

**COURSE STRUCTURE  
AND  
DETAILED SYLLABUS  
(Choice Based Credit System)**

**R19**

**Mechanical Engineering**

**For  
B.TECH. FOUR YEAR DEGREE COURSE  
(Applicable for batches admitted from 2019-2020)**



**SWARNANDHRA  
COLLEGE OF ENGINEERING & TECHNOLOGY  
(AUTONOMOUS)**

**SEETHARAMAPURAM, NARSAPUR-534 280, W.G.DT., A.P.**

**SEMESTER-I**

S.No	Course Code	Course Title	L	T	P	C	IM	EM	TM
1	19MA1T01	Calculus and Linear Algebra	3	1	-	4.0	30	70	100
2	19BS1T01	Engineering Physics	3	-	-	3.0	30	70	100
3	19EE1T01	Basic Electrical Engineering	3	-	-	3.0	30	70	100
4	19ME1T01	Engineering Graphics	2	-	2	3.0	30	70	100
5	19CS1L02	IT Workshop	-	-	3	1.5	30	70	100
6	19BS1L01	Engineering Physics Lab	-	-	3	1.5	30	70	100
7	19EE1L01	Basic Electrical Engineering Lab	-	-	3	1.5	30	70	100
8	19HS1L01	English Proficiency Lab	-	-	3	1.5	30	70	100
<b>Total</b>			<b>11</b>	<b>1</b>	<b>14</b>	<b>19</b>	<b>240</b>	<b>560</b>	<b>800</b>

**SEMESTER-II**

S.No	Course Code	Course Title	L	T	P	C	IM	EM	TM
1	19MA2T02	Differential Equations and Vector Calculus	3	-	-	3.0	30	70	100
2	19BS2T02	Engineering Chemistry	3	-	-	3.0	30	70	100
3	19CS2T01	Problem Solving and Programming Using C	3	-	-	3.0	30	70	100
4	19HS2T01	English	3	-	-	3.0	30	70	100
5	19ME2T03	Computer Aided Engineering Drawing	2	-	2	3.0	30	70	100
6	19ME2L01	Engineering Workshop	-	-	3	1.5	30	70	100
7	19BS2L02	Engineering Chemistry Lab	-	-	3	1.5	30	70	100
8	19CS2L01	C Programming Lab	-	-	3	1.5	30	70	100
9	19HS2L02	English Communication Skills Lab	-	-	3	1.5	30	70	100
<b>Total</b>			<b>14</b>	<b>-</b>	<b>14</b>	<b>21</b>	<b>270</b>	<b>630</b>	<b>900</b>

L-LECTURE HOURS, T- TUTORIAL HOURS, P-PRACTICAL HOURS, C-CREDITS.  
IM-INTERNAL MARKS, EM- EXTERNAL MARKS, TM- TOTAL MARKS

**SEMESTER-III**

S.No	Course Code	Course Title	L	T	P	C	IM	EM	TM
1	19BM3T01	Managerial Economics and Financial Analysis	3	-	-	3.0	30	70	100
2	19CS3T04	Internet of Things	3	-	-	3.0	30	70	100
3	19ME3T01	Engineering Mechanics	3	1	-	4.0	30	70	100
4	19MA3T05	Probability and Statistics	3	-	-	3.0	30	70	100
5	19ME3T02	Fluid Mechanics and Hydraulic Machinery	3	-	-	3.0	30	70	100
6	19ME3T03	Production Technology	3	-	-	3.0	30	70	100
7	19ME3L01	Fluid Mechanics and Hydraulic Machinery Lab	-	-	3	1.5	30	70	100
8	19ME3L02	Production Technology Lab	-	-	3	1.5	30	70	100
9	19CS3L04	Internet of Things Lab	-	-	2	1.0	30	70	100
10	19BM0M04	Essence of Indian Traditional Knowledge	2	-	-	-	-	-	-
<b>Total</b>			<b>20</b>	<b>1</b>	<b>8</b>	<b>23</b>	<b>270</b>	<b>630</b>	<b>900</b>

**SEMESTER-IV**

S.No	Course Code	Course Title	L	T	P	C	IM	EM	TM
1	19ME4T01	Thermodynamics	3	1	-	4.0	30	70	100
2	19ME4T02	Theory of Machines	3	1	-	4.0	30	70	100
3	19ME4T03	Strength of Materials	3	1	-	4.0	30	70	100
4	19ME4T04	Metallurgy and Material Science	3	-	-	3.0	30	70	100
5	19CS4T06	Python Programming	2	-	-	2.0	30	70	100
6	19ME4L01	Theory of Machines Lab	-	-	3	1.5	30	70	100
7	19ME4L02	Strength of Materials and Metallurgy Lab	-	-	3	1.5	30	70	100
8	19CS4L04	Python Programming Lab	-	-	2	1.0	30	70	100
9	19BM0M03	Indian Constitution	2	-	-	-	-	-	-
<b>Total</b>			<b>16</b>	<b>3</b>	<b>8</b>	<b>21</b>	<b>240</b>	<b>560</b>	<b>800</b>

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**SEMESTER - V**

S.No	Course Code	Course Title	L	T	P	C	IM	EM	TM
1	19ME5T01	Design of Machine Elements	3	-	-	3.0	30	70	100
2	19ME5T02	Machine tools	3	-	-	3.0	30	70	100
3	19ME5T03	Thermal Engineering	3	-	-	3.0	30	70	100
4	19ME5T04	Machine Drawing	1	-	2	2.0	30	70	100
5		<b>Elective -I</b>	3	-	-	3.0	30	70	100
6		<b>Open Elective-I</b>	3	-	-	3.0	30	70	100
7	19ME5L01	Machine Tools Lab	-	-	3	1.5	30	70	100
8	19ME5L02	Thermal Engineering Lab	-	-	3	1.5	30	70	100
9	19CE0M01	Environmental Science	2	-	-	-	-	-	-
<b>Total</b>			<b>18</b>	<b>-</b>	<b>8</b>	<b>20</b>	<b>240</b>	<b>560</b>	<b>800</b>

**SEMESTER - VI**

S.No	Course Code	Course Title	L	T	P	C	IM	EM	TM
1	19ME6T01	Design of Mechanical Transmission Systems	3	-	-	3.0	30	70	100
2	19ME6T02	Heat Transfer	3	-	-	3.0	30	70	100
3	19ME6T03	Metrology and Instrumentation	3	-	-	3.0	30	70	100
4		<b>Elective-II</b>	3	-	-	3.0	30	70	100
5		<b>Elective -III</b>	3	-	-	3.0	30	70	100
6		<b>Open Elective-II</b>	3	-	-	3.0	30	70	100
7	19ME6L01	Heat Transfer Lab	-	-	3	1.5	30	70	100
8	19ME6L02	Metrology and Instrumentation Lab	-	-	3	1.5	30	70	100
9	19HS6L03	Advanced English Communication Skills Lab	-	-	2	1.0	30	70	100
10	19BM0M01	Professional Ethics and Intellectual Property Rights	2	-	-	-	-	-	-
<b>Total</b>			<b>20</b>	<b>0</b>	<b>8</b>	<b>22</b>	<b>270</b>	<b>630</b>	<b>900</b>

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**SEMESTER – VII**

S.No	Course Code	Course Title	L	T	P	C	IM	EM	TM
1	19ME7T01	3D Printing and Design	3	-	-	3	30	70	100
2		<b>Elective-IV</b>	3	-	-	3	30	70	100
3		<b>Open elective-III</b>	3	-	-	3	30	70	100
4		<b>Open elective-IV</b>	3	-	-	3	30	70	100
5	19ME7L01	Automation and Robotics Lab	-	-	3	1.5	30	70	100
6	19ME7L02	CAD Lab	-	-	3	1.5	30	70	100
7	19ME7P01	Mini Project	-	-	6	3.0	30	70	100
8	19ME7I01	Internship	-	-	2	1.0	50	-	50
<b>Total</b>			<b>12</b>	<b>-</b>	<b>14</b>	<b>19</b>	<b>240</b>	<b>560</b>	<b>800</b>

**SEMESTER – VIII**

S.No	Course Code	Course Title	L	T	P	C	IM	EM	TM
1		<b>Elective-V</b>	3	-	-	3	30	70	100
2		<b>Elective-VI</b>	3	-	-	3	30	70	100
3	19ME8P01	Major Project	-	-	18	9	60	140	200
<b>Total</b>			<b>6</b>	<b>-</b>	<b>18</b>	<b>15</b>	<b>120</b>	<b>320</b>	<b>400</b>

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<b>ELCTIVE-I (SEM-5)</b>									
<b>S.NO</b>	<b>COURSE CODE</b>	<b>COURSE NAME</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>IM</b>	<b>EM</b>	<b>TM</b>
1	<b>19ME5E01</b>	Finite Element Analysis	3	-	-	3	30	70	100
2	<b>19ME5E02</b>	Hydrogen and Fuel Cells	3	-	-	3	30	70	100
3	<b>19ME5E03</b>	Tool Design	3	-	-	3	30	70	100
4	<b>19ME5E04</b>	Production Planning and Control	3	-	-	3	30	70	100
5	<b>19CS5E19</b>	Operating Systems Concepts	3	-	-	3	30	70	100
<b>ELCTIVE-II (SEM-6)</b>									
6	<b>19ME6E05</b>	Mechanical Vibrations	3	-	-	3	30	70	100
7	<b>19ME6E06</b>	Automobile Engineering	3	-	-	3	30	70	100
8	<b>19ME6E07</b>	Un Conventional Machining Processes	3	-	-	3	30	70	100
9	<b>19ME6E08</b>	Industrial Engineering Management	3	-	-	3	30	70	100
10	<b>19CS6E22</b>	Interactive Computer Graphics	3	-	-	3	30	70	100
<b>ELCTIVE-III (SEM-6)</b>									
11	<b>19ME6E09</b>	Vehicle Dynamics and Control	3	-	-	3	30	70	100
12	<b>19ME6E10</b>	Steam and Gas Power Systems	3	-	-	3	30	70	100
13	<b>19ME6E11</b>	Automation in Manufacturing	3	-	-	3	30	70	100
14	<b>19ME6E12</b>	Total Quality Management	3	-	-	3	30	70	100
15	<b>19CS6E23</b>	Object Oriented Programming Through Java	3	-	-	3	30	70	100
<b>ELCTIVE-IV (SEM-7)</b>									
16	<b>19ME7E13</b>	Industrial Robotics	3	-	-	3	30	70	100
17	<b>19ME7E14</b>	Refrigeration and Air Conditioning	3	-	-	3	30	70	100
18	<b>19ME7E15</b>	Lean Manufacturing	3	-	-	3	30	70	100
19	<b>19ME7E16</b>	Supply Chain Management	3	-	-	3	30	70	100
20	<b>19CS7E26</b>	Principles of Software Engineering	3	-	-	3	30	70	100

<b>ELCTIVE-V (SEM-8)</b>									
21	<b>19ME8E17</b>	Designing for the Human Body	3	-	-	3	30	70	100
22	<b>19ME8E18</b>	Power plant Engineering	3	-	-	3	30	70	100
23	<b>19ME8E19</b>	MEMS	3	-	-	3	30	70	100
24	<b>19ME8E20</b>	Optimization Techniques	3	-	-	3	30	70	100
25	<b>19CS8E28</b>	Artificial Intelligence	3	-	-	3	30	70	100
<b>ELCTIVE-VI (SEM-8)</b>									
26	<b>19ME8E21</b>	Advanced Mechanics of Solids	3	-	-	3	30	70	100
27	<b>19ME8E22</b>	Computational Fluid Dynamics	3	-	-	3	30	70	100
28	<b>19ME8E23</b>	Flexible Manufacturing Systems	3	-	-	3	30	70	100
29	<b>19ME8E24</b>	Statistical Quality Control	3	-	-	3	30	70	100
30	<b>19CS8E29</b>	Virtual Reality	3	-	-	3	30	70	100

## LIST OF OPEN ELECTIVES

S. No.	COURSE CODE	COURSE TITLE	L	T	P	C	IM	EM	TM
1	19EEXO01	Electrical Safety Management	3	-	-	3	30	70	100
2	19EEXO02	Non-conventional Energy sources	3	-	-	3	30	70	100
3	19EEXO03	Electrical Vehicle	3	-	-	3	30	70	100
4	19EEXO04	Electrical Energy Conservation and Auditing	3	-	-	3	30	70	100
5	19CEXO01	Disaster Management	3	-	-	3	30	70	100
6	19CEXO02	Environmental Pollution and Control	3	-	-	3	30	70	100
7	19CEXO03	Solid Waste Management	3	-	-	3	30	70	100
8	19CEXO04	Building Planning and Drawing	3	-	-	3	30	70	100
9	19MEXO01	3D Printing	3	-	-	3	30	70	100
10	19MEXO02	Farm Machinery	3	-	-	3	30	70	100
11	19MEXO03	Bio-Mechanical Engineering	3	-	-	3	30	70	100
12	19MEXO04	Waste to Energy Conversion	3	-	-	3	30	70	100
13	19CSXO01	Internet of Things and Applications	3	-	-	3	30	70	100
14	19CSXO02	Foundation to Data Analytics	3	-	-	3	30	70	100
15	19CSXO03	Data Engineering	3	-	-	3	30	70	100
16	19CSXO04	Machine Learning	3	-	-	3	30	70	100
17	19ECXO01	Nanotechnology and Applications	3	-	-	3	30	70	100
18	19ECXO02	Global Positioning and Navigation Satellite Systems	3	-	-	3	30	70	100
19	19ECXO03	Remote Sensing	3	-	-	3	30	70	100
20	19ECXO04	Mobile Communication and Applications	3	-	-	3	30	70	100
21	19ITXO01	Software Engineering Principles	3	-	-	3	30	70	100
22	19ITXO02	Cloud Computing Principles	3	-	-	3	30	70	100
23	19ITXO03	E-Commerce	3	-	-	3	30	70	100
24	19ITXO04	Web Technology Principles	3	-	-	3	30	70	100
25	19BMXO01	Innovations and Entrepreneurship	3	-	-	3	30	70	100
26	19BMXO02	Industrial Sociology and Psychology	3	-	-	3	30	70	100
27	19BMXO03	Digital Marketing	3	-	-	3	30	70	100
28	19BMXO04	Business Environment	3	-	-	3	30	70	100
29	19MAXO01	Operations Research	3	-	-	3	30	70	100
30	19MAXO02	Optimization Models	3	-	-	3	30	70	100
31	19BSXO01	Quantum Computing	3	-	-	3	30	70	100
32	19BSXO02	Optoelectronics	3	-	-	3	30	70	100



I SEMESTER	L	T	P	C
	3	1	-	4

**19MA1T01 - CALCULUS AND LINEAR ALGEBRA****Course Objectives:**

- This course will illuminate the students in the concepts of calculus and linear algebra.
- To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various realworld problems and their applications.

**Bridge Course:** Limits, continuity, Types of matrices

**Unit I: Matrix Operations and Solving Systems of Linear Equations**

Rank of a matrix by echelon form, Normal form - solving system of homogeneous and non-homogeneous linear equations- Gauss Elimination, Jacobi and Gauss Seidel methods - Eigen values and Eigen vectors and their properties (without proof).

**Learning Outcomes:**

At the end of this unit, the student will be able to solve systems of linear equations, determine the rank, Eigen values and eigenvectors(K2).

**Unit II: Cayley-Hamilton theorem and Quadratic forms**

Cayley-Hamilton theorem (without proof), Finding inverse and power of a matrix by Cayley-Hamilton theorem - Reduction to diagonal form - Quadratic forms and nature of the quadratic forms, reduction of quadratic form to canonical form by orthogonal transformation.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- reduce to diagonal form and identify special properties of a matrix, such as positive definite, etc.,and use this information to facilitate the calculation of matrix characteristics; (K3)

**Unit III: Multivariable calculus**

Expansions of functions: Taylor's and Maclaurin's series - Partial derivatives, total derivatives, chain rule, change of variables, Jacobians, maxima and minima of functions of two variables, method of Lagrange multipliers.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- Expand the given function as series of Taylor's and Maclaurin's (K3)
- Find partial derivatives numerically and symbolically and use them to analyze and interpret the way a function varies. (K3)
- Acquire the Knowledge in maxima and minima of functions of several variables (K1)
- Utilize Jacobian of a coordinate transformation to deal with the problems in change of variables(K3)

**Unit IV: Multiple Integrals**

**Double Integrals:** change of order of integration, double integrals in polar coordinates, areas enclosed by plane curves.

