test, and a major theory.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understanding of measurement and measuring instruments, sensors, and transducers.
2. The knowledge of measurements of displacement, pressure, strain, temperature, force, torque with different principles.
3. Knowledge of different micro-fabrication techniques.
4. Able to understand the fundamentals of micro manufacturing, bulk manufacturing, etc.
5. The knowledge of different types of actuators, and motors
6. The knowledge of different actuation materials such as piezo electric and shape memory alloys

Topics Covered

UNIT-I

Brief overview of measurement: 9

Measurement systems, measurement variables, Introduction to Instruments, Simple instrument model, Modifying and Interfering Inputs, characteristics of instruments, Static characteristics, Accuracy, Precision, Resolution, sensitivity, linearity, and stability etc., Dynamic characteristics, speed of response, fidelity, lag, dynamic errors etc., calibration of instruments.

UNIT-II

Sensors: Classification of sensors, Measurement of physical quantities with working principles, displacement sensors, position sensors, motion sensors, tactile and proximity sensors, strain gauge sensors, force sensors, temperature sensors. Optical encoder, ultrasonic transducers etc. 9

UNIT-III

Sensor-fabrication technologies: Miniaturization, need of miniaturization, classification of micro-fabrication, Ion-implantation, Diffusion, Photolithography, Introduction to micro-fabrication technologies, Bulk micromachining, surface micromachining, LIGA, assembly, and packaging. 9

UNIT-IV

Pneumatic and hydraulic actuation systems: definition, example, types, selection. Pneumatic actuator. Electro-pneumatic actuator. Hydraulic actuator, control valves and valve selection. 9

Electrical actuation systems: Electric motors; single phase motor; 3-phase motor; induction motor; synchronous motor; stepper motors and servo motors, solid-state switches, solenoids.

Books & References

1. Measurement, Instrumentation, and Sensors Handbook. John G. Webster, Editor-in-chief, CRC Press 1999).
2. Handbook of modern Sensors. Jacob Fraden, AIP Press, Woodbury (1997).
3. An Introduction to Microelectromechanical Systems Engineering. Nadim Maluf, Artech House Publishers, Boston (2000).
4. Fundamentals of Microfabrication. Marc Madou, CRC Press, Boca Raton (1997).
5. Micromachined Transducers. Gregory Kovacs, "", McGraw-Hill, New York (1998).
6. Measurement Systems – Application and Design. E. O. Deobelin and D. Manik, Tata McGraw-Hill (2004).
7. Principles of Industrial Instrumentation. D. Patranabis, Tata McGraw-Hill, eleventh reprint (2004).
8. Instrument Engineers' Handbook: Process Measurement and Analysis. B. G. Liptak, CRC (2003).

EME-502 Energy Storage Systems

Course category	:	Professional Elective (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and One Minor test and One Major Theory.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course.

1. Explain the principles of various energy storage technologies.
2. Analyze the performance of battery storage systems.
3. Evaluate thermal and mechanical storage systems for renewable integration.
4. Design energy storage solutions for specific applications.
5. Assess the economic viability of storage systems.
6. Integrate storage systems with renewable energy technologies, including hydraulic systems.

Topics Covered

UNIT-I

Introduction to Energy Storage 9

Need for energy storage in renewable energy systems, including hydraulic energy, Types of energy storage: Electrochemical, thermal, mechanical, and electrical, Key parameters: Energy density, power density, efficiency, and lifespan, Role of energy storage in grid stability and renewable integration.

UNIT-II

Battery Storage Systems 9

Principles of electrochemical storage: Lead-acid, lithium-ion, and flow batteries, Battery performance: Charge-discharge cycles, efficiency, and degradation, Battery management systems (BMS) and safety considerations, Applications of batteries in renewable energy systems, including hydropower.

UNIT-III

Thermal and Mechanical Storage 9

Thermal storage: Sensible heat, latent heat, and thermochemical storage, Mechanical storage: Pumped hydro, compressed air energy storage (CAES), flywheels, Performance analysis and efficiency of thermal and mechanical systems, Integration with solar thermal, hydraulic, and other renewable systems.

UNIT-IV

Emerging Storage Technologies and Applications 9

Emerging technologies: Solid-state batteries, hydrogen storage, supercapacitors, Hybrid storage systems: Combining multiple storage technologies for renewable integration, Case studies on energy storage in microgrids and off-grid systems, including hydropower, Challenges and future trends in energy storage development.

Books & References

1. Huggins, R. A. (2010). Energy Storage. Springer.
2. Dunn, B., Kamath, H., & Tarascon, J. M. (2011). Electrical Energy Storage for the Grid: A Battery of Choices. Science.
3. Züttel, A., et al. (2011). Hydrogen as a Future Energy Carrier. Wiley.
4. Ter-Gazarian, A. (2011). Energy Storage for Power Systems. IET.

EME-503	**Smart Materials and Structures**	
Course category	:	Professional Electives (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, one Minor test and one Major Theory
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

CO1: Understand the fundamental principles and types of smart materials

CO2: To understand the working principles and applications of various sensors and actuators

CO3: Analyze the behavior of smart composites

CO4: Able to formulate and simulate the governing equations of motion for smart composite beams

CO5: To acquire knowledge of data acquisition, signal processing, and control systems

CO6: Able to evaluate the latest advancements in smart structures

Topics Covered

UNIT-I

Introduction to different types of crystal system 9

Introduction to Single Crystals and Polycrystalline, metallic, ionic, covalent and mixed bonding; fundamentals of crystallography, crystal systems, unit cells, primitive cells, structures of metals, ceramics, polymers, and glass used in composite materials.

UNIT-II

Smart Composites 9

Piezoelectric Polymers, Magneto strictive materials, Electro-active Materials, Electronic Materials, Polymer Matrix Composite (PMC), Metal Matrix Composite (MMC), Ceramic Matrix Composite (CMC), Nanocomposite, Biomaterials and Biocomposite, Shape Memory Effect, Shape Memory Alloys.

UNIT-III
Applications of Smart materials 9

Strain gauges, optical fiber sensors, piezoelectric sensors, MEMS sensors, Actuators: Types, working principles (piezoelectric, SMA-based, electrostatic, and magnetic), Control systems: Basic control strategies for smart structures (PID, fuzzy logic, neural networks).

UNIT-IV
Future Trends of Smart Materials 9

Smart structures in aerospace (adaptive wings, morphing structures), Civil infrastructure monitoring (bridges, buildings, seismic damping)**,** Biomedical applications (smart implants, drug delivery systems)**,** Smart composites and morphing materials.

Challenges, limitations, and research trends in smart materials and structures.

Books & References

1. A.V. Srinivasan, Smart Structures –Analysis and Design, 1st Edition, Cambridge University Press, New York, 2001.
2. M. V. Gandhi and B. S. Thompson, Smart Materials and Structures, Chapmen & Hall, London, 1992
3. C. Brian, Smart Structures and Materials, Artech House, 2000
4. P. Gauenzi, Smart Structures, Wiley, 2009
5. W. G. Cady, Piezoelectricity, Dover Publication, New York, 2014.

EME-504	**Computational Modelling and Simulation**
Course category	: Professional Electives
Pre-requisite Subject	: NIL
Contact hours/week	: Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	: 4
Course Assessment Methods	: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, one minor test, and one major theory & practical examination
Course Outcomes	: The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understanding the techniques of modelling
2. Knowledge of different types of simulation techniques.
3. The knowledge to simulate the models for optimum control by using software.
4. The knowledge of neurons, the architecture of neural networks, knowledge representation, and learning algorithms.
5. Able to understand the optimizations and design of Systems.
6. The modeling knowledge based on expert knowledge like: Fuzzy sets, Fuzzy models etc.

Topics Covered
UNIT-I
Introduction 9
System, environment, input and output variables, State variables; Static and Dynamic systems; Hierarchy of knowledge about a system and Modeling Strategy

Physical Modeling

Dimensions analysis, Dimensionless grouping of input and output variables of find empirical relations, similarity criteria and their application to physical models.

UNIT-II

Modeling of System with Structure 9

Review of conservation laws and the governing equation for heat, mass and momentum transfer, Deterministic model-(a) distributed parameter models in terms of partial identification and their solutions and (b) lumped

parameter models in terms of differential and difference equations, state space model, transfer functions block diagram and sub systems, stability of transfer functions, modeling for control

UNIT-III

Optimizations and Design of Systems 9

Summary of gradient-based techniques: Nontraditional optimization techniques (1) genetic Algorithm (GA)- coding, GA operations, elitism, Application using MATLAB:(ii) Simulated Annealing.

Neural Network Modeling of Systems only with Input-output Database: Neurons, architecture of neural networks, knowledge representation, learning algorithm. Multilayer feed forward network and its back propagation learning algorithm, Application to complex engineering systems and strategy for optimum output

UNIT-IV

Modeling Based on Expert Knowledge: Fuzzy sets, Membership functions, Fuzzy Inference systems, Expert Knowledge and Fuzzy Models, Design of Fuzzy Controllers. 9

Simulation of Engineering Systems: Monte-Carlo simulation, Simulation of continuous and discrete processes with suitable examples from engineering problems

EXPERIMENTS

Minimum five experiments are to be conducted from the followings:

1. Introductions to programming with MATLAB
2. Find the response of a lumped variable model expressed in terms of transfer function using MATLAB for input of (i) unit step function (ii) unit impact function and (iii) unit ramp function
3. Use of Simulink in MATLAB for engineering problems
4. Use of Neural Network in MATLAB for engineering problems
5. Use of FIS and ANFIS in MATLAB for engineering problems
6. Monte Carlo simulation

Books & References

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

EME-505 Machine Design

Course category	:	Professional Elective (PE)
Pre-requisites	:	----
Contact Hours/Week	:	Lecture: 3, Tutorial: 0, Practical: 2
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through Practical, attendance, home assignments, quizzes, one Minor test and One Major Theory
Course Objectives	:	Enabling students to analyze, design, and optimize machine components and systems using engineering mechanics, material science, and failure theories.

Course Outcomes : The students are expected to be able to demonstrate the following knowledge and skills after completing this course

1. Demonstrate the ability to design different types of mechanical spring under static and fatigue loading.
2. Demonstrate the ability to design different types of screw threads and design of screw jack.
3. Demonstrate the ability to design spur gear, helical gear and worm gear.
4. Demonstrate the ability to select the sliding contact bearing, its lubrication and applications.
5. Demonstrate the ability to select the rolling contact ball and roller bearing, its lubrication and applications.
6. Demonstrate the ability to design the IC engines parts such as design of cylinder head, piston, connecting rod and crankshaft and belts, brakes, clutches etc.

Topics Covered

UNIT-I

Design of Mechanical Springs 9

Types, Material for helical springs, End connections for compression and tension helical springs, Stresses and deflection of helical springs of circular wire, Design of helical springs subjected to static and fatigue loading.

Power Screws

Forms of threads, multiple threads, Efficiency of square threads, Trapezoidal threads, Stresses in screws, Design of screw jack

UNIT-II

Spur Gears 9

Tooth forms, System of gear teeth, contact ratio, Standard proportions of gear systems, Interference in involute gears, Backlash, Selection of gear materials, Gear manufacturing methods, Design considerations as per AGMA, Beam strength of gear tooth, Dynamic tooth load, Wear strength of gear tooth, Failure of gear tooth, Design of spur gears, AGMA and Indian standards.

Helical and Worm Gears

Terminology, Proportions for helical gears, Beam strength and wear strength of helical gears, herringbone gears, crossed helical gears, Design of helical gears.

Types of worms, Terminology, Gear tooth proportions, Efficiency of worm gears, Heat dissipation in worm gearing, Strength and wear tooth load for worm gears, Design of worm gearing

UNIT-III

Sliding Contact Bearing 9

Types, Plain journal bearing, Hydrodynamic lubrication, Properties and materials, Lubricants and lubrication, Hydrodynamic journal bearing terminology, Bearing characteristic number, Heat generation, Design of journal bearing, Thrust bearing-pivot and collar bearing, Hydrodynamic thrust bearing,

Rolling Contact Bearing

Advantages and disadvantages, Types of ball bearing, Thrust ball bearing, Types of roller bearing, Selection of radial ball bearing, Bearing life, Selection of roller bearings, Dynamic equivalent load for roller contact bearing under constant and variable loading, Reliability of Bearing, Selection of rolling contact bearing, Lubrication of ball and roller bearing, Mounting of bearing

UNIT-IV

IC Engine Parts 9

Selection of type of IC engine, General design considerations, Design of Cylinder and cylinder head; Design of piston, piston ring and gudgeon pin; Design of connecting rod; Design of centre crankshaft

Design of Miscellaneous Parts

Design of Belts, Brakes, Clutches, Flywheels and Pressure Vessels.

Note: Design data book is allowed in Minor/Major/Practical Examinations

EXPERIMENTS

Minimum eight experiments out of the following are to be performed. Students are advised to use design data book for the design. Drawing shall be made wherever necessary on small drawing sheets.

