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 MECHANICAL ENGINEERING
MADAN MOHAN MALAVIYA UNIVERSITY OF TECHNOLOGY (MMMUT)
GORAKHPUR-273 010, UP, INDIA
JUNE 2025

B. Tech. in Mechanical Engineering

Vision

To become an Internationally Acclaimed Department of Higher Learning, Research, Innovation and Incubation in Mechanical Engineering by 2035.

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 students in the area of mechanical engineering for successful careers in industries, academia and research organizations through state-of-the-art education.

PEO-2. To provide students with a sound foundation in science and engineering fundamentals necessary to formulate, analyze and solve mechanical engineering problems and to prepare them for research activities.

PEO-3. To develop ability in the field of machine design, thermal engineering, manufacturing and industrial engineering so as to design and create novel products, processes and solutions for the real-life problems.

PEO-4. To inculcate in students professional and ethical attitude, effective communication & teamwork skills, and ability to apply multidisciplinary knowledge to relate mechanical engineering problems to broader environmental and social context.

PEO-5. To engage students in professional development through the self-learning and keep abreast with the state-of-the-art technology needed for a successful professional career.

Programme Outcome (POs)

PO-1 Apply knowledge of mathematics, science, and mechanical engineering fundamentals to solve real life problems.

PO-2 Identify, formulate, apply engineering knowledge, and conduct research to solve real life mechanical engineering problems.

PO-3 Ability to design a system, component, or process by applying the knowledge of Machine Design, Thermal Engineering, Manufacturing to meet desired needs within realistic constraints such as economic, environment, cultural, societal, health and safety and sustainability.

PO-4 Ability to design and conduct experiments, as well as to analyze and interpret data and synthesis of information to reach out to solutions.

PO-5 Select, create and apply modern engineering and IT tools, including CAD, CAM to solve complex engineering problems.

PO-6 Apply reasoning to assess the impact of engineering solutions and practices in a global, societal, health, safety, legal and cultural context.

PO-7 Understand the impact of engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

PO-8 Apply ethical principle, inculcate moral values and commit to professional ethics, responsibility and norms of engineering practice.

PO-9 Function effectively as member or leader in diverse teams and in multi-disciplinary settings.

PO-10 Communicate effectively on complex engineering activities with engineering fraternity and society at large such as being able to understand and write effective reports, documents, presentations and give and take instructions clearly.

PO-11 Apply knowledge and understanding of industrial engineering and management principles and function in multidisciplinary teams as a member or leader to manage projects.

PO-12 Recognition of the need for and an ability to engage in life-long self- learning in state-of-the-art technology.

Programme Specific Outcome (PSOs)

PSO1. Graduates will be able to identify, analyze and solve engineering problems relating to mechanical systems together with allied engineering streams.

PSO2. Graduates will learn managerial skills and interdisciplinary technologies to work effectively in a team and in a society by following ethical and environmental practices.

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. The additional 18-20 credits required for Minor Degree Courses.
• Micro specializations (MS) will be run by the department in order to aligned to industry careers or higher studies</td><td>Offered as a Professional Electives (PE)</td></tr>
</table>

DEPARTMENT OF MECHANICAL ENGINEERING
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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**	**1**	**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-212	Operational Research	3	1	0	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/AC	AUC 102-AUC 115		2	0	0	0
7.	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	3	0	2	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-1	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
6.	PE-2	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	Fundamentals of EV and HEV	3	1	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

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

S. No.	Subjects	Codes
1.	Constitution of India	AUC 101
2.	Indian Culture and Heritage	AUC 102
3.	Indian Architecture	AUC 103
4.	Indian Festivals	AUC 104
5.	Vaidic Mathematics	AUC 105
6.	Astronomy	AUC 106
7.	Arts of India	AUC 107
8.	Intellectual Property Right	AUC 108
9.	Human Rights	AUC 109
10.	Logical Research	AUC 110
11.	Professional Ethics	AUC 111
12.	Environmental Law	AUC 112
13.	Health Law	AUC 113
14.	National Cadet Corps	AUC 114
15.	Basics of Human Health and preventive medicines	AUC 115

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 Branches	ECA	Games & Sports-VI	ECA-431	2	0
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.).**

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

OR

Equivalent skills-enhancement courses from MOOC/SWAYAM.

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

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

S. N.	Category	Paper Code	Subject	L	T	P	Credit
1.	Skill Enhancement	BME-260	Welding Technology	2	0	2	3
2.	Skill Enhancement	BME-261	Fundamentals of CNC programming and operation	2	0	2	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 developmentof 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 Practical

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 of Communication- 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: DraftingE-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 NewDelhi.
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 **9**

Introduction to AC Circuits:

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 **9**

Measuring Instruments:

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.

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: DraftingE-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, Modern Language 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 NewDelhi.
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-fall-
7. 2012/video galleries/lecture-notes-and-videos/

Skill-Based Courses to Qualify for UG Certificate (Engg.) in Mechanical Engineering

BME-159		**Heating Ventilation and Air Conditioning (HVAC)**
Course category	:	UG Certificate (Engg.)
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.