**Triple Integral:** Evaluation of triple integrals, change of variables

**Learning Outcomes:**

At the end of this unit, the student will be able to

- evaluate double integrals of functions of several variables in two dimensions using Cartesian and polar coordinates (K3)
- apply double integration techniques in evaluating areas bounded by a region (K4)

**Unit V: Special Functions**

Beta and Gamma functions and their properties, relation between beta and gamma functions.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- Conclude the use of special functions in multiple integrals (K3)

**Textbooks:**

1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 42/e, 2012.

**References:**

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 9/e, 2013.
2. B.V. RAMANA, Higher Engineering Mathematics, Tata McGraw Hill, 2007.

**Course Outcomes:**

At the end of the course, the student will be able to

1. develop the use of matrix algebra techniques that is needed by engineers for practical applications (K3)
2. familiarize with functions of several variables which is useful in optimization (K3)
3. learn important tools of calculus in higher dimensions. Students will become familiar with double integral (K3)
4. familiarize with triple integral and also learn the utilization of special functions

I SEMESTER	L	T	P	C
	3	-	-	3

**19BS1T01 – ENGINEERING PHYSICS**

## COURSE OUTCOMES

After completion of course student able to:

1. Describe Basic crystal systems and determination of crystal structures
2. Explain Magnetic and Dielectric Materials properties
3. Describe Concept of Magnetic Induction and Super Conducting properties
4. Explain Pure & Doped Semiconductor materials for better utility
5. Describe Optical fibers and Optical properties of materials and their applications

## SYLLABUS

### UNIT –I: CRYSTAL STRUCTURE AND X-RAY

#### DIFFRACTIONCRYSTAL STRUCTURE:

Introduction – Space lattice – Basis – Unit Cell – Lattice parameters – Bravais lattices – Crystal systems  
– Structures and packing fractions of SC, BCC and FCC.

#### X-RAY DIFFRACTION:

Directions in crystals- planes in crystals- Miller indices and procedure to find Miller indices- Various planes in crystals- Separation between successive (h k l) planes-Bragg's law-Bragg's Spectrometer.

**Learning Outcomes: At the end of this unit, the students will be able to**

- **Explain** the seven crystal systems
- **Interpret** the crystal structure based on Bragg's law

### UNIT – II: MAGNETIC AND DIELECTRIC PROPERTIES

**MAGNETIC PROPERTIES:** Introduction-Magnetic permeability – Magnetization – Relation between three magnetic vectors - Origin of magnetic moment – Classification of Magnetic materials- Dia, Para, Ferro, Anti-Ferro and Ferri-magnetism – Hysteresis- soft and Hard Magnetic materials.

**DIELECTRIC PROPERTIES:** Introduction-Dielectric constant- Relation between three electric vectors-Electronic and ionic polarizations (Quantitative) - orientation polarizations (Qualitative) - Internal fields in solids- Clausius - Mossotti equation.

**Learning Outcomes: At the end of this unit, the students will be able to**

- **Classify** the magnetic materials into dia, para, ferro, anti ferro and ferri
- **Explain** the importance of hysteresis
- **Explain** the concept of polarization in dielectric materials.
- **Summarize** various types of polarization of dielectrics .
- **Interpret** Lorentz field and Claussius- Mosotti relation in dielectrics.

### **UNIT-III: ELECTROMAGNETIC WAVES AND SUPERCONDUCTIVITY**

**ELECTROMAGNETIC WAVES:** Introduction-Electric flux –magnetic flux- Gauss law in electrostatics- Gauss law in magnetostatics- Ampere’s law - Biot-Savart’s law-Magnetic Induction due to current carrying circular loop- Faraday’s law - Maxwell’s equations.

**SUPERCONDUCTIVITY:** General and Thermal properties –Meissner effect – Type-I and Type-II superconductors – Flux quantization – BCS Theory of Superconductivity - Josephson effects – Applications of Superconductors.

**Learning Outcomes: At the end of this unit, the students will be able to**

- **Illustrate** the concept of electro magnetism based on fundamental laws of electro magnetism
- **Explain** Maxwell’s equations
- **Summarize** various properties and applications of superconductors

### **UNIT-IV: PHYSICS OF SEMICONDUCTORS:**

Classification of solids based on band theory - Intrinsic semiconductors- density of charge carriers- Equation for conductivity – Extrinsic semiconductors- P-type and N-type- density of charge carriers- Drift and diffusion – Einstein’s equation – Hall Effect- Hall coefficient – Applications of Hall effect– direct & indirect band gap semiconductors.

**Learning Outcomes: At the end of this unit, the students will be able to**

- **Summarize** various types of solids based on band theory.
- **Outline** the properties of n-type and p-type semiconductors.
- **Identify** the type of semiconductor using Hall effect

### **UNIT-V: LASERS AND OPTICAL FIBERS**

**LASERS:** Introduction– Characteristics of lasers – Spontaneous and Stimulated emission of radiation – Einstein’s coefficients – Population inversion - Three level and four level laser pumping schemes - Rubylaser – Helium-Neon laser- Applications of Laser.

**FIBER OPTICS:** Introduction to Optical fibers- Critical angle of propagation- Total internal reflection- Acceptance angle and acceptance cone- Numerical aperture- Classification of optical fibers based on refractive index profile-Classification of optical fibers based on modes- Applications of optical fibers.

**Learning Outcomes: At the end of this unit, the students will be able to**

- **Design** various types of lasers
- **Explain** the principle and propagation of light through Optical fibers
- **Discuss** the application of lasers and Optical fibers

### **TEXT BOOK:**

M. N. Avadhanulu, P.G. Kshirasagar & TVS Arun Murthy , A text book of “EngineeringPhysics”, S Chand publications, 11<sup>th</sup> Edition 2019.

### **REFERENCE BOOKS:**

1. Shatendra Sharma and Jyotsna Sharma , Engineering Physics, Pearson Education, 2018.

I SEMESTER	L	T	P	C
	3	-	-	3
<b>19EE1T01 – BASIC ELECTRICAL ENGINEERING</b>				

**COURSE OUTCOMES: after successful completion of this course, students should be able to:**

- CO1 : Solve simple DC circuit using KVL, KCL and Network Theorems.
- CO2 : Understand the fundamental concepts of single-phase and three phase systems analysis for simple AC circuit.
- CO3 : Demonstrate the construction, working principles and operating characteristics of DC machines, transformer and AC rotating machines.
- CO4 : Understand the basic Concepts of Electrical installations.

**SYLLABUS****UNIT-I : DC CIRCUIT ANALYSIS**

Electrical Circuit Elements (R, L and C), Voltage and Current Sources, Ohms Laws, Kirchoff's Laws and Star/Delta Conversion, Network Reduction Techniques-Series-Parallel- Series and Parallel (Only Resistor), Problems in Simple Circuits with DC Excitation, Superposition, Thevenin's and Norton's Theorems.

**UNIT-II : AC CIRCUIT ANALYSIS**

Representation of Sinusoidal Waveforms, Peak and RMS Values, Phasor Representation, Real Power, Reactive Power, Apparent Power, Power Factor, Analysis of Single Phase AC Circuits Consisting of R, L, C, RL, RC and RLC Combinations (Series and Parallel), Resonance, Three Phase Circuits- Voltage and Current Relations in Star and Delta Connections.

**UNIT-III : DC MACHINES & TRANSFORMERS**

**DC MACHINES:** Introduction-Construction Details - Principle of Operation - EMF Equation – Classification Based on Excitation - Torque Equation- Characteristics-OCC of Generator-Load Characteristics of DC Shunt Motor, Type of Starters – Speed Control Methods of DC Motors – Swinburne's Test - Applications -Simple Problems.

**TRANSFORMERS:** Introduction-Constructional Details - Principle of Operation - EMF Equation – OC and SC Test – Equivalent Circuit, Load Test-Voltage Regulation, Losses and Efficiency, Auto Transformer and Three Phase Transformer Connections.

**UNIT-IV : AC MACHINES**

**INDUCTION MOTOR:** Introduction-Construction Details - Principle Operation of a Three Phase Induction Motor - Generation of Rotating Magnetic Fields, Torque-Slip Characteristic. Losses and Efficiency, Speed Control of Induction Motor

**ALTERNATOR:** Introduction-Construction Details - Principle of Operation - Winding Factors- E.M. F Equation - Determination of Voltage Regulation by E.M.F and M.M.F Methods.

**SINGLE PHASE INDUCTION MOTOR:** Introduction-Construction Details - Theory of Operation - Methods of Starting.

**UNIT-V : ELECTRICAL INSTALLATIONS**

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Type of Batteries, Important Characteristics for Batteries. Elementary Calculations for Energy Consumption, Power Factor Improvement and Battery Backup.

**TEXT BOOKS:**

1. D.P. Kothari and I.J. Nagrath, Basic Electrical Engineering, Tata McGraw Hill, 3rd edition, 2010.
2. P. V. Prasad, S. Sivanagaraju, K. R. Varmah, and Chikku Abraham, Basic Electrical Engineering, Cengage, 2019.

**REFERENCE BOOKS:**

1. D.C. Kulshreshtha, Basic Electrical Engineering, Tata McGraw Hill, 2009.
2. L.S. Bobrow, Fundamentals of Electrical Engineering, Oxford University Press, 2011
3. E. Hughes, Electrical and Electronics Technology, Pearson, 10<sup>th</sup> Edition, 2010.
4. Vincent Deltoro, Electrical Engineering Fundamentals, Prentice Hall India, Second Edition, 1989.
5. V K Mehta & Rohit Mehta, Principles of Electrical Engineering and Electronics”, S Chand Publishers, 2019 edition.

I SEMESTER	L	T	P	C
	2	-	2	3

**19ME1T01 - ENGINEERING GRAPHICS**

**COURSE OBJECTIVE**

Engineering drawing is the principle method of communication for engineers; the objective is to introduce the students, the techniques of constructing the various types of polygons, curves. The objective is also to visualize and represent the 3D objects in 2D planes with proper dimensioning, scaling etc.

**COURSE OUTCOMES:** Students are able to

CO1: Construct polygons, conics, cycloids, involutes. (K3)

CO2: Draw the orthographic projections of points, lines in different positions. (K2)

CO3: Draw the orthographic projections of plane surfaces in different positions. (K2)

CO4: Draw the orthographic projections of solids like prisms, cylinder, pyramids and cone. (K2)

CO5: Convert Isometric views to orthographic views and vice-versa and also visualize 2D & 3D objects using Auto CAD. (K3)

**UNIT I**

**Polygons:** Constructing regular polygons by general methods, describing polygons on circles.

**Curves:** Parabola, Ellipse and Hyperbola by Eccentricity method, Cycloid, Epi-cycloid and Hypo-cycloid and Involute.

**UNIT II**

**Orthographic Projections:** Reference plane, importance of reference lines, projections of points in various quadrants, projections of lines, line parallel to both the planes, line parallel to one plane and inclined to other plane. Projections of straight lines inclined to both the planes, determination of true lengths, and angle of inclination.

**UNIT III**

**Projections of Planes:** regular planes perpendicular and parallel to one reference plane and inclined to the other reference plane; inclined to both the reference planes.

**UNIT IV**

**Projections of Solids:** Prisms, Pyramids, Cone and Cylinder, Simple positions of solids and Axis of the Solid parallel to one plane and inclined to other plane.

**UNIT V**

**Isometric Views:** Conversion of isometric views to orthographic views; Conversion of orthographic views to isometric views.

**CAD:** Fundamentals of AutoCAD - For Polygons, Creating 2d And 3d Drawings.

**Using Auto CAD:** Computer Aided Design, Drawing practice using Auto CAD simple figures like polygons, creating 2D&3D drawings of objects using Auto CAD.

**Note:** In the End Examination there will be no question from CAD.

**TEXT BOOKS:**

1. Engineering Drawing by N.D. Butt, Chariot Publications 2016
2. Engineering Drawing + AutoCAD by K. Venugopal, V. Prabhu Raja, New Age 2010

**REFERENCE BOOKS:**

1. Engineering Drawing by K.L.Narayana & P. Kannaiah, Scitech Publishers 2016
2. Engineering Graphics for Degree by K.C. John, PHI Publishers 2009
3. Engineering Graphics by PI Varghese, McGrawHill Publishers 2013



I SEMESTER	L	T	P	C
	-	-	3	1.5

**19CS1L02 - IT WORKSHOP**

**Course Objectives:**

1. Understand the components of personal computer system.
2. To Demonstrate the Use of Office Tool
3. To know purpose of internet and how to use it.
4. To Introduce Programming Through Visual Programming Tool — Scratch.

**Course Outcome: On completion of the course students will be able to**

1. Identify the components of a personal computer system and know how it works
2. Demonstrate how to organize files and documents
3. Demonstrate window and menu commands and how they are used
4. Create, format and edit a word, excel documents and prepare PPTs.
5. Send and receive email messages (with or without attachments) and navigate and search through the Internet

**LIST OF EXPERIMENTS:****Week 1:**

Inside a Computer Cabinet:

1. Demonstration of Hardware Components of a Computer.

**Week 2:**

Demonstration of Operating System:

2. Working with Different Operating Systems (Windows 7/10, Ubuntu).
3. Managing Files and Directories.

**Week 3:**

4. Working with Different MS-DOS and Unix command
5. Managing Files and Directories.

**Week 4:**

Text Editing (MS-Word)

6. Creating Bio-Data.
7. Sample Time Table creation.

**Week 5:**

Presentations (Ms-PowerPoint)

8. Simple presentation about your family and village.
9. Creating a Digital Story with Animations.

**Week 6:**

Spreadsheets (Ms-Excel)

10. Student Result data creation and Analysis.
11. Representation of student data using different charts.

**Week 7:**

Building Animations (Scratch)

12. Create an animation for the fall of Humpty Dumpty.

**Week 8:**

Using Internet

13. Communicating with e-mail.

**Week 9:**

Cloud based collaboration tools:

14. Event registrations, create quizzes, and analyze responses using Google Forms

**Week 10:**

15. Simple Static web page creation

**Week 11:**

16. Simple Static web page creation

**References:**

1. Anita Goal, Computer Fundamentals, Pearson Education, 1 e, 2010
2. <https://scratch.mit.edu/ideas>
3. <https://appinventormitedu/exploreki2/tutorials>

<b>I SEMESTER</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	-	-	3	1.5
<b>19BS1L01 - ENGINEERING PHYSICS LAB</b>				

**STUDENT HAS TO DO ANY TEN OF THE  
FOLLOWING**

1. Determination of wavelength of Laser using diffraction grating.
2. Determination of Numerical Aperture and Acceptance angle of an Optical Fiber.
3. Determination of the charge carrier density by using Hall Effect.
4. Determination of the Band Gap of a Semiconductor using a p-n junction diode.
5. Study of Characteristic curves (I/V) of a Zener diode to determine its Breakdown voltage.
6. Determination of Temperature coefficient of resistance of a Thermistor by using its Characteristic curve.
7. Study the variation of intensity of magnetic field along the axis of a circular current carrying coil by using Stewart and Gee's experiment.
8. Study of Characteristic curves (I/V) of a P-N diode.
9. Determine Frequency of given electrically driven tuning fork in Transverse and Longitudinal modes by using Melde's apparatus
10. Determine frequency of A.C. supply by using Sonometer.
11. Determination of the Time Constant for a C-R Circuit
12. Determination of the Planck's constant by using Photo-Cell
13. Determination of dielectric constant of a given material

I SEMESTER	L	T	P	C
	-	-	3	1.5
<b>19EE1L01 - BASIC ELECTRICAL ENGINEERING LAB</b>				

**COURSE OUTCOMES:** *After successful completion of this course, students should be able to:*

- CO1 : Handle Various Electric Instruments and Solve DC Circuits Using Network Theorems
- CO2 : Determine Resonance Frequency and Perform Voltage, Current and Power Measurement On Three Phase Circuit
- CO3 : Determine and Predetermine the Performance of DC Machines
- CO4 : Determine and Predetermine the Performance of Transformers and AC Machines

## LIST OF EXPERIMENTS

1. Practice on Measuring Instruments – Voltmeter, Ammeter, Multimeter, Oscilloscope.
2. Verification of KCL and KVL.
3. Verification of Thevenin Theorem.
4. Verification Norton's Theorem.
5. Verification Superposition Theorem.
6. Resonance in R-L-C Circuits.
7. Three Phase Star and Delta Connections
8. Measurement of Three-Phase Power in Balanced Circuits.
9. Open Circuit Characteristics of DC Shunt Generator.
10. Load Characteristics of DC Shunt Generator.
11. Speed-Torque Characteristic of DC Motor.
12. Load Test on a Single Phase Transformer
13. Open Circuit and Short Circuit Test on a Single Phase Transformers.
14. Load Test on a Single-Phase Induction Motor.
15. Load Test on Three Phase Induction Motor.
16. Regulation of Alternator Using EMF Method.