1. Design and drawing of helical spring subjected to static and fatigue loading
2. Design and drawing of screw jack

3. Generation of gear tooth profile
4. Design of spur gear drive
5. Design of helical gear drive
6. Design of worm and worm wheel
7. Design of journal bearing
8. Design of thrust bearing
9. Selection of ball and roller bearing
10. Design of cylinder and cylinder head, piston, connecting rod and crankshaft
11. Design of Brakes
12. Design of Clutches
13. Design of flywheels

Textbooks

1. Design of Machine Elements-V.B. Bhandari (Tata McGraw Hill)
2. Mechanical Engineering Design – Joseph E. Shigley (McGraw Hill)
3. Mechanical Design of Machine Components – Norton (Prentice Hall)
4. Fundamentals of Machine Components Design – Juvinall (Wiley)

Reference books

1. Design of Machine Members - Alex Valance and VI Doughtie (McGraw Hill)
2. Machine design-M.F. Spott (Prentice Hall India)
3. Machine Design-Maleev and Hartman (CBS)

EME-511 VEHICLE DYNAMICS AND CONTROL

Course category	:	Professional Electives
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment Methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, and one Minor test and one Major Theory Examination.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understanding of importance of vehicle control and its dynamics.
2. The knowledge of driving assistance systems, ride quality and handling of traffic.
3. The knowledge of different vehicle dynamics systems used in the vehicles.
4. Able to understand the fundamentals lateral and longitudinal dynamic systems.
5. The knowledge of different types force generation, braking systems, tire models and its calculations.
6. The knowledge of different longitudinal control systems such as adaptive cruise control, collision avoidance, and automated highway systems etc.

Topics Covered

UNIT-I

Introduction to Vehicle Dynamics: Vehicle dynamics, importance, drive assistance systems, active stability control systems, ride quality and technologies for addressing traffic congestion. 9

Longitudinal Dynamics: Vehicle Load Distribution – Acceleration and Braking - Brake Force Distribution, Braking Efficiency and Braking Distance - Longitudinal dynamics of a Tractor-Semi Trailer.

UNIT-II

Classification Tire Mechanics – An Introduction: Mechanical Properties of Rubber - Slip, Grip and Rolling Resistance - Tire Construction and Force Development - Contact Patch and Contact Pressure Distribution. 9

A Simple Tire Model: Lateral Force Generation - Ply Steer and Conicity -Tire Models – Magic Formula - Classification of Tire Models and Combined Slip.

UNIT-III

Lateral Dynamics: Lateral Systems Under Commercial Development, Lane departure waring, lane keeping system and yaw stability control system. Bicycle Model - Stability and Steering Conditions Understeer Gradient and State space Approach, Parameters affecting vehicle handling characteristics. 9

UNIT-IV

Introduction to Longitudinal Control: Adaptive cruise control, Collision avoidance, Automated highway systems, Benefits of Longitudinal Automation, Anti-Lock Brake Systems, ABS functions, functioning of a stability control system. 9

Books & References

1. Hans. Tire and vehicle dynamics. Pacejka, Hans. Elsevier (2005).
2. Theory of ground vehicles. Wong, Jo Yung. John Wiley & Sons. (2001).
3. "The friction of pneumatic tyres". Moore, Desmond F (1975).
4. Vehicle dynamics: theory and application. Jazar, Reza N. Springer (2008).
5. Fundamentals of vehicle dynamics, Gillespie, Thomas D. (1992).
6. Vehicle dynamics and Control. Rajesh Rajamani, Springer (2012)

Syllabus for Professional Elective -6

EME-601		**Post Processing & Characterization Methods for Additive Manufacturing**
Course category	:	Professional Electives (PEs)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	quizzes, practical work, record, viva voce, and one Minor test and one Major Theory Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

CO 1: Understand the importance and types of post-processing methods in additive manufacturing.
CO 2: Able to select finishing, heat treatment, and mechanical processing techniques for AM
CO 3: Conduct mechanical and surface characterization of AM parts using appropriate instruments.
CO 4: Interpret microstructural features and phase changes due to AM and post-processing.
CO 5: Apply non-destructive testing (NDT) methods for AM part evaluation.
CO 6: Understand and apply international standards, quality assurance in AM

Topics Covered

UNIT-I

Introduction to Post-Processing in Additive Manufacturing 9

Necessity of post-processing in AM, Classification of post-processing methods: Thermal (stress relief, annealing, Hot Isostatic Pressing), Mechanical (machining, polishing, blasting), Chemical (solvent

smoothing, etching), Surface finishing (grinding, electro-polishing, coating), Support removal strategies, Challenges and process–property implications of post-processing

UNIT-II

Mechanical, Thermal, and Microstructural Characterization 9

Mechanical testing of AM parts: tensile, compression, hardness, fatigue, Thermal analysis techniques: DSC, TGA, DTA, Microstructural analysis: Optical microscopy, SEM, TEM, Phase analysis: XRD, EBSD, Grain structure, porosity, and anisotropy in AM parts

UNIT-III

Surface & Dimensional Metrology in AM 9

Surface roughness measurement: contact and non-contact methods, Coordinate Measuring Machines (CMM) and laser scanning, CT scanning and 3D scanning for internal feature validation, Geometrical accuracy, dimensional tolerance, and deviation mapping

UNIT-IV

Non-Destructive Testing (NDT), Quality Control & Certification 9

NDT techniques for AM: Ultrasonic testing, X-ray, Eddy current, Liquid penetrant, Magnetic particle, In-situ process monitoring and defect detection, AM-specific defects: porosity, delamination, unmelted powder, Standards and certification (ASTM, ISO, ASME for AM), Documentation and traceability for critical AM applications

Books & References

1. **Ian Gibson, David Rosen, Brent Stucker**, *Additive Manufacturing Technologies*, Springer.
2. **Lina Hao**, *Post Processing Techniques for Metal-Based Additive Manufacturing*, Elsevier.
3. **Peter Kruth et al.**, *Characterization Techniques in Additive Manufacturing*, CRC Press.

EME-602 Selection of Nanomaterials for Energy Harvesting and Storage Applications

Course category	:	
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce, and one Minor test and one Major Theory Examination .
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Selection of nanomaterials for energy harvesting and storage applications is an interdisciplinary course which deals with selection of nanomaterials and key challenges to improve performance of the energy harvesting and storage devices/techniques.
2. In this course we will be covering different energy harvesting and storage techniques and the parameters that are to be considered in selecting the nanomaterials for the same.

Topics Covered

UNIT-I

Introduction: 9

Introduction, Criteria for choosing the nanomaterials for energy harvesting and storage applications, Brief discussion about all types of energy harvesting and storage systems, Solar energy, Nanomaterials used for solar energy, Types of solar energy, Solar thermal and heat transfer fluids with example.

UNIT-II

Hydrogen energy: 9

Introduction, Nanomaterials used for hydrogen energy generation, Methods to produce hydrogen energy, Hydrogen production from fossil fuels and biomass, thermo-chemical process, electrolysis, solar and biological, Key Challenges for hydrogen energy generation.

UNIT-III

Nanogenerators: 9

Introduction, Types of Nanogenerators: Piezoelectric, Thermoelectric, Pyro-electric, Electromagnetic, and Triboelectric, Key challenges for choosing nanomaterials for nanogenerators, Other conventional energy generation techniques: Wind energy, Tidal, Thermal, hydro power generation, Nuclear and geothermal energy production.

UNIT-IV

Energy storage: 9

Nanomaterials used for energy storage, key challenges for energy storage, Solution of key challenges, Type of energy storages: Electrochemical (Batteries), Supercapacitor, Hydrogen storage, Thermal energy storage.

Books & References

1. Nanomaterials for sustainable energy by Quan Li, Springer
2. Materials in energy conversion, harvesting and storage by Kathy Lu, Wiley
3. Energy storage systems and components by Alfred Rufer, CRC Press
4. Handbook of Hydrogen energy by S.A. Sherif, CRC Press

BME-603 ENGINE SYSTEM AND PERFORMANCE

Course category	:	Professional Elective (PE-6)
Pre-requisite Subject	:	Thermodynamics
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment is done through tutorials, attendance, home assignments, quizzes, a minor test, and a major theory.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. The students should be to understand the basic concepts of Engine system.
2. The students should be able to understand the hardware of the system.
3. The students should be able to understand the electronic control unit.
4. The students should be able to measure the engine performance..
5. The students should be able to understand supercharger and turbocharger.
6. The student should be able to draw Heat balance sheet.

Topics Covered

UNIT-I

Engine Systems 9

Concept of Engine system, Classification of engines, Engine nomenclature: different parts, Basic cycles, and their analysis. Description of various engine components.
Engine Hardware: Design, Constructional features, Shapes, and Material of different parts.

UNIT-II
Engine Control Systems 9

Energy transfer mechanism, description and components involved and Numerical problems.
Modern engine management system: Introduction to Electronic Control Unit (ECU) and its description, Types of control system. Introduction to electronic devices and Digital circuits, Common types of sensors used in ECU.

UNIT-III
Engine Electronics and Performance measurement 9

Electronic Control Unit (ECU) – Functional Layout, Electronic Ignition System, Electronic Fuel-Injection System: Injection schemes, Modes for fuel control, Integrated engine control system. Introduction to engine performance, Engine performance parameters and their measurement, Numerical problems on performance measuring parameters.

UNIT-IV
Engine Performance and Control 9

Superchargers, Performance map of superchargers, Introduction to Turbocharger, Phenomenon of Turbo-lag in turbochargers and Numerical problem.
Engine heat balance, Measurement of heat losses in engines, Numerical problems. Speed control of IC engines, Mechanical governor and electronic governor.
Trends of recent technologies to achieve better performance and reduce pollution.SI engine performance curves, performance characteristics.

Books & References

1. Mathur and Sharma, *A course on Internal combustion Engines*, Dhanpat Rai & Sons.
2. Prof. P.L. Ballaney, *Internal Combustion Engines*, Khanna Publications, Delhi, India
3. R.K. Mohanty, *A Text Book of Internal Combustion Engines*, Standard Book House, Delhi, India.
4. I C Engine by V Ganesan , Tata McGraw hill Education Private Limited.

EME-604 Vehicle Dynamics

Course category	:	Professional Electives (PEs)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, viva voce and Two Minor tests and One Major Theory & Practical Examination

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Analyse and formulate the dynamic models for vehicle systems
2. Understand the role of aerodynamics in vehicle stability
3. Evaluate the performance characteristics of vehicle dynamics under various driving conditions
4. Demonstrate the vehicle motion and analyze the vehicle response for various driving conditions
5. To understand the various suspension kinematics and dynamics
6. To understand the role of Multi-body vibration in vehicle dynamics

Topics Covered

UNIT-I

Introduction 9

Introduction to Electric Vehicle, Vehicle Dynamics: Modelling and Simulation, transmission characteristics, vehicle performance, Fundamentals of Drives and Power Electronics for DC Drives, Modelling and Control of DC Motor Drives, Basics of Induction Motor and V/f Control, Equations of motion

UNIT-II

Aerodynamics: 9

Mechanics of Air Flow Around a Vehicle, Pressure Distribution on a Vehicle, Aerodynamic Forces, Drag Components, Aerodynamics Aids, Forces & moments affecting the vehicle, Earth Fixed coordinate system

UNIT-III

Performance Characteristics of Vehicle 9

Vehicle axis system, Forces & moments affecting vehicle, Earth Fixed coordinate system, Dynamic axle loads, Equations of motion, transmission characteristics, vehicle performance, power limited and traction limited acceleration, braking performance, Brake proportioning, braking efficiency

UNIT-IV

Suspensions 9

Suspension Kinematics, Suspension types, Solid Axles, Independent Suspensions, Anti-Squat and Anti-Pitch Suspension Geometry, Anti-Dive Suspension Geometry, Roll Center Analysis, Suspension Dynamics,

Multi-body vibration, Body and Wheel hop modes, Invariant points

Books & References

1. Hans Pacejka, Tire and Vehicle Dynamics, Elsevier, 2012.
2. Thomas D Gillespie, "Fundamentals of Vehicle dynamics", SAE USA 1992.
3. Rajesh Rajamani, Vehicle Dynamics & control, Springer.
4. R.V. Dukkipati, Vehicle dynamics, Narsova Publications.
5. Wong J Y, "Theory of Ground Vehicles", John Wiley & Sons, New York, 1978.

Syllabus for Professional Elective -7

EME-701 Industrial Automation

Course category	:	Professional Elective (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment is done through tutorials, attendance, home assignments, quizzes, a minor test, and a major theory.

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Understand the principles, strategies, and levels of automation in modern production systems, including production economics
2. Analyze various methods of automated material transport, flow lines, transfer mechanisms, and buffer storage systems.
3. Evaluate types and design aspects of material handling equipment, AGVs, and conveyor systems in automated environments.
4. Understand automated storage and retrieval systems (AS/RS) and product identification technologies like barcodes and RFID.
5. Explore the design and types of automated assembly systems and different control technologies used in industrial automation.
6. Apply principles and methods of automated inspection and testing, including CMMs, sensors, and machine vision systems.