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	: **UG Certificate (Engg.).**
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

Second year

BSM-212/262 Operational Research

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 and One Minor tests and One Major Theory Examination

Course Objectives The course aims to develop the mathematical 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. Identify and develop operational research models from the verbal description of the real system.
2. Able to build and solve Transportation Models and Assignment Models.
3. Knowledge of formulating mathematical models for quantitative analysis of managerial problems in industry
4. Aware with the basic concepts and tools of game theory and can apply these tools to real-life situations.
5. Understand different queuing situations and find the optimal solutions using models for different situations.
6. Able to design new simple models, like: CPM, PERT to improve decision making.

Topics Covered

UNIT-I 9

Linear Programming (LP): Formulation of mathematical models for various types of L.P. problems, graphical methods of solving L.P. problems, Limitations of L.P. methods. Simplex method, artificial variable technique-the big-M method, two phase Simplex method, revised simplex method, degeneracy, duality in L.P.

UNIT-II 9

Transportation and Assignment Problems: Transportation model formulation, and solution of transportation problems (Optimal), Assignment model, formulation and solution of assignment problems, sequencing problems.

UNIT-III 9

Game Theory and Network Techniques: Game theory, solution of games with and without saddle point, rules of dominance, arithmetic, and algebraic methods for 2x2 games, solution of 2xn or m x 2 games. PERT & CPM Models: Characteristics & uses, drawing of network, removal of redundancy in network, computing EST, LFT, critical path, project completion time, Free Slack, Total slack, and independent slack, Project crashing.

UNIT-IV 9

Queuing Theory: Elements of Queuing model, Pure-birth and Pure-death models, Empirical queuing models – M/M/1: ∞/FCFS, M/M/1: N/FCFS and M/M/C: ∞/FCFS models and their steady state performance analysis.

Books & References

1. Hillier, F. S., & Lieberman, G. J. Introduction to operations research- concepts and cases. New Delhi: Tata McGraw Hill (Indian print).
2. Taha, H. A. Operations research-an introduction. New Delhi: Pearson Prentice Hall.
3. Ravindran, A., Phillips, D. T., and Solberg, J. J. Operations research- principles and practice. New Delhi: Wiley India (P.) Ltd. (Indian print).
4. Kanti Swaroop, P K Gupta and Manmohan, Operations Research, Sultan Chand & Sons
5. Gross, D., Shortle, J. F., Thompson, J. M., & Harris, C. M. Fundamentals of queueing theory. Wiley India (P.) Ltd. (Indian print).

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:

14. Static experiments on equilibrium
15. Experiment on jib and tie.
16. Friction experiments on an inclined plane
17. Experiments on friction between belt and pulley

18. Experiment on moment of inertia
19. Experiments on flywheel
20. Study of Fire Tube boiler
21. Study of Water Tube boiler
22. Study of Steam Engine model
23. 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	:	**Program 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, imperfections, 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	:	Program 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: 1. The students should be able to understand the fundamental concepts, different laws of fluid Mechanics and its application in different fluid flow problem. 2. The students should be able to understand fluid statics, pressures on submerged planes and curved surface and stability of immersed and floating bodies. 3. The students should be able to understand the various aspects of Laminar, Turbulent Flow and other types of flow over different types of bodies. 4. The student be able to develop understanding about Dimensional Analysis, different types of flows and losses in a flow system 5. The student should be able to develop basic knowledge of hydraulic machines and their applications 6. 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	:	Program 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	:	Program 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)

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. Students should be able to understand the mechanical engineering concepts used in 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. Students should be able to understand the application of robots in various 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 9

Introduction to Renewable Energy

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 9

Solar and Hydraulic Energy Fundamentals

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 9

Wind and Tidal Energy

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 9

Biomass and Geothermal Energy

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: 4, Tutorial: 0, 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 **9**

Introduction to Smart Manufacturing

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 **9**

Smart Design/ Fabrication

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 **9**

Smart Communication system

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 **9**

Smart Applications

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.
7. F. Cecelja, Manufacturing Information and Data Systems, 1st edition, ButterworthHeinemann, 2002, ISBN: 9781857180312.

EME-104		**Numerical Methods for Engineers**
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

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 9

Fundamentals of Numerical Methods

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 9

Interpolation and Curve Fitting

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 9

Ordinary Differential Equations

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 9

Partial Differential Equations and Advanced Applications

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.

EME-201 **Additive Manufacturing Technology**

Course category	:	Programme 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	:	Programme 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.

Skill-Based Courses to Qualify for UG Diploma (Engg.) in Mechanical Engineering

BME-260 Welding Technology

Course category		UG Diploma (Engg.).
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-261 FUNDAMENTALS OF CNC PROGRAMMING AND OPERATION

Course category	:	UG Diploma (Engg.)
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.)