**Note: Any Ten Experiments will conduct from the above experiments** REFERENCE:

1. Department lab manual.

I SEMESTER	L	T	P	C
	-	-	3	1.5

**19HS1L01 - ENGLISH PROFICIENCY LAB**

## COURSE OBJECTIVES

- To improve the language proficiency of technical under graduates in English with emphasis on LSRW Skills.
- To provide learning environment to practice Listening, Speaking, Reading and Writing Skills within and beyond the classroom environment.
- To assist students to carry on the tasks and activities through guided instructions and materials.
- To effectively integrate English language learning with employability skills and training.
- To design the main course material and exercises with authentic materials drawn from everyday use to cater to everyday needs.
- To provide hands-on experience through case-studies, mini-projects, group and individual presentations.

## COURSE OUTCOMES

### a) Reading Skills.

- Addressing explicit and implicit meaning of a text.
- Understanding the context.
- Learning new words and phrases.
- Using words and phrases in different contexts.

### b) Writing Skills:

- Using the basic structure of a sentence.
- Applying relevant writing formats to create paragraphs, essays, letters, E-Mails, reports and presentations.
- Retaining a logical flow while writing.
- Planning and executing an assignment creatively.

### c) Interactive skills:

- Analyzing a topic of discussion and relating to it.
- Participating in discussions and influencing them.
- Communicating ideas effectively.
- Presenting ideas coherently within a stipulated time.

### d) Life Skills and Core Skills:

- Examining self-attributes and identifying areas that require improvement self-diagnosis, self-motivation.
- Adopting to a given situation and developing a functional approach to find solutions- adaptability, problem-solving.
- Understanding the importance of helping others- community service, enthusiasm.

## COURSE DESCRIPTION

Communicating in a language is also a skill. So a student has to look for an opportunity to practice English language in order to acquire proficiency in English. 'Enrich your interactive Skills: Part - A' is designed to provide opportunities for engineering students to revise and consolidate the basic skills in listening, speaking, reading and writing in addition to giving ample practice in various communicative functions and Life skills.

## PRE REQUISITES

The student is expected to have basic knowledge in English language and must be able to write in English. He is also expected to possess fundamental knowledge of general English grammar and vocabulary.

### Syllabus

Unit	TOPIC
1	Vowels, Consonants, Pronunciation, Phonetic transcripts
2	Word stress and syllables
3	Rhythm and Intonation
4	Contrastive Stress –Homographs
5	Word Stress : Weak and Strong forms , Stress in compound words

#### Text Book:

“Infotech” by Maruthi Publications (2019)

#### Reference Books:

1. J. D. O'Connor, Better English Pronunciation, Cambridge, 2 e, 1980
2. Peter Roach ,Phonetics and Phonology, Cambridge University Press, 2009

II SEMESTER	L	T	P	C
	3	-	-	3

**19MA2T02 - DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS**

**Course Objectives:**

1. To enlighten the learners in the concept of differential equations and vector calculus.
2. To furnish the learners with basic concepts and techniques at plus two level to lead them into advanced level by handling various real world applications.

**Unit I: Ordinary Differential equations of first order and first degree:**

Linear differential equations – Bernoulli's equations – Exact equations and equations reducible to exact form.

Applications: Newton's Law of cooling – Law of natural growth and decay – Orthogonal trajectories

**Learning Outcomes:**

At the end of this unit, the student will be able to

- solve first order differential equations by appropriate method (K3)
- apply to geometrical and real world problems (K3)

**Unit II: Linear differential equations of higher order:**

Solutions of Non-homogeneous equations of higher order with constant coefficients – with non-homogeneous term of the type  $e^{ax}$ ,  $\sin ax$ ,  $\cos ax$ , polynomials in  $x^n$ ,  $e^{ax} V(x)$  and  $x^n V(x)$  – Method of Variation of parameters. Applications: LCR circuit

**Learning Outcomes:**

At the end of this unit, the student will be able to

- identify the essential characteristics of linear differential equations with constant coefficients (K3)
- solve the linear differential equations with constant coefficients by appropriate method (K3)

**Unit –III: Partial Differential Equations of First Order:**

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solutions of first order linear (Lagrange) equation and nonlinear (standard types) equations.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- apply a range of techniques to find solutions of standard PDEs (K3)
- outline the basic properties of standard PDEs (K2)

**Unit IV: Vector differentiation**

Scalar and vector point functions, vector operator del, del applied to scalar point functions- Gradient, del applied to vector point functions-Divergence and Curl, physical interpretation of Gradient Div F and Curl F, Del applied twice to point functions Del applied to products of point functions.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- apply del to Scalar and vector point functions (K3)
- illustrate the physical interpretation of Gradient, Divergence and Curl (K3)

## Unit V: Vector integration

Integration of Vectors Line integral-circulation-work done, surface integral-flux, Green's theorem in the plane (without proof), Stoke's theorem (without proof), volume integral, Divergence theorem (without proof).

### Learning Outcomes:

At the end of this unit, the student will be able to

- find the work done in moving a particle along the path over a force field (K3)
- evaluate the rate of fluid flow along and across curves (K3)
- apply Green's, Stokes and Divergence theorem in evaluation of double and triple integrals (K3)

### Textbooks:

1. B. S. Grewal, Higher Engineering Mathematics, Khanna publishers, 42/e, 2012.

### References:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 9/e, 2013.
2. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, 2008.

### Course Outcomes:

At the end of the course, the student will be able to

1. Solve the differential equations related to various engineering fields (K3)
2. Identify solution methods for partial differential equations that model physical processes (K3)
3. Interpret the physical meaning of scalar and vector point functions different operators such as del, gradient, curl and divergence (K3)
4. Estimate the work done against a field, circulation and flux using vector calculus and familiarize vector integral theorems. (K3)



II SEMESTER	L	T	P	C
	3	-	-	3

**19BS2T02 - ENGINEERING CHEMISTRY**

## COURSE OUTCOMES

**At the end of semester, the students will be able to**

**CO1:** Explain the impurities present in raw water, problems associated and how to avoid them (K2)

**CO2:** Explain the advantages of Polymers in daily life (K2)

**CO3:** Explain the theory of construction of battery and fuel cells and theories of corrosion and prevention methods. (K2)

**CO4:** Differentiate conventional and non-conventional energy sources and their advantages and disadvantages. (K2)

**CO5:** Identify the usage of advanced materials in day to day life (K2)

### UNIT I: WATER TECHNOLOGY

Hardness of water-types of hardness-disadvantages of hard water-determination of hardness by EDTA complexometric method. Portable water and its specifications-steps involved in purification of water-chlorination, break point of chlorination. Boiler troubles: Scale and sludge-priming and foaming-boiler corrosion-caustic embrittlement.

Industrial Water Treatment: Softening methods: zeolite process-ion exchange process. Brackish water treatment (desalination methods): Reverse osmosis - electro dialysis.

**Learning Outcomes: At the end of this unit, the students will be able to explain**

The impurities present in raw water, problems associated with them and how to avoid them

### UNIT-II: POLYMERS AND COMPOSITE MATERIALS

**Polymers**-Introduction-Types of polymers-degree of polymerization-functionality-preparation properties and applications of individual polymers-Bakelite-PVC-Poly styrene.

**Plastics:** Types (thermosetting and thermoplastic)-compounding of plastics-moulding Process (Any Four) - recycling of e-waste.

**Rubbers and elastomers:** Introduction-natural rubber-vulcanization of rubber-synthetic rubbers-Buna-N, Buna-S.

**Composite materials:** Fiber reinforced plastics-biodegradable polymers-biomedical polymers-conducting polymers

**Learning Outcomes: At the end of this unit, the students will be able to**

- **Outline** the properties of polymers and various additives added and different methods of forming plastic materials.
- **Explain** the preparation, properties and applications of some plastic materials.
- **Discuss** natural and synthetic rubbers and their applications.

### UNIT III: ELECTRO CHEMICAL CELLS AND CORROSION

#### Electrochemical Cells

Introduction-single electrode potential-electrochemical cell-electrochemical series and applications. Reference electrodes-standard hydrogen electrode and calomel electrode-construction of glass electrode.

Batteries: Construction, working and cell reaction of primary (dry cell) and Secondary (Pb acid, Ni-Cd, Zinc-Air and Li-ion) battery. Fuel cells ( $H_2-O_2$ , Methanol-Air cells).

#### Corrosion

Definition-theories of corrosion (Chemical and Electrochemical corrosion)-types of corrosion (Galvanic, Differential aeration (waterline and pitting corrosion), stress Corrosion). Factors influencing rate of corrosion-nature of metal-nature of corrosive atmosphere.

Corrosion Prevention methods: Cathodic protection-Sacrificial anodic method-Imposed voltage method. Metallic coatings: Galvanization-Tinning-Electro plating-Electro less plating.

**Learning Outcomes: At the end of this unit, the students will be able to**

- **Explain** the theory of construction of battery and fuel cells.
- **Categorize** the reasons for corrosion and study some methods of corrosion control.

### UNIT IV: CONVENTIONAL AND NONCONVENTIONAL ENERGY RESOURCES

#### Conventional energy sources

Introduction to fuels-classification and characteristics of fuels-solid, Liquid and gaseous fuels advantages and disadvantages-calorific value-higher and lower calorific values-construction and working of bomb calorimeter-analysis of coal-proximate and ultimate analysis-numerical problems related to bomb calorimeter, Dulong's formula and coal analysis-petroleum refining-cracking-petrol and diesel knocking-octane number and cetane number-gaseous fuels-Natural gas-CNG-LPG

#### Non-conventional energy sources

Solar energy: Advantages-disadvantages of solar cells-construction and working of photo voltaic cell- Introduction to hydro power-geo thermal power-tidal and wave power.

**Learning Outcomes: At the end of this unit, the students will be able to**

- **Differentiate** conventional and non conventional energy sources and their advantages and disadvantages.
- **Explains** energy production by different natural sources

### UNIT V: CHEMISTRY OF MATERIALS

Nano materials: Introduction-sol-gel method-characterization by BET, SEM and TEM methods-carbon nano tubes and fullerenes: Types, preparation and applications

Semiconductors: Preparation (Distillation, Zone refining, Czochralski crystal pulling epitaxy, diffusion, ion implantation)-semiconductor devices (P-N junction diode as rectifier, junction transistor)

Cement: Constituents of cement-setting and Hardening of cement, Decay of Cement.

Refractories: Definition of refractory-classification and properties of refractoriness-applications of refractories.

**Learning Outcomes: At the end of this unit, the students will be able to**

- **Outline** the awareness of materials like nanomaterials and fullerenes and their uses.
- **Explain** the techniques that detect and measure the surface properties of materials.
- **Illustrate** the commonly used industrial materials.

**Text Books:**

- T1.** N. Y. S. Murthy, V. Anuradha & K. Ramana Rao, A Text Book of Engineering Chemistry, Maruthi Publications. (2018)
- T2.** K. Sesa Maheswaramma, Mridula Chugh, A Text Book of Engineering Chemistry, Pearson Publications (2018).

**Reference Books:**

- R1.** Jain & Jain, Engineering Chemistry –Dhanpat Rai Publishing Company (2017)
- R2.** Shashi Chawla, Text Book of Engineering Chemistry - Dhanpat Rai & Co. (P) Limited (2017)
- R3.** Prasanta Rath, Subhendu Chakroborthy, Chemistry – Cengage publications (2018)

II SEMESTER	L	T	P	C
	3	-	-	3

**19CS2T01 - PROBLEM SOLVING AND PROGRAMMING USING C**

**Course Objectives:**

- To impart adequate knowledge on the need of programming languages and problem solving techniques and develop programming skills.
- To enable effective usage of Control Structures and Implement different operations on arrays.
- To demonstrate the use of Strings and Functions.
- To impart the knowledge of pointers and understand the principles of dynamic memory allocation.
- To understand structures and unions and illustrate the file concepts and its operations.
- To impart the Knowledge Searching and Sorting Techniques.

**UNIT-I**

**Introduction to Computer Problem Solving:** Programs and Algorithms, Computer Problem Solving Requirements, Phases of Problem Solving, Problem Solving Strategies, Top-Down Approach, Algorithm Designing, Program Verification, Improving Efficiency, Algorithm Analysis and Notations.

**UNIT-II**

**Introduction to C Programming:** Introduction, Structure of a C Program, Comments, Keywords, Identifiers, Data Types, Variables, Constants, Input/output Statements, Operators, Type Conversion.

**Control Flow, Relational Expressions:** Conditional Branching Statements: if, if-else, if-else-if, switch. Basic Loop Structures: while, do-while loops, for loop, nested loops, The Break and Continue Statements, goto statement.

**UNIT-III**

**Arrays:** Introduction, Operations on Arrays, Arrays as Function Arguments, Two dimensional Arrays, Multi-dimensional arrays.

**Pointers:** Concept of a Pointer, Declaring and Initializing Pointer Variables, Pointer Expressions and Address Arithmetic, Null Pointers, Generic Pointers, Pointers as Function Arguments, Pointers and Arrays, Pointer to Pointer, Dynamic Memory Allocation, Dangling Pointer, Command Line Arguments.

**UNIT-IV**

**Functions:** Introduction, Function Declaration, Function Definition, Function Call, Categories of Functions, Passing Parameters to Functions, Scope of Variables, Variable Storage Classes, Recursion.

**Strings:** String Fundamentals, String Processing with and without Library Functions, Pointers and Strings.

**UNIT-V**

**Structures, Unions, Bit Fields:** Introduction, Nested Structures, Arrays of Structures, Structures and Functions, Self-Referential Structures, Unions, Enumerated Data Type –enum variables, Using Typedef keyword, Bit Fields.

**Files:** Introduction to Files, Using Files in C, Reading from Text Files, Writing to Text Files, Random File Access.

**Course Outcomes:**

At the end of the Course, Student will be able to:

- Illustrate the Fundamental concepts of Computers and basics of computer programming.
- Use Control Structures and Arrays in solving complex problems.
- Develop modular program aspects and Strings fundamentals.
- Demonstrate the ideas of pointers usage.
- Solve real world problems using the concept of Structures, Unions and File operations.

**Text Books:**

1. Reema Thareja, Computer Programming, Oxford University Press.2016.
2. R. G. Dromey , How to solve it by Computer, Pearson Education, 2011.

**Reference Books:**

1. Yaswanth Kanetkar, Let us C, BPB Publication, 16<sup>th</sup> Edition, 2019.
2. Ajay Mittal, Programming In C A-Practical Approach, Pearson. 2010

**Web Links:**

1. <http://www.c4learn.com/>
2. <http://www.geeksforgeeks.org/c/>
3. <http://nptel.ac.in/courses/122104019/>
4. <http://www.learn-c.org/>
5. <https://www.tutorialspoint.com/cprogramming/>

<b>II SEMESTER</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>-</b>	<b>-</b>	<b>3</b>
<b>19HS2T01 - ENGLISH</b>				

### **COURSE OBJECTIVES**

1. To improve the language proficiency of technical under graduates in English with emphasis on LSRW Skills.
2. To provide learning environment to practice Listening, Speaking, Reading and Writing Skills within and beyond the classroom environment.
3. To assist students to carry on the tasks and activities through guided instructions and materials.
4. To effectively integrate English language learning with employability skills and training.
5. To design the main course material and exercises with authentic materials drawn from everyday use to cater to everyday needs.
6. To provide hands-on experience through case –studies, mini –projects, group and individual presentations.

### **COURSE OUTCOMES**

#### **A) Reading Skills**

- Addressing explicit and implicit meaning of a text.
- Understanding the context.
- Learning new words and phrases.
- Using words and phrases in different contexts.

#### **B) Writing Skills**

- Using the basic structure of a sentence.
- Applying relevant writing formats to create paragraphs, essays, letters, e-mails, reports and presentations.
- Retaining a logical flow while writing.
- Planning and executing an assignment creatively.