Topics Covered

UNIT-I

Introduction: Definition and scope of industrial automation, Benefits and challenges of automation, Types of automation, Overview of automation pyramid, Industry 4.0 and smart manufacturing, Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Production Economics. 9

UNIT-II

Material Transport and Safety and Standards in Automation: Automated Flow lines, Methods of work part Transport, Transfer Mechanism, and Buffer Storage. Functional safety, Interlocks and fail-safe systems, Industrial standards, Hazardous area classification. 9

UNIT-III

Material handling and Identification Technologies: The material handling function, Types of Material Handling Equipment, Analysis for Material Handling Systems, Design of the System, Conveyor Systems, Automated Guided Vehicle Systems. 9

Automated Storage Systems: Storage System Performance, Automated Storage/Retrieval Systems, Work-in-process Storage, Product identification system: Barcode, RFID etc.

UNIT-IV

Automated Assembly Systems: Design & Types of Automated Assembly Systems. Different control technologies in automation: Automated Inspection and Testing: Automated Inspection Principles and Methods, Sensor Technologies for Automated Inspection, Coordinate Measuring Machines, Other Contact Inspection Methods, Machine Vision and other optical Inspection Methods. 9

Books & References

1. **Industrial Automation: Hands On** byFrank Lamb McGraw Hill; 1st edition
2. Computer Based Industrial Control by Krishna Kant, PHI Learning Pvt. Ltd
3. An Introduction to Automated Process Planning Systems by Tien Chien Chang & Richard A. Wysk, Prentice Hall Professional Technical Reference
4. Anatomy of Automation by Amber, George H, Prentice-Hall.

EME-702 **Environmental Impact Assessment**

Course category : Professional Elective (PE)

Pre-requisite Subject : NIL

Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment is done through tutorials, attendance, home assignments, quizzes, a minor test, and a major theory.
Course Objectives	:	The objective of this course is to provide students with knowledge of the concepts, procedures, and methodologies used in Environmental Impact Assessment (EIA) to assess the positive and negative impacts of a project.
Course Outcomes	:	Upon completion of this course, the student will demonstrate the ability to: 1. Understand the basic concepts of Environmental Impact Assessment (EIA). 2. Understand the processes involved in Environmental Impact Assessment (EIA) for various projects. 3. Apply various methodologies for adopting Environmental Impact Assessment at different stages. 4. Understand the concept and scope of Environmental auditing by applying it in different types of projects. 5. Apply the concept of Environmental Impact Assessment in various sectors, like energy, transport, mining etc. 6. Apply the concept of EIA integrated with recent emerging technologies.

Topics Covered

UNIT-I 9

Basic Concepts

Definition and Purpose of Environmental Impact Assessment (EIA), Origin and development of EIA, Methods to carry out EIA, Hierarchy in EIA, Types of EIA

EIA Process

Components of an Environmental Impact Assessment, Potential impacts of a project, Prediction and Mitigation, Management and monitoring, Environment Management Plan, Importance of EIA

UNIT-II 9

EIA Methodologies

Introduction, Criteria for the selection of EIA Methodology, EIA methods, EIA Screening and Scoping, Prediction and Assessment of Environmental Impacts, Mitigation Measures and Impact Management, Monitoring, Auditing, and Post-Assessment, Ad Hoc Method, Overlay Method

UNIT-III 9

Environmental Auditing (EA)

Basic Concepts: Introduction, Objectives, Scope, Types of environmental audits, General Audit Methodology

EA Process, Strategy and Management: Elements of Audit Process, Waste Audits and Pollution Prevention Assessments, EA in Industrial Projects

UNIT-IV 9

Sectoral Applications of EIA

EIA in Energy Sector (Thermal Power Projects, Oil & Gas Exploration), Land use planning and management, EIA in Agriculture, Cement Industries, and Mining Projects

Emerging Trends in EIA

Strategic Environmental Assessment, Climate Change and EIA, Public Participation and Social Impact Assessment

Textbooks and References:

1. Wathern P., “Environmental Impact Assessment: Theory and Practice”, Routledge Publishers,1990
2. Glasson J., Therivel Riki, Chadwick Andrew, “Introduction to Environmental Impact Assessment”, Oxford Brookes University 2012/ 4th edition

3. Shrivastava A.K., Baxter Nicola, Grimm Jacob, "Environmental Impact Assessment", APH Publishers, 2003
4. Marriott B., "Environmental Impact Assessment: A Practical Guide", McGraw-Hill Publication,1997
5. Anjaneyulu Y., Manickam Valli, "Environmental Impact Assessment Methodologies", CRC Press 2011
6. Whitelaw, K. and Butterworth, ISO 14001: Environmental System Handbook, 1997

EME-703 Automation in Manufacturing

Course category	:	Professional Electives (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, one Minor test, and one Major Theory
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Underline the Basics of knowledge of various automation components and systems.
2. Identify the architecture of the industrial automation system.
3. Construct the block diagram of an industrial automation and control system and supervisory control and data acquisition (SCADA).
4. Categorize industrial parameters like temperature, pressure, force, displacement, speed, flow, level, humidity and pH.
5. Combine the automation process of industry through Internet of Things.
6. Interpret the programmable logic controllers for industrial automation and use of robot for industrial applications.

Topics Covered

UNIT-I

Introduction to Automation 9

Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems: modbus & profibus. Levels of automation, Automation principles and strategies. Advanced automation functions: safety, maintenance.

UNIT-II

Mechanization and Automation 9

Introduction to Material storage/handling and transport systems, and its automation using AS/RS, AGVS and conveyors etc. Mechanization and automation, product cycle, hard vs. flexible automation, Capital- intensive vs. low cost automation. Assembly line Automation: automated assembly systems, transfer systems, vibratory bowl feeders, non-vibratory feeders, part orienting.

UNIT-III

Automation based components 9

Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators - Principle and selection of mechano-electrical actuators, DC motors, Stepper Motors, Servo Motors, Brushless DC Motor, Solenoid Actuators, process control valves.

UNIT-IV

Computer-aided measurement and control systems 9

Role of computers in measurement and control, Elements of computer-aided measurement and control, man-machine interface, computer-aided process control hardware, process-related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques, Computer-aided process control software

Books & References

1. Industrial Instrumentation and Control By. S.K. Singh The McGraw Hill Companies, 2003, ISBN 0-07-048290-X
2. Industrial control handbook, Parr, Butterworth-Heinemann; 3rd edition, 1998, ISBN: 9780750639347
3. Programmable logic controller, G. Dunning, Delmar, ISBN- 9781401884260
4. Automation, Production Systems and Computer-Integrated Manufacturing, Mikell P. Groover, Prentice Hall, 2007, ISBN-13: 978-8120334182
5. Industrial Instrumentation, Control and Automation, S. Mukhopadhyay, S. Sen and A. K. Deb, Jaico Publishing House, 2013, ISBN: 9788184954098.
6. Electric Motor Drives, Modelling, Analysis and Control, R. Krishnan, Prentice Hall India, 2002, ISBN: 978-0130910141

EME-704 Optimization Techniques in Engineering

Course category	:	Professional Electives (PE)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, viva voce, one minor test and one major theory exam.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

CO1: Comprehend the techniques and applications of Engineering optimization.
CO2: Analyze characteristics of a general linear programming problem.
CO3: Apply basic concepts of mathematics to formulate an optimization problem.
CO4: Analyze various methods of solving the unconstrained minimization problem.
CO5: Analyze and appreciate a variety of performance measures for various optimization problems.
CO6: Understand the application of queuing models

Topics Covered

UNIT-I

Transportation problems: Finding an initial basic feasible solution by Northwest Corner rule, Least Cost rule, Vogel's approximation method, Degeneracy, Optimality test, MODI method, Stepping stone method. 9

Assignment problems: Hungarian method for solution of Assignment problems. Integer Programming: Branch and Bound algorithm for solution of integer programming problems.

UNIT-II

Non-linear programming: Introduction to non-linear programming. Unconstraint optimization: Fibonacci and Golden Section Search method. Constrained optimization with equality constraint: 9

Lagrange multiplier, Projected gradient method. Constrained optimization with inequality constraint: Kuhn-Tucker condition, Quadratic programming.

UNIT-III

Non-linear programming: Introduction to non-linear programming. Unconstraint optimization: Fibonacci and Golden Section Search method. Constrained optimization with equality constraint: Lagrange multiplier, Projected gradient method. Constrained optimization with inequality constraint: Kuhn-Tucker condition, Quadratic programming 9

UNIT-IV

Queuing models: General characteristics, Markovian queuing model, M/M/1 model, Limited queue capacity, multiple server, Finite sources, Queue discipline. 9

Books & References

1. Operations Research- Principle and Practice, A. Ravindran, D. T. Philips, J. Solberg,
2. Second edition, Wiley India Pvt Ltd.
3. Operation Research, Prabhakar Pai ,Oxford University Press
4. Optimization for Engineering Design, Kalyanmoy Deb, PHI Learning Pvt Ltd.
5. Operations Research, H.A.Taha, A.M.Natarajan, P.Balasubramanie, A.Tamilarasi,
6. Pearson Education, Eighth Edition.
7. Engineering Optimization, S S Rao, New Age International Pvt Ltd, 2003.
8. Linear and Non-linear Optimization, Stephen G. Nash, A. Sofer, McGraw
9. Hill, 2nd Edition.
10. Engineering Optimization, A.Ravindran, K.M.Ragsdell, G.V.Reklaitis, Wiley India Pvt. Ltd, Second edition.
11. Operations Research, F.S.Hiller, G.J.Lieberman, Tata McGraw Hill, Eighth Edition,
12. 2005.
13. Operations Research, P.K.Gupta, D.S.Hira, S.Chand and Company Ltd, 2014.

EME- 711 Sustainable Energy and EVs

Course category	:	Professional Electives (PEs)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and one Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. To understand the various types of energy resources and its climatic effect
2. Ability to analyze and understand the various energy strorage concepts
3. To understand the electric vehicle dynamics and its subsystems
4. To understand the various types of electric vehicle controllers
5. Ability to understand the characteristics of Battery and
6. To understand the battery thermal management system

Topics Covered

UNIT-I

Introduction 9

Introduction and Fundamental Concepts, Renewable and Non-renewable energy, Energy Scenario in Modern World, Fossil Fuels, Climate Change Impacts and Overview of Renewable Energy Technology, Carbon- Capture

UNIT-II

Renewable energy and storage systems 9

Hydropower, Wind Energy, Solar Energy, Bioenergy and Biofuels, Geothermal Energy, Hydrogen energy

Introduction of Energy storage systems, Mechanical energy storage technologies, Energy storage system through Capacitor, Electrochemical Energy Storage Systems, Thermal Energy Storage Systems, Trends in Energy Storage Types and their Characteristics.

UNIT-III

Electric Vehicles 9

Overview of Electric Vehicles in India, Vehicle Dynamics, Vehicle Subsystems: EV Power-train, Storage for EVs, EV Battery Pack design, EV Motors and Controllers, Fundamentals and Design, Vehicle Accessories, Battery Charging and Swapping

UNIT-IV

Battery and thermal management system 9

Introduction to Electrochemical Cells, Batteries, Primary and secondary Batteries, Battery Electrode Reaction, Types of Battery: lithium-ion , lead-acid, nickel-metal hydride, solid-state , Fuel Cells, Battery Management System

Books & References

1. Energy storage, Robert A. Huggins, Springer Science & Business Media, 2010
2. The Physics of Solar Cells, Jenny A. Nelson, World Scientific Publishing Company
3. Fuel Cell Fundamentals, R. O'Hayre, S-W. Cha, W. Colella, F. B. Prinz, John Wiley and Sons, USA, 2005
4. Advanced Batteries: Materials Science Aspects, Robert Huggins, Springer; 2009.

Syllabus for Professional Elective -8

EME-801		**Machine Learning for Additive Manufacturing**
Course category	:	Professional Electives (PEs)
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Two Minor tests and One Major Theory.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

CO 1: Understand the basics of machine learning and its relevance to AM.
CO 2: Collect and prepare data from AM processes for ML analysis.
CO 3: Apply basic ML algorithms to identify patterns and predict outcomes in AM.
CO 4: Optimize AM parameters using regression, classification, and clustering techniques.
CO 5 : Use Python libraries like Scikit-learn and Pandas for ML-based AM projects.

CO 6: Analyze case studies of ML applications in metal and polymer AM.

Topics Covered

UNIT-I

Basics of Machine Learning and AM Data 9

Introduction to Machine Learning: Supervised, Unsupervised, Reinforcement Learning, Types of data in AM: Process parameters, sensor data, mechanical properties, Data collection from 3D printers: Temperature, speed, power, layer time.

UNIT-II

Data Preprocessing and Feature Engineering 9

Data cleaning: Handling missing data, outliers, normalization, Feature selection for AM: Layer height, print speed, laser power, infill density, Data splitting: Train-test-validation, Introduction to performance metrics (accuracy, RMSE, precision, recall)

UNIT-III

ML Algorithms for AM Applications 9

Regression: Linear, Polynomial, Decision Tree (e.g., predicting tensile strength), Classification: K-NN, SVM, Random Forest (e.g., defect detection), Clustering: K-means (e.g., grouping print quality data), Model evaluation and selection

UNIT-IV

Case Studies and Advanced Applications 9

Case Study 1: Predicting build failure in metal AM, Case Study 2: Optimizing print parameters for surface finish,

Real-world tools: TensorFlow basics, AutoML, MLFlow (overview only), Challenges: Data availability, interpretability, generalization

Books & References

1. **Machine Learning for Additive Manufacturing – J. Rao & J. Beuth (Springer Briefs)**.
2. ***Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow* – Aurélien Géron**
3. ***Additive Manufacturing Technologies* – Ian Gibson et al.**

EME-802 Energy Economics and Policy

Course category	:	Professional Elective
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	3
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Two Minor tests and One Major Theory.
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

1. Appreciate and understand economics of energy production and supply, energy consumption and demand, energy regulation, and energy market and trading.
2. Comprehend both theoretical and empirical aspects of energy economics.
3. Learn advanced tools and techniques for conducting empirical assessment energy sector.
4. Understand complex nuances of energy, environment and climate interactions and interdependencies.

Topics Covered

UNIT-I

Introduction 9

History of energy use, Current state of energy world, Resource substitution as the key process, Role of energy in development and growth, Classification of resources.

Energy Demand

Theoretical background: Derived energy demand, Consumer demand, Producer demand, Types of econometric demand models. Issues treated by demand models, Capital-energy substitutability, technical change, Scale effects, Short-run versus long-run analysis, Expectations, Disequilibrium and rationing, Time of day, seasonal, and block pricing.

UNIT-II

Economics of Energy Supply: 9

The depletability concept, Economic theory of depletable resources, extracted resource, timing of extraction, market price pattern over time, market changes, interest rates, changed expectations, varying market structures, taxes-change patterns of extraction, nature of the supply function for depletable resources,

Estimation of cost functions: Computational equilibrium models, Econometric models of exhaustible resource supply, Economic theory of renewable energy supply, Economics of solar, wind, Hydro and bio-fuels, Economic of oil refining, Economics of power generation

UNIT-III

Energy markets and pricing: 9

Structure of energy markets, Natural resource Cartels: An example of OPEC, Concepts of energy pricing, Average and Marginal cost pricing, Peak and off-peak pricing, Cross-Subsidization

Issues Facing the Energy Sector: Energy Access and poverty, Geopolitics and Energy Security, Key Indicators of energy security, Possible energy security externalities, Energy security policies, Energy efficiency.

UNIT-IV

Energy-Economy: 9

Environment Interactions, Externalities and their valuation, Energy and climate change, Intertemporal resource, environmental interactions, Dynamic models of resource, environmental interactions, Intertemporal efficiency and intergenerational equity.

Energy policy and regulatory issues:

Energy policy instruments, Distributional incidence of energy taxes and subsidies, Technology assessment and risk analysis.

Books & References

1. J.M. Griffin, and H.B. Steele, Energy Economics and Policy, Academic Press,1985
2. Hunt, Lester C., and Joanne Evans, eds. International handbook on the economics of energy. Edward Elgar Publishing, 2011.
3. Bhattacharyya, Subhes C., Concepts, Issues, Markets and Governance, Springer, London, 2011.
4. Shogren, Jason. Encyclopedia of Energy, Natural Resource, and Environmental Economics. Newnes, 2013.

EME- 803 AIRCRAFT PROPULSION

Course category	:	Professional Electives (PEs)
Pre-requisite Subject	:	NA
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment is done through tutorials, attendance, home assignments, quizzes, a minor test, and a major theory.

Course Outcomes : The students are expected to be able to demonstrate the following knowledge, skills, and attitudes after completing this course

1. The students should be to understand the basic thermodynamics principles behind gas turbines.
2. The students should be able to analyse the basic operation of a gas turbine and its components..
3. The students should be able to understand the various classifications of gas turbine.
4. The students should understand the concept of air propulsion.
5. The students should be able to analyse overall performance of aircraft propulsions.
6. The student should be able to understand air cooling and Water cooling.

Topics Covered

UNIT-I

Introduction to Gas turbines 9

Introduction, Development, classification and field of application of gas turbines, Gas Turbine Theory, Energy transfer between fluid and rotor, axi-symmetric flow in compressors and gas turbines

Aircraft Propulsion

Historical background, Classification of propulsive devices, Applications of aircraft and rocket engines; Principles of Aircraft Propulsion, Introduction to aircraft propulsive devices -piston-prop, turbojet, turboprop, turbofan, turbo-shaft and ramjet engines; Prop fans/Un-ducated fan engines

UNIT-II

Ideal Cycles and Real cycles analysis 9

Ideal cycle and real cycle analysis of ramjet, turbojet, turbofan and turboprop engines

Engine Performance and Engine component

Introduction of Takeoff Thrust, Engine Thrust Based on the Sum of Component Impulse, Rocket Thrust ,Engine Performance Parameters such as Specific Thrust ,Specific Fuel Consumption and Specific Impulse, Thermal Efficiency ,Propulsive Efficiency, Engine Overall Efficiency and Its Impact on Aircraft Range and Endurance

UNIT-III

Centrifugal Compressor 9

Principles of operation; compressor losses; adiabatic efficiency; slip factor; pressure coefficient; power unit; design consideration for impeller and diffuser systems; performance characteristics.

Axial Compressor

Elementary theory; vortex theory; degree of reaction; simple design; elementary air-foil theory; isolated airfoil and cascade theory; three dimensional flow; stages; stage efficiency and overall efficiency; performance characteristics.

UNIT-IV

Axial and Radial Turbines 9

Axial flow and radial flow turbines; impulse and reaction turbines; fundamental relations and velocity triangles; elementary vortex theory; limiting factors in turbine design; application of airfoil theory to the study of flow through turbine blades;

Turbine cooling methods and component matching

Air cooling, steam cooling, water cooling, Active cooling, Periodic testing and calibration of cooling system instrumentation and control systems, Monitoring and maintaining proper coolant flow rates, pressures, and temperatures.

Books & References

1. Air Craft Propulsions by Mr. Rohit Manghik , Edu Gorilla Publication.
2. Aircraft Propulsions by Saeed Farokhi , second edition, Wiley Publication.
3. Fundamentals of Aircraft and Rocket Propulsion by Ahmed F EI –Sayed , Springer publication.
4. Theory of Aerospace propulsion by Pasquale M.Sorza , B/H Publications.

EME-804 Charging Infrastructure for EV and HEV

Course category	:	Professional Elective
Pre-requisite Subject	:	NIL
Contact hours/week	:	Lecture: 3, Tutorial: 1, Practical: 0
Number of Credits	:	4
Course Assessment methods	:	Continuous assessment through tutorials, attendance, home assignments, quizzes, practical work, record, viva voce and Two Minor tests and One Major Theory & Practical Examination
Course Outcomes	:	The students are expected to be able to demonstrate the following knowledge, skills and attitudes after completing this course

Topics Covered

UNIT-I

CHARGING ARCHITECTURES FOR ELECTRIC VEHICLES 9

Classification of EV charging architectures: Onboard chargers, Dedicated converter (slow charging), Integrated converter (Semi-fast charging), Off-Board chargers, Dedicated Off-board DC chargers (Fast Charging), Common AC bus architecture, Common DC bus architecture

UNIT-II

CONVERTER TOPOLOGIES FOR CHARGING STATION 9

Vienna rectifier, Multipulse rectifier with DC active power filter, Non-isolated Multichannel Interleaved Buck

Converter, Phase-Shifted ZVS Full-Bridge Converter, Grid-connected cascaded H-bridge converter, Grid connected Modular Multilevel Converter based integrated charger for split integrated battery pack, Neutral-Point Clamped Converter

UNIT-III

CONTROL SCHEMES AND CHARGING STANDARDS 9

Control Schemes for Charging Converters, Single-Phase AC–DC Converter Control, Three-Phase AC–DC

Converter Control, voltage-oriented control (VOC) and direct power control (DPC), Electric Vehicle / Plug in

Hybrid Electric Vehicle charging Standards

UNIT-IV

LATEST DEVELOPMENTS IN EV CHARGING 9

Inductive Charging, Vehicle-to-Grid (V2G) and Vehicle-to-Home (V2H), EV charging safety configuration and

considerations, Grid-Tied Residential charging Systems, Grid-Tied Public charging Systems, EV cable communication protocols, Charging cable standards

Books & References

1. Sulabh Sachan, P. Sanjeevikumar, Sanchari Deb, Smart Charging Solutions for Hybrid and Electric Vehicles, Wiley- Scrivener Publishing LLC, 2022.
2. Mary Murphy " Electric and Hybrid Vehicles: Principles, Design and Technology ", Larsen and Keller
   Education, 2019

Syllabus of Audit Courses

CONSTITUTION OF INDIA

Course Code: : AUC 101 Credits (0-0-0)
Course Category : Audit
Pre-requisite Subject : NIL
Contact Hours/Week : 1/2 Lecture : , Tutorial : , Practical:
Number of Credits : 0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.

Course Outcomes:
At the end of the course, learners should be able to
CO1- Student will Identify and explore the basic features and modalities about Indian constitution
CO2- Students will be able to differentiate and relate the functioning of Indian parliamentary system at the center and state level.
CO3- Student will be able to differentiate different aspects of Indian Legal System and its related bodies.

UNIT 1--Introduction and Basic Information about Indian Constitution: Historical Background of the Constituent Assembly, The Preamble of the Constitution, Fundamental Rights, Fundamental Duties, Directive Principles of State Policy, Parliamentary System, Federal System.

UNIT 2-Union Executive and State Executive: Powers of Indian Parliament Functions of Rajya Sabha, Functions of Lok Sabha, Powers and Functions of the President, Powers and Functions of the Prime Minister, Judiciary.

UNIT 3- Introduction and Basic Information about Legal System: The Court System in India and Foreign Courtiers (District Court, District Consumer Forum, Tribunals, High Courts, Supreme Court).

UNIT 4- Intellectual Property Laws and Regulation to Information: Introduction, Legal Aspects of Patents, Filing of Patent Applications, Rights from Patents, Infringement of Patents, Copyright, Information Technology Act, 2000. The Company's Act:

Reference:

1) G. Austin (2004) Working of a Democratic Constitution of India, New Delhi: Oxford University Press.
2) Basu, D.D (2005), An Introduction to the Constitution of India, New Delhi, Prentice Hall.
3) N. Chandhoke & Priyadarshini (eds) (2009) Contemporary India: Economy, Society, Politics, New Delhi: Oxford University Press.
4) N.G Jayal and P.B. Maheta, (eds) (2010) Oxford Companion to Indian Politics, New Delhi: Oxford University Press.

Indian Culture and Heritage

Course Code: : AUC 102 Credits (0-0-0)
Course Category : Audit
Pre-requisite Subject : NIL
Contact Hours/Week : 1/2 Lecture : , Tutorial : , Practical:
Number of Credits : 0 Credit

Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.

Unit-I

Indian Culture: An Introduction, Characteristics of Indian culture, Significance of Geography on Indian Culture, Society in India, Religion and Philosophy in India.

Unit-II

Indian Languages and Literature, Evolution of script and languages in India, Harappan Script and Brahmi Script, History of Buddhist and Jain Literature.

Unit-III

A Brief History of Indian Arts and Architecture, Indian Art & Architecture: Gandhara School and Mathura School of Art; Hindu Temple Architecture, Buddhist Architecture, Medieval Architecture and Colonial Architecture. Indian Painting Tradition: ancient, medieval, modern Performing Arts: Divisions of Indian classical music: Hindustani and Carnatic, Dances of India: Various Dance forms: Classical and Regional, Rise of modern theatre and Indian cinema.

Unit-IV

Spread of Indian Culture Abroad, Causes Significance and Modes of Cultural Exchange - Through Traders, Teachers, Emissaries, Missionaries and Gypsies, Indian Culture in South East Asia, India, Central Asia and Western World.

Recommended Readings:

1. Barua, B. 1934-37. Barhut Vol. I-III. Calcutta: Indian Research Institute.
2. Cunningham, Alexander 1966. The Bhilsa Topes. Varanasi: Indological Book Corporation.
3. Cunningham, Alexander 1965. The Stupa of Bharhut. Varanasi: Indological Book Corporation.
4. Dallapiccola, L.S.Z. Lallemant. 1980. The Stupa : Its Religious, Historical, and Architectural Significance. Wiesbaden: Franz Steiner Verlag.
5. Dehejia, Vidya 1972. Early Buddhist Rock Temples A Chronological Study. London: Thames and Hudson

Indian Architecture

Course Code: : AUC 103 Credits (0-0-0)
Course Category : Audit
Pre-requisite Subject : NIL
Contact Hours/Week : 1/2 Lecture : , Tutorial : , Practical:
Number of Credits : 0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.