#### **C) Interactive skills**

- Analyzing a topic of discussion and relating to it.
- Participating in discussions and influencing them.
- Communicating ideas effectively.
- Presenting ideas coherently within a stipulated time.

#### **D) Grammar in context**

- Enable the skills of grammar using in a situation
- Identifying the needs of apt grammar in life related situation
- Promoting discourse with grammar effectively

**Syllabus :**

S No	Content
UNIT -I	<b>Vocabulary Building</b> <b>1.1</b> Video Lesson 1.2.1 Word formation 1.2.2. Root words 1.2.3. Prefixes and Suffixes 1.2.4. Synonyms and Antonyms <b>1.3 Parts of Speech</b> <b>1.4 Note- making, Note-taking</b>
UNIT - II	<b>Basic Writing Skills</b> <b>2.1</b> Video Lesson 2.2.1 Basic sentence structure 2.2.2. Clauses and Phrases 2.2.3 Punctuations 2.2.4 Creating coherence 2.2.5 Organizing principles of paragraph documents 2.2.6 Techniques for writing precisely <b>2.3 Tenses</b> <b>2.4 Letter Writing</b>
UNIT- III	<b>Identifying Common Errors in Writing</b> <b>3.1</b> Video Lesson 3.2.1 Sub + verb agreement 3.2.2 Noun pronoun agreement 3.2.3 Articles 3.2.4 Preposition 3.2.5 Redundancies 3.2.6 Clichés <b>3.3.1 Active - Passive Voice</b> <b>3.3.2 Reported Speech</b> <b>3.4 Resume Writing</b>
UNIT- IV	<b>Nature and Style of sensible Writing</b> <b>4.1</b> Video Lesson 4.2.1 Describing 4.2.2 Classifying 4.2.3 Writing Introduction and conclusion <b>4.3.1 Conditional Sentences</b> <b>4.3.2 Degrees of Comparison</b> <b>4.4 Email writing</b>
UNIT-V	<b>Writing Practice</b> <b>5.1</b> Video Lesson 5.2.1 Comprehension 5.2.2 Precise writing 5.2.3 Essay Writing <b>5.3 Simple Compound and Complex Sentences</b> <b>5.4 Report Writing</b>

**TEXT BOOK: Building Effective Communication Skills**

By Maruti Publications (2019)

<b>II SEMESTER</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>2</b>	<b>-</b>	<b>2</b>	<b>3</b>
<b>19ME2T03 - COMPUTER AIDED ENGINEERING DRAWING</b>				

**COURSE OBJECTIVE:**

To enhance the student's knowledge and skills in engineering drawing and to introduce drafting packages and commands for computer aided drawing and modeling.

**COURSE OUTCOMES:** Students will be able to

CO1: Draw the projections solids by auxiliary views and development of surfaces of regular solids. (K3)

CO2: Draw the isometric and perspective projections of planes and solids. (K2)

CO3: Draw the geometric entities and to create 2D and 3D wire frame modeling. (K3)

CO4: Identify the view points and view ports. (K2)

CO5: Create different Machines and Machine parts using CAD software. (K3)

**UNIT – I**

**Projections of Solids:** Projection of regular solids inclined to both the planes using auxiliary views and sectional views of regular solids.

**Development of Surfaces of Right Regular Solids:** Prisms, Cylinders, Pyramids and Cone.

**UNIT –II**

**Isometric Projections and Orthographic Projections:** Compound solids, isometric projections of objects having non-isometric lines and spherical parts.

**Perspective Projections:** perspective view of points, lines, plane figures and simple solids- vanishing point method (General method only)

**UNIT-III**

**Introduction to Computer Aided Drafting:** Generation of points, lines, curves, polygons, dimensioning. Object selection commands, edit, zoom, crosshatching, pattern filling, utility commands, 2D wire frame modeling, 3D wire frame modeling

**UNIT-IV**

**View Points and View Ports:** View point coordinates and views displayed, examples to exercise different options like save, restore, delete, joint, single option.

**UNIT-V**

**Computer Aided Solid Modeling:** Modeling of simple solids and modeling of different Machines and Machine parts

**TEXT BOOKS:**

1. Engineering Drawing by N.D.Bhatt , Charotar publications 2016
2. Engineering Drawing + AutoCad – K Venugopal, V. Prabhu Raja, New Age2010

**REFERENCE BOOKS:**

1. Engineering Drawing - K.L.Narayana, P.Kannaiah, and K.Venkata Reddy, New Age International Publishers. 2016
2. Text book of Engineering Drawing with AutoCAD - K.Venkata reddy, B.S.Publications 2017



3. Engineering Drawing - R.K. Dhawan,S.Chand 2012

The syllabus in respect of the subject "Computer Aided Engineering Drawing Practice" consists of two major portions

1. Unit I to II - conventional drawing pattern.
2. Unit III to V - computer lab pattern using any drafting package.

Max Marks – 100.

Internal Marks: 30 & External Marks: 70

The examination in respect of the above may conducted on par with lab with the following pattern:

**Mid Exam:**

I Mid Exam from first Two Units- Conventional Drawing

II Mid Exam from Last three Units - Computer Lab

**END SEMESTER EXAM:**

Part - A - Conventional Drawing test in Drawing Hall from first Two Units - 2 hrs duration.

Part - B - Exam in Computer Lab using any drafting package - 2 hrs duration.

End Exam duration - 4 hrs

<b>II SEMESTER</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	-	-	<b>3</b>	<b>1.5</b>
<b>19ME2L01 - ENGINEERING WORKSHOP</b>				

**COURSE OBJECTIVE:** To impart hands-on practice on basic Engineering trades and skills.

**COURSE OUTCOMES:** Students will be able to

CO1: Model and Develop various basic prototypes in Carpentry trade [K3]

CO2: Model and Develop various basic prototypes in Fitting trade [K3]

CO3: Perform Various Forging Operations [K3]

CO4: Perform various House Wiring Techniques. [K3]

CO5: Develop various basic prototypes in the trade of Sheet metal. [K3]

**NOTE:** At least **Two** Exercises to be done from each trade.

**TRADE:**

**I. CARPENTRY:**

1. CROSS LAP JOINT
2. DOVETAIL JOINT
3. MORTISE and TENNON JOINT

**II. FITTING:**

1. SQUARE FIT
2. V-FIT
3. HALF ROUND FIT

**III. FORGING:**

1. ROUND ROD TO SQUARE
2. S-HOOK
3. ROUND ROD TO SQUARE HEADED BOLT

**IV. HOUSE WIRING:**

1. PARALLEL/SERIES CONNECTION OF THREE BULBS
2. STAIRCASE WIRING
3. FLOURESCENT LAMP FITTING

**V. SHEET METAL:**

1. SQUARE TRAY
2. HOLLOW CYLINDER
3. OPEN SCOOP

**MANUAL:**

1. Engineering Workshop Practice Lab Manual Prepared by Mechanical Faculty.

II SEMESTER	L	T	P	C
	-	-	3	1.5
<b>19BS2L02 - ENGINEERING CHEMISTRY LAB</b>				

**Outcomes:** The experiments introduce volumetric analysis: Acid-Base, complexometric, Redox, Conductometric and potentiometric titrations. Then they are exposed to a few instrumental methods of chemical analysis.

**Thus at the end of the lab course, the student is exposed and able to**

1. Identify the concentration of given solution by different methods of chemical analysis **(K3)**
2. Analyze the water purity by checking hardness, DO and Acidity. **(K4)**
3. Estimate the  $\text{Cu}^{+2}$ ,  $\text{Fe}^{+3}$ ,  $\text{Ca}^{+2}$ ,  $\text{Mg}^{+2}$  ions and Ascorbic acid present in given solution. **(K4)**
4. Identify the pour and cloud point of lubricants. **(K3)**
5. Understand the principles of conductometric and potentiometric titrations. **(K2)**

### Syllabus:

1. Estimation of HCl using standard  $\text{Na}_2\text{CO}_3$  through acid-base titration.
2. Estimate the total hardness of water using standardized EDTA solution through complexometric titration.
3. Estimation of  $\text{KMnO}_4$  using standard  $\text{H}_2\text{C}_2\text{O}_4$  through redox titration method.
4. Estimation of Dissolved Oxygen in given water sample by Winkler's Method
5. Determination of ferric ( $\text{Fe}^{+3}$ ) ions using standard  $\text{KCr}_2\text{O}_7$  solution
6. Determination of copper (II) using standard hypo solution.
7. Estimation of strong acid by using strong base through conductometric titration method.
8. Estimation of strong acid by using strong base through potentiometric titration method.
9. Preparation of polymer (Demo).
10. Determination of Vitamin 'C'.
11. Determination of Pour and Cloud Point of lubricating oils

### Reference Books

1. A Textbook of Quantitative Analysis, Arthur J. Vogel.

II SEMESTER	L	T	P	C
	-	-	3	1.5

**19CS2L01 - C PROGRAMMING LAB**

**Course Objectives:**

- To impart knowledge on various Editors, Raptor.
- To make the students understand the concepts of C programming.
- To nurture the students on Control Structures and develop different operations on arrays.
- To make use of String fundamentals and modular programming constructs.
- To implement programs using dynamic memory allocation.
- To explain the concepts of Structure, Unions and files for solving various problems.

**List of Experiments:****1. Introduction to Algorithms and Flowcharts**

1. Implement Algorithm Development for Exchange the values of Two numbers.
2. Given a set of n student's examination marks (in the range 0-100) make a count of the number of students that passed the examination. A Pass is awarded for all of 50 and above.
3. Given a set of n numbers design an algorithm that adds these numbers and returns the resultant sum. Assume N is greater than or equal to zero.

**2. Introduction to C Programming**

1. Exposure to Turbo C, Code Blocks IDE, Dev C++, Falcon C++.
2. Writing simple programs using printf(), scanf() .

**3. Raptor**

1. Introduction to Raptor.
2. Draw a flow chart to find the Sum of 2 numbers.
3. Draw a flow chart to find Simple interest.

**4. Basic Math**

1. Write a C Program to convert Celsius to Fahrenheit and vice versa.
2. Write a C Program to find largest of three numbers using ternary operator.
3. Write a C Program to Calculate area of a Triangle using Heron's formula.

**5. Control Flow- I**

1. Write a C Program to Find Whether the Given Year is a Leap Year or not.
2. Write a C program to find the roots of a Quadratic Equation.
3. Write a C Program to make a simple Calculator to Add, Subtract, Multiply or Divide Using Switch...case.

**6. Control Flow- II**

1. Write a C Program to Find Whether the Given Number is Prime number or not.
2. Write a C Program to Find Whether the Given Number is Armstrong Number or not.
3. Write a C program to print Floyd Triangle.

**7. Control Flow- III**

1. Write a C program to find the sum of individual digits of a positive integer.
2. Write a C program to check whether given number is palindrome or not.
3. Write a C program to read two numbers, x and n, and then compute the sum of the geometric progression  $1+x+x^2+x^3+\dots+x^n$ .

**Practice Programs:**

- Write a C program to print all natural numbers from 1 to n. - using while loop
- Write a C program to print all natural numbers in reverse (from n to 1). - using while loop
- Write a C program to print all alphabets from a to z. - using while loop
- Write a C program to print all even numbers between 1 to 100. - using while loop
- Write a C program to print sum of all even numbers between 1 to n.
- Write a C program to print sum of all odd numbers between 1 to n.
- Write a C program to print table of any number.
- Write a C program to find first and last digit of any number.
- Write a C program to count number of digits in any number.
- Write a C program to calculate sum of digits of any number.
- Write a C program to calculate product of digits of any number.
- Write a C program to swap first and last digits of any number.
- Write a C program to enter any number and print its reverse.
- Write a C program to enter any number and check whether the number is palindrome or not.
- Write a C program to find frequency of each digit in a given integer.
- Write a C program to enter any number and print it in words.
- Write a C program to print all ASCII character with their values.
- Write a C program to enter any number and print all factors of the number.
- Write a C program to enter any number and calculate its factorial.
- Write a C program to find HCF (GCD) of two numbers.
- Write a C program to find LCM of two numbers.
- Write a C program to check whether a number is Prime number or not.
- Write a C program to check whether a number is Armstrong number or not.
- Write a C program to check whether a number is Perfect number or not.
- Write a C program to check whether a number is Strong number or not.
- Write a C program to print Fibonacci series up to n terms.

**8. Arrays**

1. Write a C program to search an element in the given array (Linear Search).
2. Write a C program to perform matrix addition.
3. Write a C program to perform matrix multiplication.

**Practice Programs:**

- Write a C program to read and print elements of array.
- Write a C program to find sum of all array elements. - using recursion.
- Write a C program to find maximum and minimum element in an array. - using recursion.
- Write a C program to find second largest element in an array.
- Write a C program to copy all elements from an array to another array.
- Write a C program to insert an element in an array.
- Write a C program to delete an element from an array at specified position.
- Write a C program to print all unique elements in the array.
- Write a C program to print all negative elements in an array.
- Write a C program to count total number of even and odd elements in an array.
- Write a C program to count total number of negative elements in an array.
- Write a C program to count total number of duplicate elements in an array.
- Write a C program to delete all duplicate elements from an array.
- Write a C program to count frequency of each element in an array.
- Write a C program to merge two array to third array.
- Write a C program to find reverse of an array.

Write a C program to convert lowercase string to uppercase.

Write a C program to convert uppercase string to lowercase.

Write a C program to toggle case of each character of a string.

Write a C program to find total number of alphabets, digits or special character in a string.

### 9. Pointers

1. Write a C Program to Perform Addition, Subtraction, Multiplication and Division of two numbers using Command line arguments.
2. Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using malloc () function.
3. Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using calloc () function.

### 10. Functions, Array & Pointers

1. Write a C Program to demonstrate parameter passing in Functions.
2. Write a C Program to find Fibonacci, Factorial of a number with Recursion and without recursion.
3. Write a C Program to find the sum of given numbers with arrays and pointers.

#### Practice Programs:

Program to change the value of constant integer using pointers.

Program to print a string using pointer.

Program to count vowels and consonants in a string using pointer.

Program to read array elements and print with addresses.

### 11. Strings

1. Implementation of string manipulation operations with library function:
  - a) copy
  - b) concatenate
  - c) length
  - d) compare
2. Implementation of string manipulation operations without library function:
  - a) copy
  - b) concatenate
  - c) length
  - d) compare
3. Verify whether the given string is a palindrome or not.

### 12. Structures

1. Write a C Program to Store Information of a book Using Structure.
2. Write a C Program to Add Two Complex Numbers by Passing Structure to a Function.

### 13. Files

1. Write a C program to open a file and to print the contents of the file on screen.
2. Write a C program to copy content of one file to another file.
3. Write a C program to merge two files and store content in another file.

### 14. Application

Creating structures to capture the student's details save them in file in proper record format, search and prints the student details requested by the user.

**Note:** Draw the flowcharts using Raptor from Experiment 3 to Experiment 6.

**Course Outcomes:**

- Implement basic programs in C and design flowcharts in Raptor.
- Use Conditional and Iterative statements to solve real time scenarios in C.
- Implement the concept of Arrays and Modularity and Strings.
- Apply the Dynamic Memory Allocation functions using pointers.
- Develop programs using structures, and Files.

**Reference Books:**

1. Yashwanth Kanetkar, Let Us C, 16<sup>th</sup> edition, BPB Publications, 2019,
2. Ajay Mittal, Programming In C A-Practical Approach, Pearson. 2010

**Web Links:**

1. <https://www.hackerrank.com/>
2. <https://www.codechef.com/>
3. <https://www.topcoder.com/>
4. <https://code-cracker.github.io/>
5. <https://raptor.martincarlisle.com/>
6. <https://nptel.ac.in/courses/106105085/2>

II SEMESTER	L	T	P	C
	-	-	3	1.5

**19HS2L02- ENGLISH COMMUNICATION SKILLS LAB**

### COURSE OBJECTIVES

- To improve the language proficiency of technical under graduates in English with emphasis on LSRW Skills.
- To provide learning environment to practice Listening, Speaking, Reading and Writing Skills within and beyond the classroom environment.
- To assist students to carry on the tasks and activities through guided instructions and materials.
- To effectively integrate English language learning with employability skills and training.
- To design the main course material and exercises with authentic materials drawn from everyday use to cater to everyday needs.
- To provide hands-on experience through case-studies, mini-projects, group and individual presentations.

### COURSE OUTCOMES:

#### a) Reading Skills.

- Addressing explicit and implicit meaning of a text.
- Understanding the context.
- Learning new words and phrases.
- Using words and phrases in different contexts.

#### b) Writing Skills:

- Using the basic structure of a sentence.
- Applying relevant writing formats to create paragraphs, essays, letters, E-Mails, reports and presentations.
- Retaining a logical flow while writing.
- Planning and executing an assignment creatively.

#### c) Interactive skills:

- Analyzing a topic of discussion and relating to it.
- Participating in discussions and influencing them.
- Communicating ideas effectively.
- Presenting ideas coherently within a stipulated time.

#### d) Life Skills and Core Skills:

- Examining self-attributes and identifying areas that require improvement self-diagnosis, self-motivation.
- Adopting to a given situation and developing a functional approach to find solutions- adaptability, problem-solving.
- Understanding the importance of helping others- community service, enthusiasm.

### COURSE DESCRIPTION

Communicating in a language is also a skill. So a student has to look for an opportunity to practice the language he is learning in order to acquire communication skills. 'Enrich your interactive Skills: Part

- B' is designed to provide opportunities for engineering students to revise and consolidate communication skills in different contexts formal and informal. It prepares the student for facing Interviews, participating in group discussions and making presentations.

### PRE REQUISITES



The student is expected to have basic knowledge in English language and must be able to write in English. He is also expected to possess fundamental knowledge of general English grammar and vocabulary.

### Syllabus

UNIT	TOPIC
1	Oral Activity : JAM, Hypothetical situations, self / peer profile, Common errors in pronunciation, Neutralizing Accent
2	Oral Activity : Telephonic Etiquette, Role plays, Poster presentations and e-mail Writing
3	Oral Activity : Oral Presentation Skills, Public Speaking Data Interpretation
4	Oral Activity : Group Discussion: Do's and Don'ts –Types, Modalities
5	Oral Activity : Interview Skills: Preparatory Techniques, FAQ, Mock Interviews Pronunciation : Connected speech (pausing, tempo, tone, fluency etc.,)

### Text Book:

“Infotech” by Maruthi Publications (2019)

### Reference Books:

1. Clive Fletchers, How to Face Interviews
2. Stephen Covey , The 7 Habits of Highly Effective People.

III SEMESTER	L	T	P	C
	3	-	-	3
<b>19BM3T01- MANAGERIAL ECONOMICS AND FINANCIAL ANALYSIS</b>				

### COURSE OBJECTIVES:

1. To acquire knowledge of economics to facilitate the process of economic Decision making
2. To analyze production function and its laws of variable proportions and cost concepts
3. To differentiate and distinguish price and output decisions in different market structures
4. To compare and contrast the difference between private and public sector in their functioning
5. To develop the skills to analyze financial statements.

### COURSE OUTCOMES

At the end of the course the student should be able to

1. Describe the importance of Managerial Economics and its utility in decision making
2. Understand the meaning and usefulness of production function and cost function in analyzing firm's production activity.
3. Comprehend the concept of Market structure, different types of Markets and pricing policies.
4. Identify different forms of business organizations and analyze their merits and demerits.
5. Evaluate the investment proposals through techniques of capital budgeting and Financial performance of the company through Financial Statements.

**UNIT-I Managerial Economics & Demand Analysis:** Definition – Nature and Scope - Relation with other disciplines - Concept of Demand-Types-Determinants - Law of Demand – Exceptions - Elasticity of Demand - Types and Measurement-Demand forecasting and its Methods.

**UNIT-II Production and Cost Analysis:** Production function - Law of Variable proportions - Isoquants and Isocosts -Law of returns Economies of Scale - Cost Concepts - Fixed, Variable Costs, Explicit Costs, Implicit Costs & Opportunity cost - Cost Volume Profit Analysis - Break Even Point (Simple Problems)

**UNIT-III Market Structures & Pricing Policies:** Perfect Competition, Monopoly, Monopolistic Competition and Oligopoly – Features – Price & Output Determination - Pricing Methods

**UNIT-IV Forms of Organizations & Business Cycles:** Business Organization- Sole Trader – Partnership - Joint Stock Company - State/Public Enterprises and their forms - Business Cycles: Meaning and Features - Phases of Business Cycle.

**UNIT-V Capital Budgeting and Accounting:** Concept and sources-Techniques of capital budgeting- Traditional and Modern Methods (Simple problems)

**Introduction to accounting:** Branches-Systems of Accounting-Single Entry-Double Entry System-Journal-Ledger-Trail Balance-Final Accounts(Simple problems)

### TEXTBOOKS:

1. Aryasri: Managerial Economics and Financial Analysis, 2/e, TMH, 2005.
2. T.V.Ramana & B. Kuberudu: Managerial Economics and Financial Analysis, Himalaya PublishingHouse,Mumbai
3. Varshney & Maheswari: Managerial Economics, Sultan Chand, 2003.

**REFERENCE BOOKS:**

1. Ambrish Gupta, Financial Accounting for Management, Pearson Education, New Delhi.
2. H. Craig Peterson & W. Cris Lewis, Managerial Economics, PHI, 4th Ed.
3. Suma Damodaran, Managerial Economics, Oxford University Press.
4. Lipsey & Chrystel, Economics, Oxford University Press.
5. S. A. Siddiqui & A. S. Siddiqui, Managerial Economics & Financial Analysis, New age InternationalSpace Publications.
6. Domnick Salvatore: Managerial Economics in a Global Economy, 4th Edition, Thomson.
7. Narayanaswamy: Financial Accounting A Managerial Perspective, PHI.
8. Raghunatha Reddy & Narasimhachary: Managerial Economics& Financial Analysis, Scitech.
9. S.N.Maheswari & S.K. Maheswari, Financial Accounting, Vikas.

III SEMESTER	L	T	P	C
	3	-	-	3

**19CS3T04 - INTERNET OF THINGS**

**COURSE OBJECTIVE**

- Discuss the fundamentals relating to IoT, Things in IoT, Communication Models and APIs
- Explain the difference between M2M and IoT, and familiarize the concepts of SDN and Network Virtualization.
- Expose various hardware used for IoT Applications
- Demonstrate the use of IoT through various case studies
- Familiarize IIoT and Industry 4.0.

**COURSE OUTCOMES: Students will be able to**

- CO1: Summarize the basic principles, Physical and logical design, functional blocks, Communication systems and API of IoT systems. [K2]
- CO2: Differentiate between IoT and M2M technologies, Explain the concepts of Software Defined Networks (SDN) and Network Virtualization. [K2]
- CO3: Describe hardware components used for computing, communicating, sensing, Actuation, I/O interfaces in IoT. [K2]
- CO4: Summarize the applications of IoT through various case studies. [K2]
- CO5: Explain the concepts of IIoT and Industry 4.0, their requirements and benefits [K3]

**UNIT – I**

Introduction to IoT: Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs

**UNIT – II**

IOT & M2M: Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Software defined networks (SDN), Network Virtualization

**UNIT -III**

ELEMENTS OF IOT: Hardware Components- Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces.

**UNIT – IV**

IOT CASE STUDIES: IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation

**UNIT – V**

**IIOT:** Key IIOT Technologies, Catalysts and Precursors of the IIoT, Innovation and the IIoT, Intelligent Devices, Key Opportunities and benefits, **INDUSTRY 4.0:** Definition, four main characteristics of Industry 4.0, Industry 4.0 design principles, Building blocks of Industry 4.0, Smart Manufacturing.

**TEXT BOOKS:**

1. Internet of Things: A Hands-On Approach Paperback by Arsheep Bahga, Vijay Madiseti, 1st Edition, Orient Blackswan Private Limited (2015)

2. Internet of Things Paperback by Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, Wiley (2019)
3. Industry 4.0: The Industrial Internet of Things Paperback by Alasdair Gilchrist, 1st edition, Apress (2017)

**REFERENCE BOOKS:**

1. Internet of Things: Principles and Paradigms by Rajkumar Buyya, Amir Vahid Dastjerdi, 1st Edition, Morgan Kaufmann (2016)
2. Internet-of-Things (IoT) Systems: Architectures, Algorithms, Methodologies by Dimitrios Serpanos, Marilyn Wolf, 1st Edition, Springer(2018)
3. Internet of Things with Arduino Cookbook by Marco Schwartz, Packt Publishing Limited (2016)
4. Architecting the Internet of Things by Dieter Uckelmann, Mark Harrison, Florian Michahelles, Springer (2011)

III SEMESTER	L	T	P	C
	3	1	-	4

**19ME3T01- ENGINEERING MECHANICS**

**COURSE OBJECTIVES:**

- To impart knowledge on the concept of forces and its resolution in different planes, resultant of force system and moment of forces.
- To develop capacity to forecast the effect of force and its motion.
- To make the students compute the centre of gravity and moment of inertia.
- To educate the students about dynamic forces in rigid body.

**COURSE OUTCOMES:** Student will be able to

CO1. Illustrate the various types of forces and moments.[K2]

CO2. Analyze the rigid body in equilibrium and determine the effects by the laws of friction.[K4]

CO3. Evaluate the centroid, moment of inertia of surfaces and centre of gravity, mass moment of inertia of solids. [K5]

CO4. Calculate the kinetics and kinematics force exerted in rigid body. [K3]

CO5. Perceive the concept of work energy principle and virtual work its application.[K3]

**UNIT-I**

**Introduction to Engineering Mechanics:** System of Forces, Coplanar Concurrent Forces, Components in plane - Resultant- Moment of Forces and its Application; Couples - General case of parallel forces in a plane. Equilibrium of Rigid Bodies in two dimensions - Free body diagram.

**UNIT-II**

**Spatial Systems:** Components of force in space – Resultant- Moment of Forces and its Application.

**Friction:** Introduction, Types of friction, Laws of Friction, Limiting friction, Angle of repose, Angle of friction, Cone of friction. Equilibrium analysis of simple systems with sliding friction, Wedge friction, Screw friction.

**UNIT-III**

**Centroid & Centre Of Gravity:** Centroid- Simple and Composite figures. Centre of gravity - Simple and Composite bodies, Theorems of Pappus.

**Moment Of Inertia:** Moment of Inertia, Product of Inertia and Principal moment of inertia for planes. Mass moment of inertia for solids.

**UNIT-IV**

**Kinetics:** Analysis as a Particle and analysis as a Rigid Body in Translation – Central Force Motion – Equations of Plane Motion – Fixed Axis Rotation – Rolling Bodies.

**Kinematics:** Rectilinear and Curvilinear Motion – Velocity and Acceleration – Motion of Rigid Body – Types and their Analysis in Planar Motion.

**UNIT-V**

**Work Energy Method:** Work-Energy principle and its Application in plane motion of connected bodies. Impulse-Momentum method.

**Virtual Work:** Virtual displacements, Principle of virtual work for particle and Ideal system of rigid bodies. Application of virtual work principle.

**TEXT BOOKS:**

1. Engineering Mechanics - S. Timoshenko & D.H. Young, McGraw Hill education, 5<sup>th</sup> edition, 2017.
2. A Text Book of Engineering Mechanics - Bansal R.K.by Laxmi Publications, 6<sup>th</sup> edition, 2013.
3. Engineering Mechanics - R.S. Khurmi & N.Khurmi, by S. Chand publications, 22<sup>nd</sup> edition, 2019.
4. Engineering Mechanics, D.S. Bedi and MP Poonia, Khanna Book Publishing Co. (P) Ltd, 2<sup>nd</sup> edition, 2019.
5. Engineering Mechanics, DP Sharma, Pearson Education, 1<sup>st</sup> edition, 2011.

**REFERENCE BOOKS:**

1. Engineering Mechanics - S. S. Bhavikatti, New Age International Publishers, 6<sup>th</sup> edition, 2018.
2. Engineering Mechanics - A.K.TAYAL – UMESH Publications, 14<sup>th</sup> edition, 2010.
3. Engineering Mechanics – Statics & Dynamics - Reddy Vijay Kumar K. and J. Suresh Kumar, BSP Books Pvt.Ltd, 3<sup>rd</sup> edition,2010.

<b>III SEMESTER</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	3	-	-	3
<b>19MA3T05- PROBABILITY AND STATISTICS</b>				

**Course Objectives:**

1. To familiarize the students with the foundations of probability and statistical methods
2. To impart probability concepts and statistical methods in various applications of Engineering
3. To introduce the correlation and regression and method of least squares

**Unit-1 Probability:**

Probability, probability axioms, addition law and multiplicative law of probability, conditional probability, Baye's theorem, random variables (discrete and continuous), probability density functions, properties, mathematical expectation.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- define the terms trial, events, sample space, probability, and laws of probability ( $K_1$ )
- make use of probabilities of events in finite sample space from experiments ( $K_3$ )
- apply Baye's theorem to real time problems ( $K_3$ )
- explain the notion of random variable, distribution functions and expected value ( $K_2$ )

**Unit-2 Probability distributions:**

Probability distribution-Binomial, Poisson approximation to the binomial distribution and normal distribution –their properties.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- apply Binomial and Poisson distributions for real data to compute probabilities, theoretical frequencies ( $K_3$ )
- interpret the properties of normal distribution and its applications ( $K_2$ )

**Unit-3 Sampling distribution and Testing of hypothesis, large sample tests:**

Basic terminology in sampling, sample techniques (with and without replacement), sampling distribution of means for large and small samples (with known and unknown variance).

Formulation of null hypothesis, alternative hypothesis, the critical and acceptance regions, level of significance, two types of errors.

Large Sample Tests: Test for single proportion, difference of proportions, test for single mean and difference of means. Confidence interval for parameters in one sample and two sample problems

**Learning Outcomes:**

At the end of this unit, the student will be able to

- Explain the concept of sampling distribution for large and small samples ( $K_2$ )
- apply the concept of hypothesis testing for large samples ( $K_4$ )

**Unit-4 Small sample tests:**

Student t-distribution (test for single mean, two means and paired t-test), testing of equality of variance (F-test), Chi-square test for goodness of fit and independence of attributes.



**Learning Outcomes:**

At the end of this unit, the student will be able to

- apply the concept of testing of hypothesis for small samples to draw the inferences (K<sub>3</sub>)
- estimate the goodness of fit (K<sub>4</sub>)

**Unit-5 Curve Fitting and Correlation:**

**Curve Fitting :**Method of least squares -Fitting a straight line, Second degree parabola - exponential curve-power curves

**Correlation:** Simple correlation, correlation coefficient (for ungrouped data), rank correlation. Linear regression, regression lines, regression coefficients.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- Adopt correlation methods and principle of least squares, regression lines (K<sub>4</sub>)

**Course Outcomes:**

At the end of this unit, the student will be able to

1. make use of the concepts of probability and their applications (k<sub>3</sub>)
2. apply discrete and continuous probability distributions(K<sub>3</sub>)
3. design the components of a classical hypotheses test(K<sub>6</sub>)
4. infer the statistical inferential methods based on small and large sampling tests(K<sub>6</sub>)
5. adopt correlation methods and principle of least squares, regression lines (K<sub>4</sub>)

**Books:**

1. Dr. B.S.Grewal, Higher Engineering Mathematics, Khanna Publications, 42<sup>nd</sup> Edition, 2012.
2. Dr. K. Murugesan & P.Gurusamy, Probability and Statistics, Anuradha Publications, 2011.

**Reference:**

1. Miller & Freund, Probability and statistics for engineers, Prentice Hall, 8<sup>th</sup> Edition, 2011.
2. Ramana B.V., Higher Engineering Mathematics, Tata Mc Graw Hill New Delhi  
11<sup>th</sup> Reprint 2010

III SEMESTER	L	T	P	C
	3	-	-	3

**19ME3T02- FLUID MECHANICS AND HYDRAULIC MACHINERY**

**COURSE OBJECTIVES:**

- To understand the conservation laws of fluid flow, the dimensional analysis applied to fluid flow and hydraulic machines.
- To understand the behavior of fluids at various conditions

**COURSE OUTCOMES:** Students will be able to

- CO1. Define the fundamental properties of fluids and apply the concepts of fluid statics. [K1]  
 CO2. Apply the principles of fluid kinematics and boundary layer concepts for fluid flow problems.[K3]  
 CO3. Analyze the fluid flow through pipes. [K4]  
 CO4. Explain working principles of hydraulic turbines. [K2]  
 CO5. Explain working principles of hydraulic pumps. [K2]

**UNIT I**

**Basic Concepts and Properties:** Fluid – definition, distinction between solid and fluid - Units and dimensions - Properties of fluids: density, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapour pressure, capillarity and surface tension. Fluid statics: concept of fluid static pressure, absolute and gauge pressures - pressure measurements by manometers and pressure gauges.