Course outcomes

CO1- This course will help student learn about the development of Indian architecture and its contextual and traditional aspects.
CO2- The learner will gain knowledge of the development of architectural forms with reference to technology, style and character in various aspects of Hindu architecture.

CO3- The students will comprehend and relate to the theoretical basis of Budhdhist and Jain Architectures.

UNIT 1; Indus Valley Civilization: Town planning principles, cultural ethos, economy exemplified. The Aryan civilization: With its emphasis on the Vedic town plan.
UNIT 2: Buddhist Architecture Typology of lats, eddicts, stupas, viharas, and chaityas, both in rock-cut or other wise. The Buddhist philosophy and its imprint

UNIT3; Hindu Architecture, Indo Aryan: The evolution of the temple form, evolution of the shikhara in north India. The three schools of architecture - the Gujarat, the Khajuraho, and the Orrisan styles, Introduction to Dravidian Hindu Architecture.

UNIT 4: Jain Architecture : The temple cities of Palitana, Mount Abu and Girnar. Jain Theory The Jain philosophy and its imprint in built form.

REFERNCE BOOKS

1. Stella Kramrisch, The Hindu temple, Volume 1 & 2, Motilal Banarsidass Publications, 1996.
2. Percy Brown, Indian Architecture (Buddhist and Hindu period), D.B.Taraporewala Sons & co Pvt. Ltd. 1965
3. Volwahsen, Andreas, Living Architecture
4. Satish Grover, The Architecture of India- Volume 2, Vikas, 1980.
5. Henri Stierlin, Anne Stierlin, Hindu India: from Khajuraho to the temple city of Madurai, Taschen, 1998.
6. James Fergusson, History of Indian & Eastern Architecture, 2007
7. C. Batley, Design Development of Indian Architecture, John murray, London, 1934.

Indian Festivals

Course Code: : AUC 104 Credits (0-0-0)
Course Category : Audit
Pre-requisite Subject : NIL
Contact Hours/Week : ½ Lecture : , Tutorial : , Practical:
Number of Credits : 0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.

Course Outcomes:

CO1-Students will learn about rich cultural aspects associated with Indian religions

CO2-The course will give deep insight in to understand the importance of festivals.

UNIT 1; Indian Festivals: Introduction to major Indian festivals Bihu, Raksha Bandhan , Onam, Pongal, Holi, Dipawali, Dushehra, Easter, Good Friday, Christmas , Eid-ul-fitr and Eid-ul-Azha , Cultural aspects of festivals .

UNIT 2 ; **Characteristics of Indian festivals** ; Seasonal in nature, seasonal festival are Agro based, worships of animals.

UNIT 3; festivals observed at same time but with different names in different parts of country.

UNIT3 : Artificial or non religious festivals- like Jaisalmer desert festivals, Mango festivals in Delhi, Elephant festivals in India. Etc.

REFERENCE BOOKS

1) Discover India; Festival of India by Sonia Mehta

2) Hindu Festival : Origin, sentiments and Rituals by Mukuncharan Das.

VAIDIC MATHEMEATICS

Course Code: : AUC 105 Credits (0-0-0)
Course Category : Audit
Pre-requisite Subject : NIL
Contact Hours/Week : 1/2 Lecture : , Tutorial : , Practical:
Number of Credits : 0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.

Course outcomes:

● Vedic mathematics methods are used in coding and VLSI implementation of encryption.
● Vedic mathematics method of division, exponentiation and multiplication are used in internet security and cryptographic algorithms for making these calculations faster than before.
● Arithmetic and logic unit (ALU) is responsible for all mathematical and logical calculations in computers. Some sutras like udharvtriyakbhyam and nikhilam are used for implementing multiplication methods.
● Digital Signal Processing (DSP) includes face recognition, text speech conversion, image processing and audio -video processing and also filtering of noise. In this area VM methods are very useful to improve the performance of DSP algorithms.

UNIT-I
Introduction & history of Vedic mathematics, Arithmetic and number, Vedic Maths Formulae, Addition and Subtraction: Addition - Completing the whole , Addition from left to right , Addition of list of numbers - Shudh method , Subtraction - Base method , Subtraction - Completing the whole, Subtraction from left to right

UNIT-II

Multiplication: Ekadhikenpurven method (multiplication of two numbers of two digits), Eknunenpurven method (multiplication of two numbers of three digits), Urdhvatiragbhyam method (multiplication of two numbers of three digits), Nikhilam Navtashchramam Dashtaha (multiplication of two numbers of three digits), Combined Operations

Division and Divisibility: Division, Nikhilam Navtashchramam Dashtaha (two digits divisor), Paravartya Yojyet method (three digits divisor)

Divisibility: Ekadhikenpurven method (two digits divisor), Eknunenpurven method (two digits divisor)

UNIT-III
Least Common Multiple **(LCM)** and Highest Common Factor **(HCF)**
Power and Root Power: Square (two digit numbers), Cube (two digit numbers).
Root: Square root (four digit number), Cube root (six digit numbers)
UNIT-IV

Contribution of Indian Mathematicians (In light of Arithmetic) , Aryabhatt , Brahmagupt , Mahaveeracharya , Bharti Krishna Tirtha

Reference Books:

1. Vedic Mathematics, Motilal Banarsi Das, New Delhi.
2. Vedic Ganita: Vihangama Drishti-1, Siksha Sanskriti Uthana Nyasa, New Delhi.
3. Vedic Ganita Praneta, Siksha Sanskriti Uthana Nyasa, New Delhi.
4. Vedic Mathematics: Past, Present and Future, Siksha Sanskriti Uthana Nyasa, New Delhi.
5. Leelavati, Chokhambba Vidya Bhavan, Varanasi.
6. Bharatiya Mathematicians, Sharda Sanskrit Sansthan, Varanasi.

ASTRONOMY

Course Code: : AUC 106 Credits (0-0-0)
Course Category : Audit
Pre-requisite Subject : NIL
Contact Hours/Week : 1/2 Lecture : , Tutorial : , Practical:
Number of Credits : 0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.

UNIT-I

Historical introduction: Old Indian and western – astronomy – Aryabhatta, Tycho Brahe, Copernicus, Galileo – Olbers paradox – solar system – satellites, planets, comets, meteorites, asteroids.
Practical astronomy – telescopes and observations & techniques – constellations, celestial coordinates, ephemeris.
Celestial mechanics – Kepler's laws – and derivations from Newton's laws.
Sun: Structure and various layers, sunspots, flares, faculae, granules, limb darkening, solar wind and climate.

UNIT-II

Stellar astronomy: H-R diagram, color-magnitude diagram – main sequence – stellar evolution – red giants, white dwarfs, neutron stars, black holes – accretion disc – Schwartzchild radius – stellar masses Saha–Boltzman equation – derivation and interpretation.

Variable stars: Cepheid, RR Lyrae and Mira type variables – Novae and Super novae. Binary and multiple star system – measurement of relative masses and velocities. Interstellar clouds – Nebulae.

UNIT-III

Transformations Generalized Coordinates, Canonical transformations, Conditions for canonical transformation and problem, Poisson brackets, invariance of PB under canonical transformation, Rotating frames of reference, inertial forces in rotating frames.

UNIT-IV

Relativity and Application Concept of Special Theory of Relativity, Lorentz Transformation, Length Contraction and time dilation, Relativistic addition of velocities, conservation of mass and momentum, Concept of General Theory of Relativity, Equivalence of mass and energy, Relativistic Doppler shift and aberration of light. Lagrangian and Hamiltonian of relativistic particles, Relativistic degenerate electron gas.

Reference Books:

1. "Textbook of Astronomy and Astrophysics with elements of Cosmology", V. B. Bhatia, Narosa publishing 2001.
2. William Marshall Smart, Robin Michael Green "On Spherical Astronomy", (Editor) Carroll, Bradley W Cambridge University Press ,1977
3. Bradley W.Carroll and Dale A. Ostlie. "Introduction to modern Astrophysics" Addison-Wesley, 1996.
4. Bradley W.Carroll and Dale A. Ostlie, "An Introduction to Modern Astrophysics" Addison Wesley Publishing Company,1996
5. 'Stellar Astronomy' by K. D Abhayankar.
6. 'Solar Physics' by K. D Abhayankar.

ARTS OF INDIA

Course Code: : AUC 107 Credits (0-0-0)
Course Category : Audit
Pre-requisite Subject : NIL
Contact Hours/Week : 1/2 Lecture : , Tutorial : , Practical:
Number of Credits : 0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.
Course Outcomes:

CO1- Students will be introduced to emergence and development of art traditions upto 6th century C.E. Monuments will be studied in their cultural context.

CO2-Students will able to understand the monuments in their religious, regional and stylistic context. Students will be able to prepare plans of the monuments.

Unit 1:

Introduction to traditions of Art and Architecture in India . Introduction to Art and Architecture and prelude to historical art. ii. Art of the pre-Mauryan period. iii. Art and Architecture of Mauryan Period iv. Sources of Inspiration of Mauryan Art and Architecture: Foreign and Indigenous.

Unit 2:

Emergence and Development of Structural Stupa Architecture . Origin of Stupa Architecture. ii. Stupa Architecture - Pre-Mauryan and Mauryan periods. iii. North India, Central India, Deccan and Gandhara iv. Structural monasteries and Chaityas.

Emergence and Development of Rock-cut Architecture. Origin of Rock-cut Architecture. ii. Eastern India, Western Deccan, Eastern Deccan, Central India.

Unit 3:

Unit 4: Emergence and Development of Temple Architecture (08 hrs) i. Origin of Temple Architecture-Theoretical aspects. ii. Concept and symbolism of Temple. iii. Archaeological remains of structural temples. iv. Temple Architecture during the Gupta period. v. Temple Architecture during the Vakataka period.

Unit 4:

Sculptural Art and Paintings - Emergence and Development (10 hrs) i. Sculptural Art and Paintings - Concept and Symbolism. ii. Terracottas, Ivories and Bronzes iii. Paintings iv. Stone sculptures-Gandhara, Mathura, Sarnath and Andhra schools of Art. v. Art during the Gupta-Vakataka period.

Recommended Readings:

1. Barua, B. 1934-37. Barhut Vol. I-III. Calcutta: Indian Research Institute.
2. Cunningham, Alexander 1966. The Bhilsa Topes. Varanasi: Indological Book Corporation.
3. Cunningham, Alexander 1965. The Stupa of Bharhut. Varanasi: Indological Book Corporation.
4. Dallapiccola, L.S.Z. Lallemant. 1980. The Stupa : Its Religious, Historical, and Architectural Significance. Wiesbaden: Franz Steiner Verlag.
5. Dehejia, Vidya 1972. Early Buddhist Rock Temples A Chronological Study. London: Thames and Hudson

INTELLECTUAL PROPERTY RIGHTS

Course Code: : AUC 108 Credits (0-0-0)
Course Category : Audit
Pre-requisite Subject : NIL
Contact Hours/Week : 1/2 Lecture : , Tutorial : , Practical:
Number of Credits : 0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.
Course Outcomes: After the completion of the course the student will be able to
CO1: Create an understanding on Intellectual Properties and the importance of it.
CO2: Understand Trademarks and Trade secrets. To create awareness of unfair completion and methods of it.
CO3: Create awareness on the protection copyrights and patents. Understand the Ownership rights and transfer.
CO4: Create awareness of Cyber laws, Cyber Crime and get understanding of Privacy of Data.
CO5: To create awareness international aspects of IPR and the Emerging Trends in IPR.

Course Content

UNIT – I: Introduction to Intellectual property: Introduction, types of intellectual property—Patent, Trademarks, Copy rights, IPR and World Trade Organization, other international organizations, agencies and treaties, importance of intellectual property rights. Creating Intellectual Property. Intellectual Property Management. Emerging Issues in IPR. Research and Development in India.

UNIT – II: Fundamentals of Patent: Historical Overview of Patent Law; Concept of Patent; Patentable Inventions; Procedure for Obtaining Patent; Rights and Obligations of Patent Holder; Transfer and Infringement of Patent Rights, Geographical Indications, Case Study: Apple versus Samsung Patent Dispute.

UNIT – III: Trademarks: Purpose and function of trademarks, acquisition of trademark rights, protectable matter, selecting, and evaluating trademark, trade mark registration processes.

UNIT – IV: Copy rights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law. Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer.

Textbooks

- Textbook of Intellectual Property Rights, N.K. Acharya. Asia Law House, ed. 2021.
- Intellectual property right, Deborah. E. Bouchoux, Cengage learning.
- Intellectual Property Rights–Pandey Neeraj, Dharni Khushdeep. PHI.
- Intellectual Property Rights: Text and Cases R. Radhakrishnan, S. Balasubramanian. Excel Books.

Reference Books

1) Intellectual property right – Unleashing the knowledge economy, Prabuddha Ganguli, Tate McGraw Hill ltd.