**UNIT II**

**Fluid Kinematics and Boundary Layer Concepts:** Fluid Kinematics: Flow visualization, lines of flow, types of flow, continuity equation (one dimensional flow) - Fluid dynamics: equations of motion, Euler's equation along a streamline, Bernoulli's equation, applications, Venturimeter, Orifice meter, Pitot tube - Boundary layer flows, boundary layer thickness, boundary layer separation - drag and lift coefficients.

**UNIT III**

**Flow Through Pipes and Dimensional Analysis:** Flow through pipes: Darcy -Weisbach equation, pipe roughness, friction factor, minor losses. Flow through pipes in series and in parallel, power transmission - Dimensional analysis, Buckingham's  $\pi$  theorem, applications, similarity laws and models. Introduction to CFD: Necessity, limitations, philosophy behind CFD, applications.

**UNIT IV**

**Hydraulic Turbines:** Hydro turbines: definition and classifications - Pelton turbine - Francis turbine - Kaplan turbine - working principles - velocity triangles - work done - specific speed - efficiencies - performance curves of turbines.

**UNIT V****HYDRAULIC PUMPS:**

Pumps- classifications - Centrifugal pump- classifications, working principles, priming, velocity triangles, specific speed, efficiency and performance curves - Reciprocating pump- classification, working principles, slip, performance curves and work saved by air vessels - cavitations in pumps.

**TEXT BOOKS:**

1. White, F.M., “Fluid Mechanics”, Tata McGraw-Hill, 5<sup>th</sup> Edition, New Delhi, 2011.
2. Rajput.R.K., A Textbook of Hydraulic Machines in SI Units (Fluid Mechanics and Hydraulic Machines Part –II), Reprint 2012, Laxmi publications (P) Ltd., New Delhi, 2012.

**REFERENCE BOOKS:**

1. Bansal, R.K., “Fluid Mechanics and Hydraulics Machines”, (9<sup>th</sup> edition), Laxmi publications (P) Ltd., New Delhi, 2010.
2. Ramamirtham, S., “Fluid Mechanics and Hydraulics and Fluid Machines”, Dhanpat Rai and Sons, Delhi, 2011.
3. Som, S.K., Biswas, G., “Introduction to fluid mechanics and fluid machines”, Tata McGraw-Hill, 4<sup>th</sup> Edition, 2011.
4. Kumar, K.L., “Engineering Fluid Mechanics”, Eurasia Publishing House (P) Ltd., New Delhi (7<sup>th</sup> edition), 2011.
5. Streeter, V.L., and Wylie, E.B., “Fluid Mechanics”, McGraw-Hill, 2011.



<b>III SEMESTER</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>-</b>	<b>-</b>	<b>3</b>
<b>19ME3T03- PRODUCTION TECHNOLOGY</b>				

**COURSE OBJECTIVES:**

- To impart the students to understand the fundamentals of casting and their application.
- To make the knowledge of solidification of metals and melting furnace working principle.
- To perceive the students various types of welding processes and welding defects.
- To enable the students to acquire Hot and Cold working processes concept.
- To introduce the fundamentals of plastic processing techniques and Rapid Prototyping.

**COURSE OUTCOMES:** Students will be able to

- CO1. Explain various metal casting processes. [K2]
- CO2. Illustrate melting furnace working principle and solidification processes. [K2]
- CO3. Explain various welding techniques, soldering and brazing. [K2]
- CO4. Summarize various hot working and cold working methods of metals. [K2]
- CO5. Explain plastics processes and Rapid Prototyping. [K2]

**UNIT I**

**Casting Processes:** Basic casting process and its characteristics, Patterns and Pattern making, Pattern allowances and their application, Principles and design of Gating systems, Special moulding methods and processes- CO<sub>2</sub> & Shell moulding processes and machine moulding. Centrifugal, Cold & Hot chamber Die Casting, Investment Casting processes.

**UNIT II**

**Melting and Solidification:** Crucible melting and cupola operation, steel making processes, Solidification of casting, Solidification of pure metal and alloys, short & long freezing range alloys, Principles and design of Rising system.

**UNIT III**

**Welding Processes:** Classification of welding processes, Types of welded joints and their characteristics, Welding processes: Gas welding and cutting, Arc welding, Resistance welding, Thermit welding and Plasma welding processes and their characteristics. Friction welding, Induction welding, Explosive welding, Laser welding, Soldering & Brazing. Heat affected zones in Welding, Welding defects.

**UNIT IV**

**Mechanical Working of Metals - Extrusion of Metals:**

Hot and cold working processes, characteristics, recovery, recrystallization and grain growth analysis, Theory of rolling, Fundamentals, types of Rolling mills and products. Analysis of rolling process and estimation of power requirement.

Introduction of extrusion process and its characteristics, Press working operations and their characteristics, Extrusion of metals, Drawing processes and its force analysis, Hot and Cold spinning.

## UNIT V

**Plastic Process & Rapid Prototyping:** Plastics processing methods & Equipment (blow & injection moulding), Introduction to powder metallurgy. Fundamentals of Rapid Prototyping Technologies, Stereolithography, Selective Laser Sintering, Laminated Object Manufacturing, Fused Deposition Modeling, 3D Printing.

## TEXTBOOKS

1. S Kalpakjian, S R. Schmid, Manufacturing- Engineering and Technology, Pearson publications, 7<sup>th</sup> Edition, 2014.
2. P.C Sharma, Production Technology, S.Chand and Co. Ltd., 2014.
3. Gerardus Blokdyk, Rapid Prototyping, Emereo Pty Limited, 3<sup>rd</sup> Edition, 2018.

## REFERENCES

1. R. K. Jain, Production Technology, Khanna publishers, 16<sup>th</sup> Edition, 2014.
2. G.Thirupati Reddy, Production Technology, Scitech Publications, 2013.
3. P.N. Rao, Manufacturing Technology - Foundry, Forming and Welding, 4<sup>th</sup> Edition, TMH-2013.



III SEMESTER	L	T	P	C
	-	-	3	1.5

**19ME3L01- FLUID MECHANICS AND HYDRAULIC MACHINERY LAB**

**COURSE OBJECTIVE**

To impart practical exposure on the performance evaluation methods of various flow measuring equipments, hydraulic turbines and pumps.

**COURSE OUTCOMES:** Students will be able to

- CO1. Predict major and minor losses in various piping system.
- CO2. Predict performance characteristics of various Turbines and Pumps.
- CO3. Calibrate Venturi meter and Orifice meter.
- CO4. Apply the impulse momentum concepts on jets.

**LIST OF EXPERIMENTS:**

1. Impact of jet on flat plate.
2. Performance Test on Pelton Wheel.
3. Performance Test on Francis Turbine.
4. Performance Test on Kaplan Turbine.
5. Performance Test on Single Stage Centrifugal Pump.
6. Performance Test on Multi Stage Centrifugal Pump.
7. Performance Test on Reciprocating Pump.
8. Calibration of Venturi meter.
9. Calibration of Orifice meter.
10. Determination of friction factor of a given pipe line.
11. Determination of loss of head due to sudden contraction in a pipeline.
12. Determination of loss of head due to sudden enlargement in a pipeline.
13. Bernoulli's apparatus.

**NOTE:** Any 10 of the above 13 experiments are to be conducted



<b>III SEMESTER</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	-	-	<b>3</b>	<b>1.5</b>
<b>19ME3L02 - PRODUCTION TECHNOLOGY LAB</b>				

**COURSE OBJECTIVES****To make the students familiarize with**

- Design and manufacture of simple patterns.
- Sand testing.
- Arc welding, gas welding and resistance welding equipment for the fabrication of welded joints.
- Injection and blow moulding processes.

**COURSE OUTCOMES:** Students will be able to

- CO1. Describe effects of the properties of green sand of grain size, moisture content, compressive strength, shear strength, permeability. [K2]
- CO2. Perform Arc Welding and Spot Welding. [K3]
- CO3. Perform the Metal Casting and Press working operations.[K3]
- CO4. Perform the Pattern making. [K3]

**I. METAL CASTING LAB:**

1. Pattern Design and making - for one casting drawing.
2. Sand properties testing - Exercise -for strengths, and Permeability.
3. Moulding Melting and Casting.

**II WELDING LAB:**

1. ARC Welding Lap & Butt Joint.
2. Spot Welding.

**III METAL FORMING:**

1. Blanking & Piercing operations, study of simple, compound and progressive dies.
2. Deep Drawing and Extrusion operations.

**IV PROCESSING OF PLASTICS:**

1. Injection Moulding.

Blow Moulding.

III SEMESTER	L	T	P	C
	-	-	2	1

**19CS3L04 - INTERNET OF THINGS LAB**

**COURSE OBJECTIVE**

- Familiarize students with the use of Arduino for sensing and actuation purposes.

**COURSE OUTCOMES: Students will be able to**

- CO1: Measure temperature and humidity using various sensors [K3]  
 CO2: Use IR sensor/push button to on/off LED [K3]  
 CO3: Interface Bluetooth module with Arduino and Use the same [K3]  
 CO4: Interface Actuating elements with Arduino and control the same [K3]

- Expt 1:** Familiarization with Arduino and perform necessary software installation.  
**Expt 2:** To interface LED/Buzzer with Arduino and write a program to turn ON LED for 1 sec after every 2 seconds.  
**Expt 3:** To interface Push button/Digital sensor (IR/LDR) with Arduino and write a program to turn ON LED when push button is pressed or at sensor detection.  
**Expt 4:** To interface DHT11 sensor with Arduino and write a program to print temperature and humidity readings.  
**Expt 5:** To interface motor using relay with Arduino and write a program to turn ON motor when push button is pressed.  
**Expt 6:** To interface OLED with Arduino and write a program to print temperature and humidity readings on it.  
**Expt 7:** To interface Bluetooth with Arduino and write a program to send sensor data to smart phone using Bluetooth.  
**Expt 8:** To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when '1'/'0' is received from smart phone using Bluetooth.  
**Expt 9:** To interface Servo motor with Arduino and write a program to control the same  
**Expt 10:** To interface Stepper motor with Arduino and write a program to control the same using potentiometer  
**Expt 11:** To interface thermistor with Arduino for temperature measurement  
**Expt 12:** To measure temperature using thermocouple by interfacing it with Arduino  
**Expt 13:** Write a program to create TCP server on Arduino/Raspberry Pi and respond with humidity data to TCP client when requested.  
**Expt 14:** Write a program to create UDP server on Arduino/Raspberry Pi and respond with humidity data to UDP client when requested.

NOTE: Any 10 of the above 14 experiments are to be conducted

III SEMESTER (MANDATORY COURSE)	L	T	P	C
	2	-	-	-
<b>19BM0M04 - ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE</b>				

**UNIT-1:**

Introduction to traditional knowledge: Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge (IK), characteristics, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge

**UNIT-2:**

Protection of traditional knowledge: The need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

**UNIT-3:**

Legal framework and TK: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016.

**UNIT-4:**

Traditional knowledge and intellectual property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge

**UNIT-5:**

Traditional Knowledge in Different Sectors: Traditional knowledge and engineering, Traditional medicine system, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK

**Text books:**

1. Traditional Knowledge System in India, by Amit Jha, 2009.

**Reference Books:**

1. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
2. "Knowledge Traditions and Practices of India" Kapil Kapoor<sup>1</sup>, Michel Danino<sup>2</sup>.

**Web Links:**

1. <https://www.youtube.com/watch?v=LZP1StpYEPM>
2. <http://nptel.ac.in/courses/121106003/>

IV SEMESTER	L	T	P	C
	3	1	-	4

**19ME4T01 - THERMODYNAMICS**

**COURSE OBJECTIVES:**

To impart the knowledge of the thermodynamic laws and principles so as to enable the student to prepare an energy audit of any mechanical system that exchange heat and work with the surroundings

**COURSE OUTCOMES:** Students will be able to

**CO1:** Apply basic principles and Zeroth law of thermodynamics to solve problems. [K3]

**CO2:** Apply first law of thermodynamics to different thermodynamic systems. [K3]

**CO3:** Apply second law of thermodynamics and general thermodynamic property relations to solve problems. [K3]

**CO4:** Describe the thermodynamic concepts of pure substances and identify their properties using standards. [K2]

**CO5:** Analyze various power cycles, vapour power cycles and Refrigeration cycles. [K4]

**UNIT – I**

**Introduction: Basic Concepts :** System, Surroundings, Boundary, Universe, Types of Systems, Control volume, Macroscopic and Microscopic view points, Thermodynamic Equilibrium, Property, State, Process, Cycle, Quasi - static Process, Irreversible Process, Causes of Irreversibility, Energy in State and in Transition- Types- Work and Heat, Point function and Path function, Zeroth Law of Thermodynamics, Concept of Temperature, Principles of Thermometry – Reference Points – Constant Volume gas, electrical resistance thermometers and thermocouple, Ideal Gas Scale.

**UNIT II**

**First Law of Thermodynamics:** Perfect Gas Laws – Equation of State, specific heat at constant volume, specific heat at constant pressure and Universal Gas constant, Joule's Experiment – First law for a closed system undergoing a cycle and a change of state – PMM I, First law applied to a Process, various Non-flow processes- properties-end states-Heat transfer-Work Transfer-change in Internal Energy, Throttling and Free Expansion Processes, First law applied to a flow system – Steady Flow Energy Equation –Applications.

**UNIT – III**

**Second Law of Thermodynamics:** Limitations of the First Law, Thermal Reservoir, Heat Engine, Refrigerator and Heat pump, Parameters of performance, Second Law of Thermodynamics – Kelvin-Planck and Clausius Statements and their Equivalence – PMM of Second kind, Carnot's principle, Carnot cycle and its specialties, Thermodynamic scale of Temperature, Clausius Inequality, Entropy, Principle of Entropy Increase – Availability and Irreversibility – Thermodynamic Potentials, Gibbs and Helmholtz Functions, Maxwell Relations – Elementary Treatment of the Third Law of Thermodynamics.

**UNIT IV**

**Properties of Pure Substances:** Pure Substances – Phase Transformation–P-V diagram – P-T diagram– T-S diagram and h-s diagram or Mollier Chart– P-V-T- surface –Triple point at critical point, Dryness Fraction – Steam Calorimetry, Property tables, Various Thermodynamic processes and energy Transfer.

## **UNIT - V**

**Power Cycles:** Otto, Diesel, Dual Combustion cycles – Description and representation on P–V and T-S diagram, Thermal Efficiency, Mean Effective Pressures on Air standard basis – comparison of Cycles.

**Vapour Power & Refrigeration Cycles:** Brayton cycle and Rankine cycle – thermal efficiency, Bell-Coleman cycle and Vapour compression refrigeration cycle - Coefficient of performance – simple problems on ideal cycles.

### **TEXT BOOKS:**

1. Engineering Thermodynamics - P.K. Nag, 6th Edition, Tata McGraw Hill Education Private Limited, New Delhi. 2017
2. Thermodynamics – An Engineering Approach – Yunus Cengel & M.A.Boles, Tata McGraw Hill Publishing Company Limited, New Delhi. 2017

### **REFERENCE BOOKS:**

1. Fundamentals of Thermodynamics by Claus Borgnakke, Richard E. Sonntag, 8th Edition, John Wiley & Sons (2013)
2. A Text Book of Engineering Thermodynamics- R.K. Rajput, Tenth Edition– Lakshmi Publications, New Delhi. 2017
3. Engineering Thermodynamics - K. Ramakrishna, 2nd edition, Anuradha Publishers, India.2011
4. An Introduction to Thermodynamics- Y. V. C. Rao, Revised Edition, Universities Press, Hyderabad, India.2003

<b>IV SEMESTER</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>1</b>	<b>-</b>	<b>4</b>
<b>19ME4T02 - THEORY OF MACHINES</b>				

**COURSE OBJECTIVES**

Machines are those mechanical systems which achieve their task through mobility. The first step in designing machines is synthesizing and performing rigid body dynamic analysis so as to estimate the velocities, accelerations and forces on various members. The current course aims at imparting knowledge as how to analyze various mechanisms for designing a machine. The objectives of the course are as follows:

1. To impart knowledge on various terminologies, criteria and analysis methods related to mechanisms, various mechanisms with lower pairs and their applications.
2. To impart skills to analyze the position, velocity and acceleration of mechanisms.
3. To familiarize higher pairs like cams and gears.
4. To impart mathematical methods for estimating rotary and reciprocating unbalance in mechanisms and machines.
5. To familiarize The Governors.