2) A short course in International Intellectual Property Rights – Karla C. Shippey, World Trade Press.

3) Intellectual Property Rights – Heritage, Science, & Society under international treaties – A. Subbian, - Deep & Deep Publications – New Delhi.

HUMAN RIGHTS

Course Code: : AUC 109 Credits (0-0-0)
Course Category : Audit
Pre-requisite Subject : NIL
Contact Hours/Week : 1/2 Lecture : , Tutorial : , Practical:
Number of Credits : 0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.

Course Outcomes:

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

1. Simply put, human rights education is all learning that develops the knowledge, skills, and values of human rights.
2. Strengthen the respect for human rights and fundamental freedoms.
3. Enable all persons to participate effectively in a free society.
4. Learn about human rights principles, such as the universality, indivisibility, and interdependence of human rights.

UNIT-I

The Basic Concepts: Individual, Group, Civil Society, State, Equality, Justice, Human Values: Humanity, Virtues, Compassion.

UNIT-II Human Rights and Human Duties:

i) Philosophical and historical foundation of human rights and duties
ii) Theories of rights
iii) Concept and classifications of human rights and duties
iv) Human rights and duties

1. Correlation of rights and duties/responsibilities
2. Tensions between rights inter se, duties inter se, and rights and duties

UNIT-III

Society, Religion, Culture, and their Inter-Relationship: Impact of Social Structure on Human behavior, Roll of Socialization in Human Values, Science and Technology, Modernization, Globalization, and Dehumanization.

UNIT-IV

Social Structure and Social Problems: Social and Communal Conflicts and Social Harmony, Rural Poverty, Unemployment, Bonded Labour, Migrant workers and Human Rights Violations, Human Rights of mentally and physically challenged.

Books & References:

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

LOGICAL RESEARCH

Course Code: : AUC 110 Credits (0-0-0)
Course Category : Audit
Pre-requisite Subject : NIL
Contact Hours/Week : 1/2 Lecture : , Tutorial : , Practical:
Number of Credits : 0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination
Course outcomes: In this course you should develop the following competencies:

CO1: To understand about research methodology with its different aspects, about logical reasoning, and types of research.
CO2: It will also result in knowledge appraisal from data collection to data interpretation.
CO3: Mathematical reasoning will also help them to acquire several skills required for the placement.

Course Content

UNIT1- Research Methodology: meaning, characteristics, Types of research; Process of research; Research methods and Ethical issues in research.

UNIT2- Logical Reasoning: arguments, deductive and inductive research, quantitative and qualitative research, scientific research; logical approach in research - Venn diagram; Inferences; analogies.

UNIT3- Data collection, Organization of data, Data analysis and mapping, Parametric and non-parametric; Data Interpretation.

UNIT4- Mathematical Reasoning, number series, letter series, codes; relationships, classification.

References:

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.

3.ResearchMethodology–C.R.Kothari
4. Marketing Research- G C Beri
5. Logical reasoning- R S Agarwal

PROFESSIONAL ETHICS

Course Code: : AUC 111 Credits (0-0-0)
Course Category : Audit
Pre-requisite Subject : NIL
Contact Hours/Week : 1/2 Lecture : , Tutorial : , Practical:
Number of Credits : 0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.

Course Outcomes

Course Outcomes: After the completion of the course the student will be able to-
CO1: Understand the core values that shape the ethical behaviour of a professional.
CO2: Identify the multiple ethical interests at stake in a real-world situation or practice.
CO3: Explain the role and responsibility in technological development by keeping personal ethics and legal ethics.
CO4: Solve moral and ethical problems through exploration and assessment by established experiments.
CO5: Apply the knowledge of human values and social values to contemporary ethical values and global issues.

Course Content

Unit I:
Understanding Professional Ethics and Human Values: Morals, values and Ethics – Integrity- Academic integrity-Work Ethics- Service Learning- Civic Virtue Respect for others- Living peacefully- Caring and Sharing- Honestly- courage-Cooperation commitment Empathy-Self Confidence -Social Expectations.

Unit II:
Ethics for Engineers: Ethics – its importance – code of ethics – person and virtues – habits and morals – 4 main virtues – ethical theories – Kohlberg's theory – Gilligan's theory – towards a comprehensive approach to moral behaviour – truth – approach to knowledge in technology.

Unit III:
Environmental Ethics and Sustainability: Problems of environmental ethics in engineering – engineering as profession serving people – engineer's responsibility to environment – principles of sustainability – industrial, economic, environmental, agricultural, and urban sustainability – Sustainable development. - Global Ethical Issues.

Unit IV:
Social Experimentation, Responsibility and Rights: Engineers and responsible experiments – safety and risk – confidentiality – knowledge gained confidentiality – experimental nature of engineering – Intellectual Property Rights – professional rights – employee rights – occupational crime.

Textbooks

- Mike W Martin, Roland Schinzinger, " Ethics in Engineering", Tata McGraw –Hill.
- Govindarajan M, Natarajan S, Senthil Kumar V S, "Engineering Ethics" PHI India.
- R.R Gaur, R Sangal, G P Bagaria, A foundation course in Human Values and professional Ethics, Excel books, New Delhi.

Reference Books

- Aarne Vesblind, Alastair S Gunn, "Engineering Ethics and the Enviornment".
- Edmund G Seebauer, Robert L Barry, "Fundamentals of Ethics for scientists and engineers" Oxford University Press.
- B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.

ENVIRONMENTAL LAWS

Course Code: : AUC 112 Credits (0-0-0)
Course Category : Audit
Pre-requisite Subject : NIL
Contact Hours/Week : 1/2 Lecture : , Tutorial : , Practical:
Number of Credits :
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.
Course Outcomes:

The course gives students the opportunity to grapple with contemporary legal debates in environment law. Therefore, the learning outcomes of this course can be encapsulated as follows:

1) The primary learning outcome is to sensitize the students towards human activities that adversely affect the environment and the need for regulation of such activities.
2) Students will develop a thorough understanding of practice and procedure followed by various environmental law enforcing agencies/bodies.
3) Students will be able to pursue environmental litigation before the National Green Tribunal and assist the Tribunal as a researcher or in any other capacity.
4) Students will be able to assist industries and projects in obtaining environmental clearance and compliances with other environmental laws.

UNIT-I

Development of Environmental Laws and Policies in India:

I. Concept of 'environment' and understanding scope of environmental law.
II. Two approaches towards environmental protection- 'Eco-centric approach' and 'Anthropocentric' approach.
III. Impact of IEL on environmental law in India.
IV. Significance of Environmental Protection in Five Year Plans.
V. Development of the 'Right to Environment' as a Fundamental Right and challenges.

UNIT-II Judicial remedies and the role of National Green Tribunal:

I. Civil Remedies i.e. Tortious remedy and Class Action
II. Criminal Law Remedies under relevant provisions of Indian Penal Code, 1860 and Criminal Procedure Code, 1973

III. Constitutional Law Remedies i.e. Writ Jurisdiction & Public Interest Litigation
IV. Statutory Remedies i.e. Remedies under Public Liability Insurance Act 1991, National Environment Tribunal Act, 1995, National Green Tribunal Act, 2010

UNIT-III

Statutory framework for Prevention of Environmental, Air and Water Pollution:

I. Water (Prevention and Control of Pollution) Act 1974 [Framework of the Act, Criminal Liability and Judicial relief under the Act, Constitutional Challenges of Restraining Orders under Section 33]
II. The Air (Prevention and Control of Pollution) Act 1981 [Framework of the Act, Criminal Liability and Judicial relief under the Act, Noise Pollution]
III. Environment (Protection) Act, 1986 [Framework of the Act, Enforcement mechanisms and Role of Pollution Control Boards, Environment Impact Assessment, Coastal zone regulations Notifications]
IV. Law on Waste Management and Handling
V. Procedural environmental rights under various environmental laws
- Right to Information
- Right to public consultation
- Right of access to justice

UNIT-IV

Statutory framework governing Forest, Wildlife and Biodiversity:

II. Statutory Framework on Forest Preservation [The Indian Forest Act, 1927; Forest (Conservation) Act, 1980; National Forest Policy, 1988; The Scheduled Tribe and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006]
III. Statutory Framework on Wildlife & Biodiversity Protection [The Wildlife (Protection) Act, 1972; Implementation and gaps and Judicial Perspective; Biological Diversity Act, 2002]

Books & References:

1) Shyam Divan & Armin Rosencranz, Environmental Law & Policy in India (2 nded, Oxford University Press, 2014)
2) P. Leelakrishnan, Environmental law in India (4th ed, LexisNexis, 2016)
3) Lavanya Rajamani and Shibani Ghosh, Indian Environmental Law: Key Concepts and Principles (Orient Blackswan, 2019)
4) Gitanjali Nain Gill, Environmental Justice in India: The National Green Tribunal (Routledge, 2017)
5) Patricia Birnie, Alan Boyle and Catherine Redgwell, International Law and the Environment (3rd ed., Oxford University Press, 2009)
6) Philippe Sands, Principles of International Environmental Law (2nd ed, Cambridge University Press, 2003)

HEALTH LAW

Course Code: : AUC 113 Credits (0-0-0)
Course Category : Audit
Pre-requisite Subject : NIL
Contact Hours/Week : ½ Lecture : , Tutorial : , Practical:
Number of Credits : 0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination
Course Outcomes: In this course you should develop the following competencies:
CO1: Knowledge and understanding of the values and policies underlying Health Law.

CO2: Knowledge and understanding of substantive law related to health care, health care insurance markets as well as related procedural law.
CO3: Written and oral communication in the legal context.

Course Content

UNIT-1 BASICS OF HEALTH LAW- Basic of Health and its provider, Origin & Evaluation, All Council Acts.

UNIT-2 NEED FOR HEALTH LAW -Fraudulence, Negligence and Abuse, Human Rights, Rights & Duties of Health Care Provider (Public & Private Activities).

UNIT-3 LEGAL ASPECTS OF HEALTH LAW- Role of Health Policy & Health Care Delivery, General Laws on Health Law (Medical Allied Agencies), Specific Laws on Health Law (NDT, PWD/etc.).

UNIT-4 MEDICAL INSURANCE –Introduction-Various types, Significance and Kind of Medical Insurance/Policies, Insurance & Assurance, General Principles of Law and Contract, Medical Insurance Regulations.

REFERENCES:
1)Jonathan Herring- Medical Law and Ethics
2)Mason and Mc Call Smith- Law and Medical Ethics
3)S. V. Jogarao- Current Issues in Criminal Justice and Medical Law

National Cadet Corps (NCC)

Course Code: : AUC 114 Credits (0-0-0)
Course Category : Audit
Pre-requisite Subject : NIL
Contact Hours/Week : ½ Lecture : , Tutorial : , Practical:
Number of Credits : 0 Credit
Course Outcomes: In this course you should develop the following competencies:
CO1: Imbibe the conduct of NCC cadets.
CO2: Respect the diversity of different Indian culture.
CO3: Perform his/her role in Nation Building
CO4: Do the social services on different occasions.
CO5: Practice togetherness and empathy in all walks of their life.
CO6: Do the asana and gain the physical& mental fitness

Course Content

UNIT 1
NCC General

History, Aims, Objective of NCC, NCC as Organization. Incentives of NCC, Duties of NCC Cadet, NCC Camps: Types & Conduct.

UNIT 2
National Integration & Awareness

National Integration: Importance & Necessity, Factors Affecting National Integration, Unity in Diversity & Role of NCC in Nation Building, Threats to National Security

UNIT 3
Social Service and Community Development

Celebration of Days of National & International Importance, Social Service and Community

Development Activities to be conducted.

UNIT 4

Health & Hygiene:

Yoga- Introduction, Definition, Purpose, Benefits.

Asanas-Padamsana, Siddhasana, Gyan Mudra, Surya Namaskar, Shavasana, Vajrasana, Dhanurasana, Chakrasana, Sarvaangasana, Halasana etc.

Textbooks:

1. R. Gupta, "NCC: Handbook of NCC Cadets for 'A', 'B' and 'C' Certificate Examinations" 1st Edition (English, Paperback, RPH Editorial Board)

Basics of Human Health and Preventive Medicines

Course Code: : AUC 115 Credits (0-0-0)
Course Category : Audit
Pre-requisite Subject : NIL
Contact Hours/Week : 1/2 Lecture: , Tutorial : , Practical:
Number of Credits : 0 Credit
Course Assessment Methods: Continuous assessment through tutorials, attendance, home assignments, quizzes, practical, Tutorial class, viva voce and Minor tests and One Major Theory Examination.

UNIT- 1

Health- Definition, dimensions, concept of wellbeing, Physical quality of life index, Spectrum of health, Determinants of health.

Concept of disease- Epidemiological triad, Natural history of disease, Risk factors, risk group, Iceberg of disease, Disease control, Disease elimination, Disease eradication, **Monitoring and surveillance-** Concept of prevention, Primary, Secondary and Tertiary, Modes of Intervention.

UNIT- 2

Communicable diseases- Type of microorganisms, Mode of transmission, Prevention of infectious diseases, Vaccination/immunization**.**

Diarrheal diseases and dehydration- Prevention and role of ORS**.**

Fever- cause and how to deal with.

Respiratory problems and cough

UNIT - 3

Non communicable diseases/ Lifestyle related disorder- Risk factors, CAD, risk and prevention, Hypertension, Diabetes mellitus, Obesity, Cancer, Accidents.

UNIT – 4

Nutrition and health- Classification of food, Balance diet.

Occupational hazards

Mental health and substance abuse

Medical Emergencies- BLS and ALS.

Reference Textbook

1) K. Park – "Park's Textbook of Preventive and Social Medicine"
2) Yash Pal Bedi & Pragya Sharma– "Handbook of Preventive and Social Medicine, Seventeenth Edition, CBS Publication".
3) Sunder Lal, Adarsh, Pankaj – "Update on Textbook of Community Medicine Preventive and Social Medicine with Recent Advances" 5th Edition, Publication 2018.
4) Dr. B. Saha- "Preventive and Social Medicine Communicable Disease Hygiene".

5) Rabindra Nath Roy, Indernil Saha- "Mahajan and Gupta Textbook of Preventive and Social Medicine" 4th Edition, Japee

CONSTITUTION OF INDIA AND ENVIRONMENTAL GOVERNANCE: ADMINISTRATION AND ADJUDICATION

Course Code	**: AUC 116**	**Credits (0-0-0)**
Course Category	**: VAC (Audit)**	
Pre-Requisite Subject	**: NIL**	
Contact Hours/ Week	**: 1 / 2 Lecture, Tutorial, Practical**	
Number of Credits	**: 0 Credit**	
Course Assessment Method	**: Continuous assessment through Tutorial classes, Home Assignments, Quizzes, Practical, Viva-Voce, Attendance, Minor Tests and One Major Theory Examination.**	

COURSE OUTCOME

At the end of the course, learners should be able to:

CO1- Understand the fundamental principles of environmental governance.

CO2- Understand Constitutional perspectives of environmental governance in India.

CO3- Procedural compliance under environmental legislations and role of Judiciary and quasi-judicial bodies in environmental governance.

CO4- Develop an understanding of bio-diversity conservation, climate change, forest protection, waste management and other issues.

COURSE CONTENTS

UNIT-I: Foundations of Environmental Law and Governance
Principles and Legal Instruments of Environmental Governance
Emerging Trends in Environmental Law

UNIT- II: Constitution of India and the articles relating Environment
Pollution Control Laws and Administrative processes
Environment Protection Act and Administrative processes
Waste Management Laws and Role of Municipalities and other agencies

UNIT- III: Basics of Forest Management in India
Judiciary and its role
Biodiversity Laws and its Application; ABS Guidelines

UNIT- IV: Wildlife Protection and management in India
Adjudicatory Mechanisms- Supreme Court, High Court, National Green Tribunal

BOOKS AND REFERENCES

- Philippe Sands, Principles of International Environmental Law, Cambridge, 2018
- Indian Environmental Law: Key Concepts and Principles, ed. Shibani Ghosh, Orient BlackSwan (2019).
- NawneetVibhaw, Environmental Law: An Introduction, LexisNexis (2016).
- Shyam Divan and Armin Rosencranz, Environmental Law and Policy in India: Cases, Material & Statutes
- Justice T S Doabia (2010) Environmental and Pollution Laws in India, Lexis Nexis Butterworths Wadhwa. Chapters 10 and 11.

- S Ghosh, S Lele, N Henle, Appellate Authorities under Pollution Control Laws in India: Powers, Problems and Potential, LEAD 2018
- Ritwick Dutta and Bhupender Yadav (2012) Supreme Court on Forest Conservation, Universal Law Publishing. Introduction (The Court's Journey through Forests) and Chapter1.
- Gitanjali Gill, Environmental Justice in India: The National Green Tribunal, Routledge (2016)
- Abhayraj Naik and Parul Kumar, India's Domestic Climate Policy is Fragmented and Lacks Clarity, available at https://www.epw.in/engage/article/indias-domestic-climate-policy-fragmented-lacks-clarity
- Suggested Documentaries- Climate Change the Facts, BBC (April, 2019)

DIRECTIVE PRINCIPLES OF STATE POLICY AND FUNDAMENTAL DUTIES: CONSTITUTIONAL IMPERATIVE

Course Code : **AUC 117** **Credits (0-0-0)**
Course Category : **VAC (Audit)**
Pre-Requisite Subject : **NIL**
Contact Hours/ Week : **1 / 2 Lecture, Tutorial, Practical**
Number of Credits : **0 Credit**
Course Assessment Method : **Continuous assessment through Tutorial classes, Home Assignments, Quizzes, Practical, Viva-Voce, Attendance, Minor Tests and One Major Theory Examination.**

COURSE OUTCOME

At the end of the course, learners should be able to:
CO1- Understand the fundamental concepts behind Directive Principles of State Policy.
CO2- Evolution and the adoption of the DPSP through the Constituent Assembly debates.
CO3- Learn how the three organs of the governance play role in shaping and achieving DPSP.
CO4- Understand the basics and relevance of Fundamental Duties.
CO5- Evaluate the relationship between Indian Knowledge System and Fundamental Duties.

COURSE LAYOUT

UNIT-I: Evolution and Concept of Directive Principles of State Policy, Incorporation of the Directive Principles of State Policy: Constituent Assembly Debates

UNIT-II: Salient Features of the Directive Principles of State Policy under the Indian Constitution, The Legislative, the Executive and the Judiciary on the Directive Principles of the State Policy

UNIT III: The Legislative, the Executive and the Judiciary on the Directive Principles of the State Policy (Cont.,), Evolution and Relevance of the Fundamental Duties

UNIT-IV: Relationship between Fundamental Duties and Indian Knowledge System, The Legislative, the Executive and the Judiciary on Fundamental Duties

BOOKS AND REFERENCES

- H.M. Seervai, Constitutional Law of India, Vol. I and 2, Universal Law Publishing (LexisNexis) 4th Edition, 2015
- Samaraditya Pal, India's Constitution: Origins and Evolution, Vol. 3, LexisNexis, 2015 Constituent Assembly Debates, Loksabha Secretariat
- Justice R C Lahoti, Fundamental Duties: A Forgotten Chapter of the Constitution, LexisNexis, 2015
- NCRWC, A Consultation Paper on Effectuation of Fundamental Duties of Citizens, 2001
- Granvile Austin, The Indian Constitution: A Cornerstone of a Nation, Oxford Clarendon Press, 1966.

INTRODUCTION TO INTELLECTUAL PROPERTY TO ENGINEERS AND TECHNOLOGISTS

Course Code	**: AUC 118**	**Credits (0-0-0)**
Course Category	**: VAC (Audit)**	
Pre-Requisite Subject	**: NIL**	
Contact Hours/ Week	**: 1 / 2 Lecture, Tutorial, Practical**	
Number of Credits	**: 0 Credit**	
Course Assessment Method	**: Continuous assessment through Tutorial classes, Home Assignments, Quizzes, Practical, Viva-Voce, Attendance, Minor Tests and One Major Theory Examination.**	

COURSE OUTCOME

After the completion of the course the learners should be able to:

CO1: Create an understanding on Intellectual Properties and the importance of it.

CO2: Learn basics of Patents, Trademarks and copyrights.

CO3: Create awareness on the filing, protection copyrights and patents and understand the Ownership rights and their transfer.

CO4: Understand trade secrets and able to compare their positives and negatives traits.

CO5:, Aware of emerging trends in IPR, and learn about IP management.

COURSE LAYOUT

UNIT -I: Introduction to Intellectual Property, Types of intellectual property—Patent, Trademarks, Copy rights, IPR and World Trade Organization, Other international organizations,

UNIT -II: Basics of Patent, Patent filing procedure, Obligations of Patent Holder, Basics of Copyright- Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration Industrial Design, Emerging issue

UNIT -III: Trademark basic, Purpose and function of trademarks, acquisition of trademark rights, protectable matter, selecting, and evaluating trademark, trade mark registration processes GI basic**,** IC Layout Design

UNIT –IV: Trade secret**,** Comparative analysis, IP management

BOOKS AND REFERENCES:

- THE ECONOMIC STRUCTURE OF INTELLECTUAL PROPERTY LAW, William M. LANDES, Richard A. Posner, Harvard University Press, 2003.
- Intellectual Property and Development: Theory and Practice, Rami M. Olwan, Springer
- Narayanan, P (2006) Intellectual Property Law. 3rdedition. Eastern Law House
- Colston, C., Middleton, K. 2004 Modern Intellectual Property Law. 2nd Edition. Cavendish Publishing Ltd
- Cornish W, Llewelyn, D (2003) Intellectual Property: Patents, Copyrights, Trademarks and Allied rights. Fifth edition. Sweet and Maxwell.
- William M. Landes & Richard A. Posner, Indefinitely Renewable Copyright, 70 U. CHI. L. REV. Goldstein, Kitch and Perlman, 2006, Selected Statutes and International Agreements on Unfair Competition, Trademark, Copyright, and Patent
- Paul Goldstein, 2002, Copyright, Patent, Trademark and Related State Doctrines: Cases and Materials on Intellectual Property Law, Revised 5th edition, New York, NY: Foundation Press, 1025 pages.
- T.K.Bandyopadhyay and Saurabh Bindal, "Introduction to Intellectual Property" 1st edition Eastern Book Company, 2015

AUC119	:	**Fundamentals of Artificial Intelligence**
Course category	:	Audit Course
Pre-requisite Subject	:	Basic Programming Knowledge
Contact hours/week	:	Lecture: 2, Tutorial: 0, Practical:0
Number of Credits	:	0
Course Assessment methods	:	Continuous assessment through assignments, quizzes, tutorials, course-based project, one minor test and one major examination
Course Objectives	:	The course aims to: 1. Introduce fundamental concepts of Artificial Intelligence. 2. Develop basic Python programming skills for AI applications. 3. Build foundations in data analysis and preprocessing. 4. Provide understanding of machine learning concepts. 5. Expose students to AI use cases in various engineering domains.

Course Outcomes : After successful completion of this course, students will be able to:

CO1. Understand fundamental concepts of Artificial Intelligence and intelligent systems.
CO2. Apply Python libraries for data handling and visualization.
CO3. Perform data preprocessing and exploratory data analysis.
CO4. Understand basic machine learning concepts and evaluation metrics.
CO5. Identify and analyze AI applications in various engineering domains.
CO6. Develop simple AI-based solutions using data preprocessing, visualization, and basic machine learning models.

Topics Covered

UNIT I: Introduction to AI and Python Programming **6**

Overview of Artificial Intelligence: History, scope, types of AI, Applications of AI in modern technology, Python Basics: Data types, variables, operators, Control Structures: Conditional statements, loops, Functions and Modules, Data Structures: Lists, tuples, dictionaries, sets, File Handling Introduction to NumPy, Pandas, Matplotlib.

UNIT II: Exploratory Data Analysis **6**

Types of Data: Numerical and Categorical**,** Steps in Exploratory Data Analysis**,** Descriptive Statistics**,** Data Visualization Techniques**,** Introduction to Data-driven Decision Making.

UNIT III: Data Preprocessing and Introduction to Machine Learning **6**

Data Cleaning and Deduplication, Handling Missing Data, Data Transformation: Normalization, Scaling, Binning, Introduction to Supervised and Unsupervised Learning (Conceptual Only), Model Evaluation Metrics: Accuracy, Precision, Recall, F1-score.

UNIT IV: AI Use Cases in Engineering 6

Predictive maintenance and fault detection in industrial systems using sensor data, Smart infrastructure monitoring, Process optimization, quality inspection, and automation in manufacturing environments, Intelligent decision support systems for healthcare, environmental monitoring, and cybersecurity applications.

TEXTBOOKS

1. **Aurélien Géron**, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, O'Reilly
2. **Wes McKinney**, *Python for Data Analysis*, O'Reilly
3. **Ethem Alpaydin**, *Introduction to Machine Learning*, MIT Press
4. **Jake VanderPlas**, *Python Data Science Handbook*, O'Reilly

REFERENCE BOOKS

1. **Ian Goodfellow, Yoshua Bengio, Aaron Courville**, *Deep Learning*, MIT Press
2. **Sebastian Raschka**, *Machine Learning with Python*, Packt
3. **Stuart Russell & Peter Norvig**, *Artificial Intelligence: A Modern Approach*, Pearson
4. **Andreas C. Müller & Sarah Guido**, *Introduction to Machine Learning with Python*, O'Reilly.