**COURSE OUTCOMES:** Students will be able to

**CO1. Analyze and Explain** the terminology and criteria of mechanisms as well as working of mechanisms with lower pairs [K3, K2]

**CO2. Analyze** the velocity of various links in mechanisms using velocity diagrams or instantaneous center method as well as **determine** the acceleration of links using acceleration diagrams. [K3]

**CO3. Explain** the terminology of Gears as well as **Analyze** Gears and Gear Trains kinematically. [K2, K3]

**CO4. Design and Analyze** Cams for specified motion and follower. [K4, K3]

**CO5. Estimate** unbalances force in rotating members and reciprocating mechanisms and **Solve** problems of Governors. [K3]

**UNIT-I: SIMPLE MECHANISMS**

**Basics of Mechanisms And Machines:** Types of links, Degrees of freedom, Kinematic pairs – lower pairs and higher pairs, Kinematic chains, mechanisms, Machines, Mobility (Chebychev–Grübler–Kutzbach criterion), inversions - Grashof's conditions for 4-bar chain, inversions of slider crank chain and double slider crank chain with their applications

**Mechanisms with Lower Pair:** Pantograph, Exact Straight-Line Mechanisms – Peaucellier, Hart and Scott Russell mechanisms, Approximate Straight-Line Mechanisms – Grasshopper, Watt, Tchebicheff and Robert Mechanisms, Modified Scott Russell mechanism, Hooke's Joint.

**UNIT-II: VELOCITY & ACEELERATION DIAGRAMS**

**Velocity and Acceleration Analysis of Mechanisms:** Velocity and acceleration – Motion of link in machine – Determination of Velocity Acceleration diagram for a given mechanism, Klein's construction, Coriolis acceleration, determination of Coriolis component of acceleration.

**Plane motion of body:** Instantaneous center of rotation, centrodes and axodes – relative motion between two bodies – Three centers in line theorem – Graphical determination of instantaneous center, diagrams for Simple mechanisms and determination of angular velocity of points and links.

### **UNIT-III: GEARS & GEAR TRAINS**

**Gears & Gear Trains:** Gear – Types and profile – nomenclature of spur & helical gears – laws of gearing – interference – requirement of minimum number of teeth in gears – gear trains – simple, compound and reverted gear trains – determination of speed and torque in epicyclic gear trains.

### **UNIT – IV: CAMS**

**Cams:** Cam – Types of cams and followers – Cam design for different follower motions (SHM, Uniform Velocity, Uniform Acceleration, Cycloidal profiles), circular and tangent cams – pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers.

### **UNIT-V: BALANCING OF MASSES AND GOVERNORS**

**Balancing of Rotating Masses:** Static and dynamic balancing, balancing of single rotating mass by balancing masses in same plane and in different planes.

**Balancing of Reciprocating Masses:** Inertia effect of crank and connecting rod, unbalance in slider crank mechanism

**Governors:** Introduction, Centrifugal governor, Watt, Porter and Proell governors, spring loaded governors, Hartnell and Hartung with auxiliary springs

#### **TEXT BOOKS:**

1. S.S Rattan, Theory of Machines, 5<sup>th</sup> Edition, Tata McGrawHill, 2017
2. Thomas Bevan, Theory of Machines, 3<sup>rd</sup> edition, CBS Publishers & Distributors, 2009.

#### **REFERENCE BOOKS:**

2. R. K. Bansal, Theory of Machines, 5<sup>th</sup> Edition, Laxmi Publications (P)Ltd., 2016
3. John J. Uicker, Gordon R. Pennock, Joseph E. Shigley, Theory of Machines And Mechanisms, 4<sup>th</sup> Edition, Oxford University Press, 2014
4. Cleghorn W.L., Nikolai Dechev, Mechanics of Machines, Oxford University Press, 2015.
5. Ghosh A. and Mallick A.K., Theory of Mechanisms and Machines, 3<sup>rd</sup> Edition, Affiliated East-West Pvt. Ltd, New Delhi, 2008.
6. Robert L. Norton, Kinematics and Dynamics of Machinery, SIE, Tata McGrawHill, 2017.
7. R S Khurmi, Theory of Machines, 14<sup>th</sup> Edition, S. Chand, 2017.

<b>IV SEMESTER</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>1</b>	<b>-</b>	<b>4</b>
<b>19ME4T03 - STRENGTH OF MATERIALS</b>				

**COURSE OBJECTIVES:**

1. The student will acquire the fundamental concepts of deformable bodies.
2. The student will be able to draw the shear force and bending moment diagrams for various beams with different loads.
3. The student will acquire the knowledge to sketch both stress distribution curves for bending and shear loads for different sections.
4. The student will compute beam deflections under transverse loads using various methods.
5. The student will compute stress in thin cylinder thick cylinder and spheres due to external and internal pressure.

**COURSE OUTCOMES:** Student will be able to:

**CO1:** Calculate stresses and strains in structural members subjected to various types of loadings.[K3]

**CO2:** Sketch the Shear force and Bending moment diagrams of beams subject to combination of loads.[K3]

**CO3:** Determine and Sketch the stress distribution in section of the beam subjected to Bending and Shear loads.[K3]

**CO4:** Determine the Shear stresses and Modulus of rigidity, Slope and Deflection in shafts.[K3]

**CO5:** Evaluate stresses in thin and thick cylinders.[K4]

**UNIT – I**

**Simple Stresses and Strains:** Introduction, Stress, Strain, Types of Stresses, Elasticity and Elastic Limit, Hooke's Law and Elastic Moduli, Modulus of Elasticity, Factor of Safety, Constitutive Relationship between Stress and Strain.

**Elastic Constants:** Introduction, Longitudinal Strain, Lateral Strain, Poisson's Ratio, Volumetric Strain, Volumetric Strain of a Cylindrical Rod, Sphere and Rectangular block Bulk Modulus, Expression for Young's Modulus in Terms of Bulk Modulus.

**Principal Stresses and Strains**

Introduction, Principal Planes and Principal Stresses, Methods of Determining Stresses on Oblique Section, Analytical Method for Determining Stresses on Oblique Section, Graphical Method for Determining Stresses on Oblique Section, Mohr's Circle.

**UNIT – II**

**Shear Force and Bending Moment:** Introduction, Types of Beams, Types of Loads, Sign Conventions for Shear Force and Bending Moment, Shear Force and Bending Moment Diagrams for a Cantilever, simply supported and over hanging beams with different loads and combination of loads- Point loads, UDL, UVL and couple. Relation between Load, Shear Force and Bending Moment.

**UNIT – III**

**Flexural Stresses:** Introduction, Pure Bending or Simple Bending, Theory of Simple Bending with Assumptions Made, Expression for Bending Stress, Neutral Axis and Moment of resistance, Bending



**Shear Stresses:** Introduction, Shear Stress at a Section, Shear Stress Distribution for Different Sections like Rectangular, Circular, Triangular, I, T and Angle sections.

#### UNIT – IV

**Deflection of Beams:** Introduction, Deflection and Slope of a Beam Subjected to Uniform Bending Moment, Relation between Slope, Deflection and Radius of Curvature, Deflection of a Simply Supported, cantilever Beams Carrying point load and UDL using Macaulay's Method and Moment Area Method.

#### **Torsion:**

Introduction, Derivation of Shear Stress Produced in a Circular Shaft Subjected to Torsion, Maximum Torque Transmitted by a Circular Solid Shaft and Hollow Circular Shafts, Power Transmitted by Shafts, Expression for Torque in Terms of Polar Moment of Inertia, Polar Modulus, Strength of a Shaft of Varying Sections, Combined Bending and Torsion.

#### UNIT – V

**Thin Cylinders and Spheres:** Introduction, Stresses in a Thin Cylindrical Vessel Subjected to Internal Pressure, Expression for Circumferential Stress, Expression for Longitudinal Stress, Efficiency of a Joint, Effect of Internal Pressure on the Dimensions of a Thin Cylindrical Shell, Wire Winding of Thin Cylinders. Thin Spherical Shells, Change in Dimensions of a Thin Spherical Shell Due to an Internal Pressure.

**Thick Cylinders:** Introduction, Stresses in a Thick Cylindrical Shell, Stresses in Compound Thick Cylinders, Initial Difference in Radii at the Junction of a Compound Cylinder for Shrinkage.

#### **TEXT BOOKS:**

1. Solid Mechanics, by Popov E, Prentice Hall India Learning Private Limited, 2nd edition, 2002.
2. Strength of Materials by [R K Rajput](#) S. Chand Publishing, 6th Edition, 2015.

#### **REFERENCES:**

1. Strength of Materials by R. K Bansal Revised 4<sup>th</sup> Edition, Laxmi Publications, New Delhi, 2010,
2. Strength of Materials by S.S. Rattan 2nd edition, Tata Mc-Graw Hill Private Limited, New Delhi, 2012
3. Mechanics of Materials, (2nd edition), by Stephen P. Timoshenko, James M. Gere, C B S Publishers, 2011.
4. Mechanics of Materials, by [Ferdinand P. Beer](#), [E. Russell Johnston Jr.](#), [John T. DeWolf](#), [David F. Mazurek](#), 7th Edition, 2014.
5. A Textbook Of Strength Of Materials by [R K Rajput](#), 1st Edition, S. CHAND, 2018.
6. Strength Of Materials, by Ramamrutham S, Dhanpat Rai Publishing Company (p) Ltd., 18th Edition, 2014.
7. Strength of Materials by [U. C. Jindal](#), Pearson Education; 1st edition, 2012.

<b>IV SEMESTER</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>-</b>	<b>-</b>	<b>3</b>
<b>19ME4T04 - METALLURGY &amp; MATERIAL ENGINEERING</b>				

**COURSE OBJECTIVE**

- Discuss the principles of physical metallurgy, i.e. crystallography of metals, constitution of alloys, phase diagrams and heat treatment of steels.
- Explain the methods to change the properties of materials through heat treatment processes.
- Expose commercially important metals and alloys (both ferrous and nonferrous) with engineering constraints.
- Familiarize properties and applications of ceramics, polymers and composite materials.
- Demonstrate the fundamental properties of Nano-materials and their applications.

**COURSE OUTCOMES: Students will be able to**

- CO1. Explain the importance of material science in engineering and the concept of metallography in studying the microstructures of metals and alloys. [K2]
- CO2. Illustrate various types of steels and cast iron, their properties and applications.[K2]
- CO3. Describe the concept of heat treatment of steels and strengthening mechanisms. [K2]
- CO4. Explain the importance of non-ferrous & composites metals and alloys in engineering applications.[K2]
- CO5. Discuss mechanical properties and various methods to quantify their mechanical integrity.[K2]

**UNIT – I**

Structure of Metals: Crystal Structures: Unit cells, Metallic crystal structures.

Imperfection in Solids: Point, Line, interstitial and volume defects, dislocation strengthening mechanisms and slip systems, critically resolved shear stress.

Constitution of Alloys: Necessity of alloying, substitutional and interstitial solid solutions-phase diagrams: Interpretation of binary diagrams and microstructure development, eutectic, peritectic, peritectoid and monotectic reactions. Iron-Iron-carbide diagram and microstructural aspects of ferrite, cementite, austenite, ledeburite and cast iron.

**UNIT -II**

Cast Irons and Steels: Structure and properties of White Cast iron, Malleable Cast iron, grey cast iron, nodular cast iron, Alloy cast irons. Classification of alloy steel, structure and properties of plain carbon steels, Low alloy steels, tool and die steels, applications of cast iron and steels.

**UNIT – III**

Heat Treatment: Annealing, normalizing, tempering, Hardening, spheroidizing, isothermal transformation for Fe-Fe<sub>3</sub>C system, TTT diagrams, Hardenability, surface - hardening methods, Age hardening treatment, Cryogenic treatment of alloys.

**UNIT - IV**

Non-Ferrous Metals and Alloys: Micro-Structure, properties and applications of copper and its alloys, Aluminium and its alloys, Titanium and its alloy.

Composite Materials: Classification of composites, various methods of fabrication of composites, particle reinforced and fiber reinforced composites.

#### **UNIT – V**

**Fracture Mechanism:** Types of fracture, methods of protection against fracture.

**Mechanical Properties:** Elasticity and plasticity in materials, Stress-strain curve, Resolved shear stress, Tensile properties, Hardness and hardness measurement, Impact properties, Fatigue, Creep.

#### **TEXT BOOKS:**

1. Materials Science and Engineering: A First Course, 6<sup>th</sup>ed.(2015) - V. Rahghavan, PHI Publications.
2. Introduction to Physical Metallurgy, 2<sup>nd</sup> ed. (1997)- Sidney H. Avener, Tata McGraw Hill Edition.

#### **REFERENCE BOOKS:**

1. Callister's Material Science and Engineering 2<sup>nd</sup> ed. (2014), R.Balasubramaniam, wiley india.
2. Material science and metallurgy, 42<sup>th</sup> ed (2018) by V.D. Kodgire, S.V.Kodgire, Everest Publishing House.
3. Engineering materials and metallurgy, Revised edition (2012) - R.K.Rajput, S.Chand & company, New Delhi.
4. Material Science & Metallurgy, 2<sup>nd</sup> edition (2014) by O.P.Khanna – Dhanpatrai publications.

IV Semester	L	T	P	C
	2	-	-	2

**19CS4T06 - PYTHON PROGRAMMING**

**COURSE OUTCOMES:**

At the end of the course students are able to

1. Recognize core programming basics and program design with functions using Python programming language.
2. Interpret the high-performance programs designed to strengthen the practical expertise.
3. Develop applications for real time problems by applying python data structure concepts.
4. Understand and apply the concepts of packages, handling, multithreading and socket programming.
5. Analyze the importance of object-oriented programming over structured programming.
6. Design user interface using case study for application development.

**UNIT – I:**

**Introduction:** History of Python, Need of Python Programming, Applications Basics of Python Programming Using the REPL(Shell), Running Python Scripts, Variables, Assignment, Keywords, Input-Output, Indentation.

**UNIT – II:**

**Types, Operators and Expressions:** Types - Integers, Strings, Booleans; Operators- Arithmetic Operators, Comparison (Relational) Operators, Assignment Operators, Logical Operators, Bitwise Operators, Membership Operators, Identity Operators, Expressions and order of evaluations Control Flow- if, if-elif-else, for, while, break, continue, pass

**UNIT – III:**

**Data Structures Lists** - Operations, Slicing, Methods; Tuples, Sets, Dictionaries, Sequences. Comprehensions.

**UNIT – IV:**

**Functions** - Defining Functions, Calling Functions, Passing Arguments, Keyword Arguments, Default Arguments, Variable-length arguments, Anonymous Functions, Fruitful Functions(Function Returning Values), Scope of the Variables in a Function - Global and Local Variables.

**Modules:** Creating modules, import statement, from. Import statement, name spacing,

**Python packages,** Introduction to PIP, Installing Packages via PIP, Using Python Packages

**UNIT – V:**

**Object Oriented Programming OOP in Python:** Classes, 'self variable', Methods, Constructor Method, Inheritance, Overriding Methods, Data hiding.

Error and Exceptions: Difference between an error and Exception, Handling Exception, try except block, Raising Exceptions, User Defined Exceptions

**TEXT BOOKS**

1. Mark Lutz, Learning Python, O’rielly, 5th edition, 2013
2. Vamsi Kurama, Python Programming: A Modern Approach, Pearson, 2nd edition, 2018.

**REFERENCE BOOKS:**

1. Kenneth A, Introduction to Python, Lambert, Cengage, 2e, 2019.
2. W.Chun, Core Python Programming, Pearson, 2e, 2006.
3. Allen Downey, Think Python, Green Tea Press

IV SEMESTER	L	T	P	C
	-	-	3	1.5

**19ME4L01- THEORY OF MACHINES LAB**

**COURSE OBJECTIVE:**

- Expose the students practically to the concepts they studied in Theory of Machines subject.