INDIAN KNOWLEDGE THROUGH CLASSICAL LANGUAGES

Course Code	**: IKS 101**	**Credits (0-0-0)**
Course Category	**: VAC (Audit)**	
Pre-Requisite Subject	**: NIL**	
Contact Hours/ Week	**: 1 / 2 Lecture, Tutorial, Practical**	
Number of Credits	**: 0 Credit**	
Course Assessment Method	**: Continuous assessment through Tutorial classes, Home Assignments, Quizzes, Practical, Viva-Voce, Attendance, Minor Tests and One Major Theory Examination.**	

COURSE OUTCOME:

At the end of the course learners shall be able to:

CO1- Students will be able to read, understand, and interpret the core texts of Sanskrit, Pali, Prakrit, and other Indian languages.

CO2- Students will analyze the historical and cultural significance of Indian philosophy, science, art, and social practices.

CO3- Students will develop the ability to apply the principles of Indian scriptures and folk traditions to modern contexts.

CO4- Students will critically evaluate the contributions of the Indian Knowledge Tradition in fields like medicine, architecture, and science.

CO5- Students will be equipped to promote and preserve the Indian Knowledge Tradition through innovative and creative approaches.

COURSE CONTENTS

Unit I: Sanskrit Language-Based Indian Knowledge Tradition

Objective:

To understand the fundamental principles, philosophies, and their significance in the Indian Knowledge Tradition through the Sanskrit language and its literature.

Course Content:

1. Linguistics and Literature:

- Introduction to Sanskrit language, its grammar (morphology, phonetics), and vocabulary (words, meanings, synonyms, and prosody).
- Key texts: Vedas (Rigveda, Yajurveda, Samaveda, Atharvaveda), Upanishads, Mahabharata, Ramayana, Puranas, and their significance.

2. Philosophy and Religion:
- Indian philosophical systems (Yoga, Vedanta, Nyaya, Vaisheshika, Mimamsa, Sankhya).
- Core concepts of the Bhagavad Gita and Brahmasutra.
- Jain and Buddhist philosophies (methods, principles, and statements).

3. Science and Mathematics:
- Mathematics: Contributions of Aryabhata, Bhaskaracharya, and Shulba Sutras.
- Architecture: Sushruta Samhita, Charaka Samhita.
- Ayurveda and Rasashastra (Chemistry): Contributions to medical and chemical sciences.

4. History, Culture, and Society:
- Elements of history and culture in Sanskrit literature.
- Kautilya's Arthashastra (practical approach).
- Contributions of Kalidasa, Bhavabhuti, and Kabir.
- Musicology: Gandharvacharya, Sangita Ratnakara.

Unit II: Pali Language-Based Indian Knowledge Tradition

Objective:
To understand the Buddhist perspective of the Indian Knowledge Tradition through the Pali language and its literature.

Course Content:
1. Linguistics and Literature:
- Introduction to Pali language, its structure, grammar, and vocabulary.
- Primary, secondary (various sutras, commentaries), and tertiary Pali literature.

2. Philosophy and Religion:
- Buddhist philosophy: Truth and reality, the Eightfold Path, Nirvana.
- Buddhist meditation practices and their psychological aspects.

3. Architecture and Art:
- Buddhist architecture: Stupas (Sanchi, Amaravati), viharas, universities (Nalanda, Takshashila, etc.).
- Buddhist art: Gandhara and Mathura styles, Buddhist iconography.

Unit III: Prakrit Language-Based Indian Knowledge Tradition

Objective:
To understand the Jain perspective of the Indian Knowledge Tradition through the Prakrit language and Jain literature.

Course Content:
1. Linguistics and Literature:
- Introduction to Prakrit language, its dialects (Shauraseni, Magadhi, Ardhamagadhi).
- Jain Agamas: Acharanga Sutra, Sutrakritanga, and other texts.

2. Philosophy and Religion:
- Jain philosophy: Anekantavada (non-absolutism), Syadvada (relativity), and principles of religion.
- Jain ethics and principles of non-violence.

3. Science and Mathematics:
- Jain mathematics and cosmology.
- Contributions of Jainism to astronomy and religion.

4. Culture and Art:
- Jain architecture: Dilwara temples, Ranakpur.
- Jain painting and sculpture.

- Jain music and literary traditions.

Unit IV: Indian Knowledge Tradition Based on Other Indian Languages and Folk Traditions

Objective:
To understand the Indian Knowledge Tradition through Tamil, Telugu, Kannada, and other Indian languages, as well as folk traditions.

Course Content:
1. Linguistics and Literature:
   - Tamil and Telugu literature: Bhakti literature, Tirukkural, and Shaiva-Vaishnava poetry.
   - Folk literature: Kabir, Gita, and oral traditions.
2. Folk Culture and Traditions:
   - Folk arts: Madhubani, Warli.
   - Folk music and dance: Bihu, Garba, Lavani.
   - Folk festivals, rituals, and oral traditions.
3. Education and Technology:
   - Tamil Siddha medicine and traditional knowledge systems.
   - Traditional water management and folk practices.
   - Folk astronomy and meteorology.
4. Social and Economic Traditions:
   - Traditional occupations and practices.
   - Folk beliefs and community life.
   - Regional festivals and their cultural significance.

Resources:
- Primary texts: Vedas, Upanishads, Puranas, Jain Agamas, Buddhist texts.
- Modern reference books: Works on Indian culture, history, and traditions.
- Digital resources: Digital libraries and online resources for Indian languages.
- Regional manuscripts and traditional knowledge systems.

INDIAN KNOWLEDGE SYSTEM: CONCEPTS AND APPLICATIONS IN SCIENCE

Course Code	**: IKS 102**	**Credits (0-0-0)**
Course Category	**: VAC (Audit)**	
Pre-Requisite Subject	**: NIL**	
Contact Hours/ Week	**: 1 / 2 Lecture, Tutorial, Practical**	
Number of Credits	**: 0 Credit**	
Course Assessment Method	**: Continuous assessment through Tutorial classes, Home Assignments, Quizzes, Practical, Viva-Voce, Attendance, Minor Tests and One Major Theory Examination.**	

COURSE OUTCOME
At the end of the course, learners should be able to:
CO1- Understand the basic concepts of Science in Indian Knowledge Systems.
CO2- Get an overview of aspects in which ancient science played impactful role.
CO3- Develop an insight for utilizing the scientific knowledge into contemporary fields.

COURSE CONTENTS
UNIT -I: Indian Knowledge System – An Introduction
The Vedic Corpus- Vedas, Upanishads, Schools of philosophy

Buddhist Corpus- Tripitakas, Jataka Tales
Jaina Corpus- Agamas
Wisdom through the Ages

UNIT- II: Number Systems and Units of Measurement
Mathematics- Overview, Vaidic and Later age mathematics
Astronomy- Overview and contributions

UNIT-III: Knowledge Framework and classifications
Linguistics- Panini & Sanskrit, Pali and Prakrit

UNIT IV: Health Wellness and Psychology
Town Planning and Architecture

BOOKS AND REFERENCES:

Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavana R.N. (2022), "Introduction to Indian Knowledge System: Concepts and Applications", PHI Learning Private Ltd. Delhi.

ADDITIONAL READINGS:

- Pride of India: A Glimpse into India's Scientific Heritage, Samskrita Bharati, New Delhi.
- Sampad and Vijay (2011). "The Wonder that is Sanskrit", Sri Aurobindo Society, Puducherry.
- Acarya, P.K. (1996). Indian Architecture, MunshiramManoharlal Publishers, New Delhi.
- Banerjea, P. (1916). Public Administration in Ancient India, Macmillan, London.
- Kapoor Kapil, Singh Avadhesh (2021). "Indian Knowledge Systems Vol – I & II", Indian Institute .mla, H.Pof Advanced Study, Shi
- Verma. Keshav Dev. (2012) Vedic Physics, Motilal Banarsidass Publishers.

INDIAN KNOWLEDGE SYSTEM: CONCEPTS AND APPLICATIONS IN ENGINEERING

Course Code	**: IKS 103**	**Credits (0-0-0)**
Course Category	**: VAC (Audit)**	
Pre-Requisite Subject	**: NIL**	
Contact Hours/ Week	**: 1 / 2 Lecture, Tutorial, Practical**	
Number of Credits	**: 0 Credit**	
Course Assessment Method	**: Continuous assessment through Tutorial classes, Home Assignments, Quizzes, Practical, Viva-Voce, Attendance, Minor Tests and One Major Theory Examination.**	

COURSE OUTCOME

At the end of the course, learners should be able to:
CO1- Understand the basic concepts of Engineering in Indian Knowledge Systems.
CO2- Get an overview of aspects in which ancient Engineering played an impactful role.
CO3- Develop an insight for utilizing the scientific knowledge into contemporary fields.
CO4- Understand the role of Engineering in town planning in ancient India.
CO5- Understand the interrelation of Astronomy and Architecture.

COURSE LAYOUT

UNIT-I: Indian Knowledge System – An Introduction
The Vedic Corpus

UNIT-II: Number System and Units of Measurements
Mathematics
Astronomy

UNIT-III: Engineering and Technology: Metals and Metalworking
Engineering and Technology: Other Applications

UNIT-IV: Town Planning and Architecture

Knowledge Framework and Classification
Linguistics

BOOKS AND REFERENCES:

Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavana R.N. (2022), "Introduction to Indian Knowledge System: Concepts and Applications", PHI Learning Private Ltd. Delhi.

ADDITIONAL READINGS:

- Pride of India: A Glimpse into India's Scientific Heritage, Samskrita Bharati, New Delhi.
- Sampad and Vijay (2011). "The Wonder that is Sanskrit", Sri Aurobindo Society, Puducherry.
- Bag, A.K. (1979). Mathematics in Ancient and Medieval India, Chaukhamba Orientalia, New Delhi.
- Datta, B. and Singh, A.N. (1962). History of Hindu Mathematics: Parts I and II, Asia Publishing House, Mumbai.
- Kak, S.C. (1987). "On Astronomy in Ancient India", Indian Journal of History of Science, 22(3), pp. 205–221.
- Subbarayappa, B.V. and Sarma, K.V. (1985). Indian Astronomy: A Source Book, Nehru Centre, Mumbai.
- Bag, A.K. (1997). History of Technology in India, Vol. I, Indian National Science Academy, New Delhi.
- Acarya, P.K. (1996). Indian Architecture, Munshiram Manoharlal Publishers, New Delhi.
- Banerjea, P. (1916). Public Administration in Ancient India, Macmillan, London.
- Kapoor Kapil, Singh Avadhesh (2021). "Indian Knowledge Systems Vol – I & II", Indian Institute of Advanced Study, Shimla, H.P.

INDIAN KNOWLEDGE SYSTEM

Course Code	**: IKS 104**	**Credits (0-0-0)**
Course Category	**: VAC (Audit)**	
Pre-Requisite Subject	**: NIL**	
Contact Hours/ Week	**: 1 / 2 Lecture, Tutorial, Practical**	
Number of Credits	**: 0 Credit**	
Course Assessment Method	**: Continuous assessment through Tutorial classes, Home Assignments, Quizzes, Practical, Viva-Voce, Attendance, Minor Tests and One Major Theory Examination.**	

COURSE OUTCOME

At the end of the course, learners should be able to:

CO1- Understand the history, nature and basic philosophy of Indian Knowledge System.
CO2- Develop basic understanding of ancient epistemological approaches.
CO3- Get an overview of literary and scriptural corpus of ancient India and its education system.
CO4- Develop an insight in scientific approaches relevant in contemporary times.
CO5- Understand ancient India's Governance and Public Administration.

COURSE LAYOUT

Unit 1- History of Indian Knowledge System

Genesis of Bhartiya Knowledge System
History of IKS
IKS: Nature, Philosophy and Character
India's Epistemology
Knowledge Frameworks & Classification

Unit 2- Literary Aspects of IKS

Ancient Scriptures
Ancient Education
Educating Sciences
Chandashastra (Prosody)
Bhasa Va Vyakarana (Language and Grammar)
Bharata's Natyashastra (Science of Drama, Dance and Music)
Khagol Vijnana (Astronomy)
Vastukala (Architecture)
Ayurveda
Krishi Vijnana (Agricultural) Practices

Unit 3- Scientific approaches of IKS & Torch-bearers

Dhatu Vijnana (Metallurgy)
Ganita: Mathematics in India
Yuddha Vidhya (Military Sciences)
Niyuddha Kala (Martial Arts)
Environmental Sciences

Unit 4- Governance in IKS & Way Forward

Science of Consciousness in Ancient India (Cognitive Science)
Anviksiki (Logic and Disputation)
Governance & Public Administration
IKS way forward

BOOKS AND REFERENCES:

- Introduction to Indian Knowledge System: Concepts and Applications, Archak, K.B. (2012). Kaveri Books, New Delhi.ISBN-13:978-9391818203
- Introduction To Indian Knowledge System: Concepts and Applications, Mahadevan, B.Bhat, Vinayak Rajat,Nagendra Pavana R.N.PHI, ISBN: 9789391818203
- Glimpse into Kautilya's Arthashastra Ramachandrudu P. (2010), Sanskrit Academy, Hyderabad ISBN:9788380171074
- "Introduction" in Studies in Epics and Purāṇas, (Eds.), KM Munshi and N Chandrashekara Aiyer Bhartiya Vidya Bhavan