**COURSE OUTCOMES: Students will be able to**

- CO1: **Analyze** basic mechanisms like four bar mechanism, single slider crank chain and double slider crank chain mechanisms [K3]
- CO2: **Analyze** kinematically working of cams with various types of followers [K3]
- CO3: Experimentally **determine** the performance characteristics of different types of governors [K5]
- CO4: **Estimate** unbalance existing in mechanisms [K5]

**Any 10 out of below 14 are to be executed**

- Expt 1:** A study on a combination of Four bar Mechanisms
- Expt 2:** A study on single slider crank chain mechanisms.
- Expt 3:** A study on double slider crank chain mechanisms
- Expt 4:** A study on cam with reciprocating follower and oscillating follower
- Expt 5:** A study on single face cam and face follower mechanism
- Expt 6:** To perform experiment on watt Governor to prepare performance characteristic Curves, and to find stability & sensitivity.
- Expt 7:** To perform experiment on porter Governor to prepare performance characteristic Curves, and to find stability & sensitivity.
- Expt 8:** To perform experiment on proell Governor to prepare performance characteristic Curves, and to find stability & sensitivity.
- Expt 9:** To perform experiment on Hartnell loaded Governors to prepare performance characteristic Curves, and to find stability & sensitivity.
- Expt 10:** To perform experiment on Hartung loaded Governors to prepare performance characteristic Curves, and to find stability & sensitivity.
- Expt 11:** To perform the experiment for static balancing on static balancing machine.
- Expt 12:** To perform the experiment for dynamic balancing on dynamic balancing machine.
- Expt 13:** To estimate the reciprocating unbalance in single cylinder engine.
- Expt 14:** To estimate the reciprocating unbalance in multi cylinder engine.

<b>IV SEMESTER</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	-	-	<b>3</b>	<b>1.5</b>
<b>19ME4L02 - STRENGTH OF MATERIALS LAB</b>				

**COURSE OBJECTIVE:**

To impart practical exposure on the microstructures of various materials and their hardness evaluation. Also to impart practical knowledge on the evaluation of material properties through various destructive testing procedures.

**COURSE OUTCOMES:** Students will be able to

- CO1. Illustrate the impact resistance in machine components. [K3]
- CO2. Determine the hardness of metals and rigidity modulus of spring. [K3]
- CO3. Calculate Torsional rigidity and elasticity modulus of the shaft. [K3]
- CO4. Compare microstructure of the material with standard structure. [K2]
- CO5. Observe the how the hardness is changes by Jomney end quench test. [K2]

**SECTION – A****MECHNICS OF SOLIDS LAB:**

1. Direct tension test
2. Bending test
3. Torsion test
4. Hardness test
  - a) Brinell's hardness test
  - b) Rockwell hardness test
5. Test on springs.
6. Impact test

**SECTION - B****METALLURGY LAB:**

1. Preparation and study of the Micro Structure of pure metals like Iron, Cu and Al.
2. Preparation and study of the Microstructure of Mild steels, low carbon steels, high – C steels.
3. Study of the Micro Structures of Cast Irons.
4. Study of the Micro Structures of Non-Ferrous alloys.
5. Study of the Micro structures of Heat treated steels.
6. Hardenability of steels by Jomney End Quench Test.
7. To find out the hardness of various treated and untreated steels.

**Note: ANY 5 EXPERIMENTS FROM EACH SECTION A AND B.**

IV SEMESTER	L	T	P	C
	-	-	2	1

**19CS4L04 - PYTHON PROGRAMMING LAB**

**COURSE OUTCOMES:**

**At the end of the course students are able to**

- CO1:** Apply core programming basics and program design with functions using Python **K4**
  - CO2:** programming language. **K3**
  - CO3:** Interpret the high-performance programs designed to strengthen the practical expertise. **K3**
  - CO4:** Develop applications for real time problems by applying python data structure **K4**
  - CO5:** concepts. **K4**
  - CO6:** Test and apply the concepts of packages, handling, multithreading and socket programming. **K3**
- Divide the importance of object oriented programming over structured programming.  
Design user interface using case study for application development.

**Exercise 1 - Basics**

- a) Running instructions in Interactive interpreter and a Python Script
- b) Write a program to purposefully raise Indentation Error and correct it

**Exercise 2 - Operations**

- a) Write a program to compute distance between two points taking input from the user(Pythagorean Theorem)
- b) Write a program add.py that takes 2 numbers as command line arguments and prints itssum.

**Exercise - 3 Control Flow**

- a) Write a Program for checking whether the given number is an even number or not.
- b) Using a “for loop”, write a program that prints out the decimal equivalent of 1/2, 1/3, 1/4, .. .1/10
- c) Write a program using a “for loop” that loops over a sequence. What is sequence?
- d) Write a program using a “while loop” that asks the user for a number, and prints a countdown from that number to zero.

**Exercise 4 - Control Flow - Continued**

- a) Find the sum of all the primes below two million. Each new term in the Fibonacci sequence is generated by adding the previous two terms. By starting with 1 and 2, the first 10terms will be:  
1, 2, 3, 5, 8, 13, 21, 34, 55, 89, ...
- b) By considering the terms in the Fibonacci sequence whose values do not exceed fourmillion, find the sum of the even-valued terms.

**Exercise - 5 - DS**

- a) Write a program to count the numbers of characters in the string and store them in adictionary data structure
- b) Write a program to use split and join methods in the string and trace a birthday with adictionary data structure.

**Exercise - 6 DS - Continued**

- a) Write a program combine lists that combines these lists into a dictionary.
- b) Write a program to count frequency of characters in a given file. Can you use



character frequency to tell whether the given file is a Python program file, C program file or a text file?

### **Exercise - 7 Files**

- a) Write a program to print each line of a file in reverse order.
- b) Write a program to compute the number of characters, words and lines in a file.

### **Exercise - 8 Functions**

- a) Write a function `ball_collides` that takes two balls as parameters and computes if they are colliding. Your function should return a Boolean representing whether or not the balls are colliding.  
Hint: Represent a ball on a plane as a triple of  $(x, y, r)$ ,  $r$  being the radius  
If  $(\text{distance between two balls centers}) \leq (\text{sum of their radii})$  then (they are colliding)
- b) Find mean, median, mode for the given set of numbers in a list.

### **Exercise - 9 Functions - Continued**

- a) Write a function `nearly_equal` to test whether two strings are nearly equal. Two strings `A` and `B` are nearly equal when `A` can be generated by a single mutation on `B`.
- b) Write a function `dups` to find all duplicates in the list.
- c) Write a function `unique` to find all the unique elements of a list.

### **Exercise - 10 - Functions - Problem Solving**

- a) Write a function `cumulative_product` to compute cumulative product of a list of numbers.
- b) Write a function `reverse` to reverse a list. Without using the `reverse` function.
- c) Write function to compute GCD, LCM of two numbers. Each function shouldn't exceed one line.

### **Exercise 11 - Multi-D Lists**

- a) Write a program that defines a matrix and prints
- b) Write a program to perform addition of two square matrices
- c) Write a program to perform multiplication of two square matrices

### **Exercise - 12 - Modules**

- a) Install packages `requests`, `flask` and explore them using `pip`
- b) Write a script that imports `requests` and fetch content from the page. Eg. (Wiki)
- c) Write a simple script that serves a simple HTTP Response and a simple HTML Page

### **Exercise - 13 OOP**

- a) Class variables and instance variable and illustration of the self-variable
  - i) Robot
  - ii) ATM Machine

IV SEMESTER (MANDATORY COURSE)	L	T	P	C
	2	-	-	-

**19BM0M03- INDIAN CONSTITUTION (MANDATORY COURSE)**

**UNIT I:** Introduction to Indian Constitution-Constitution meaning of the term, Indian Constitution - Sources and constitutional history, Features - Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

**UNIT II:** Union Government and Administration Structure of the Indian Union: Federalism, Centre State relationship, President: Role, powers and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha, The Supreme Court and High Court: Powers and Functions

**UNIT III:** State Government and its Administration Governor - Role and Position - CM and Council of ministers, State Secretariat: Organisation, Structure and Functions

**UNIT IV:** Local Administration - District's Administration Head - Role and Importance, Municipalities - Mayor and role of Elected Representative - CEO of Municipal Corporation PachayatiRaj: Functions of Pachayat Raj Institution: Zila Panchayat, Elected officials and their roles, CEO Zila Panchayat: Block level Organizational Hierarchy - (Different departments), Village level - Role of Elected and Appointed officials - Importance of grass root democracy.

**UNIT V:** Election Commission: Election Commission- Role of Chief Election Commissioner and Election Commissionerate -State Election Commission: Functions of Commissions for the welfare of SC/ST/OBC and women.

**TEXTBOOKS:**

1. Durga Das Basu, Introduction to the Constitution of India, Prentice Hall of India Pvt. Ltd.
2. SubashKashyap, Indian Constitution, National Book Trust
3. J.A. Siwach, Dynamics of Indian Government & Politics

**REFERENCE BOOKS:**

1. D.C. Gupta, Indian Government and Politics
2. H.M.Sreevai, Constitutional Law of India, 4th edition in 3 volumes (Universal Law Publication)
3. J.C. Johari, Indian Government and Politics Hans
4. J. Raj Indian Government and Politics
5. M.V. Pylee, Indian Constitution Durga Das Basu, Human Rights in Constitutional Law, Prentice – Hall of India Pvt. Ltd.. New Delhi
6. Noorani, A.G., (South Asia Human Rights Documentation Centre), Challenges to Civil Right), Challenges to Civil Rights Guarantees in India, Oxford University Press 2012.

**e-Resources:**

- 1) [nptel.ac.in/courses/109104074/8](http://nptel.ac.in/courses/109104074/8)
- 2) [nptel.ac.in/courses/109104045/](http://nptel.ac.in/courses/109104045/)
- 3) [nptel.ac.in/courses/101104065/](http://nptel.ac.in/courses/101104065/)
- 4) [www.hss.iitb.ac.in/en/lecture-details](http://www.hss.iitb.ac.in/en/lecture-details)
- 5) [www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution](http://www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution)

V SEMESTER	L	T	P	C
	3	-	-	3
<b>19ME5T01: DESIGN OF MACHINE ELEMENTS</b>				

**COURSE OBJECTIVES:**

- To familiarize the design procedures and machine components failure under various loadings.
- To develop the basic steps involved in the design of shaft, key and couplings.
- To analyse the functional and strength requirements of various mechanical joints.
- To learn the design procedure of different fasteners, joints, shafts, key, couplings and springs.

**COURSE OUTCOMES:** Students are able to

**CO1:** Describe the design process, material selection, stress concentrations under various loading. [K2]

**CO2:** Design the machine elements like shaft, couplings and keys. [K4]

**CO3:** Design the temporary joints such as cotter joints, knuckle joints, and screw joints. [K4]

**CO4:** Design the permanent joints such as riveted joints, welded joints. [K4]

**CO5:** Design and analyze mechanical springs for the given loading conditions. [K4]

**UNIT – I****INTRODUCTION**

Basic design procedure– General considerations in the design-Engineering Materials and their properties – Selection –Manufacturing consideration in design- Tolerances and fits– BIS codes.

Concept of Machine Design: Theories of failures, Design of simple machine parts – Impact and shock loading, Stress concentration – Stress concentration factors, fatigue failure, endurance limit, notch sensitivity, Fatigue design under combined stresses - Soderberg, Goodman and modified Goodman diagrams.

**UNIT – II**

**SHAFTS, KEYS AND COUPLINGS:** Design of shafts- Shafts subjected to bending, torsion, axial loading, Shafts subjected to fluctuating loads, Design of shafts based on rigidity, Keys-types, Design of keys, Couplings – design of flange and universal couplings. Muff and Split Muff Coupling

**UNIT – III**

**DESIGN OF TEMPORARY JOINTS:** Socket & Spigot cotter joint, Sleeve & Cotter joint, Gib and Cotter joint, Knuckle Joint.

Bolted joints – design of bolts with pre-stresses, Design of joints under eccentric loading.

**UNIT – IV**

**DESIGN OF PERMANENT JOINTS:** Types of riveted joints, Types of failures, Efficiency of riveted joint, Design of joints for boiler Shell, Eccentrically loaded riveted joints.

Welded joints- types, strength of parallel fillet welds, transverse fillet welds, axially loaded unsymmetrical welded joints, eccentrically loaded welded joints.

**UNIT – V**

**MECHANICAL SPRINGS:** Helical springs- classification, terminology, spring materials, spring end formation, Design of helical springs, Concentric springs- surge in spring, Helical torsion springs, Leaf springs.

**TEXT BOOKS:**

1. Bhandari V, “Design of Machine Elements”, 4<sup>th</sup> Edition, Tata McGraw-Hill Book Co, 2017.
2. R.S. khurmi, J.K.Guptha, “Machine Design”, 14<sup>th</sup> Edition, S Chand publications, 2020.
3. P.C. Sharma., D.K. Agarwal, “Machine Design”, 8<sup>th</sup> Edition, S.K.Kataria& Sons, 2010.
4. S MD Jalaludin, “Machine Design”,3<sup>rd</sup> Edition, Anuradha Publishers, 2016.
5. Joseph Edward Shigley, Mechanical Engineering Design, McGraw-Hill, 10th Edition, 2017.

**REFERENCES:**

1. Schaum Series, “Machine design”, 1<sup>st</sup> Edition, McGraw Hill Professional publications, 2017.
2. Pandya& shah, “Machine design”, 20<sup>th</sup> Edition, Charotar Publishing House Pvt. Limited, 2015.

V SEMESTER	L	T	P	C
	3	-	-	3

**19ME5T02 MACHINE TOOLS**

**COURSE OBJECTIVES:**

1. The course provides students with fundamental knowledge and principles in material removal processes.
2. In this course, the students apply the fundamentals and principles of metal cutting to practical applications through multiple labs using lathes, milling machines, grinding machines, and drill presses, Computer Numerical Control etc.

**COURSE OUTCOMES:** Student are able to

**CO1** Describe the metal cutting theory and analyze importance of process parameters for machining. (K2)

**CO2:** Explain the working principles of different types of lathe and various operations performed.[K2]

**CO3:** Explain working principle of shaping, slotting, planning, drilling and boring machines and various operations performed.[K2]

**CO4:** Explain the working principle of milling, methods of indexing and accessories of milling machine. (K2)

**CO5:** Describe the different types of finishing process and describe the function of jigs and fixtures. (K2)

**UNIT – I: FUNDAMENTALS OF MACHINING:**

Elementary treatment of metal cutting theory, element of cutting process, geometry of single point cutting tool, chip formation and types of chips - built up edge and its effects, chip breakers, Mechanics of orthogonal cutting , Merchant's force diagram, cutting forces, cutting speeds, feed, depth of cut, tool life, Taylor’s tool life equation, coolants, tool materials.

**UNIT – II: LATHE MACHINES:**

Engine lathe - principle of working, lathe components, lathe operations, specification of lathe, types of lathe, work holding devices, tool holding devices, turret and capstan lathes, principal features of automatic lathes - classification - single spindle and multi-spindle automatic lathes.

**UNIT – III: SHAPING, SLOTTING AND PLANNING MACHINES:**

Shaping, slotting and planning machines, Principles of working - principal parts, specification, operations performed, Crank and slotted link mechanism, Whitworth quick return mechanism, machining time calculations.

**DRILLING & BORING MACHINES:** Principles of working, specifications, types, operations performed tool holding devices, Nomenclature of twist drill ,Boring Machines - Fine boring machines , Jig boring machine, Deep hole drilling Machine.

**UNIT – IV: MILLING MACHINES:**

Principles of working - specifications, classification of Milling Machines -Principle features of horizontal, vertical and universal milling machine, Milling operations, types of cutters -geometry of milling cutters , methods of indexing , milling machines accessories.

**UNIT –V: FINISHING PROCESSES:**

Theory of grinding machines, classification of grinding machines- cylindrical and surface grinding machines, tool and cutter grinding machines, Different types of abrasives bonds specification and selection of a grinding wheel ,Lapping, Honing & Broaching operations,

**JIGS & FIXTURES:** Principles of jigs and fixtures and uses- classification of jigs & fixtures.

**TEXT BOOKS:**

1. R. K. Jain, Production Technology, Khanna Publishers, India, 1<sup>th</sup> edition 2012.
2. P.N.Rao, Manufacturing Technology: Metal Cutting and Machine Tools, 4<sup>th</sup> edition, McGraw-Hill Education, 2018.
3. Chitale, A.K., and Jain, K.C., Text book of production Engineering. PHI Learning India, 2014.

**REFERENCES:**

1. Milton Clayton Shaw, Metal cutting principles, Oxford University Press, United Kingdom, 2005.
2. Winston A Knight, and Geoffrey Boothroyd, Fundamentals of machining and machine tools, United Kingdom, Taylor & Francis, 2006.
3. HMT Bangalore, Production Technology, McGraw-Hill Education (India) Pvt Limited, 2001.

V SEMESTER	L	T	P	C
	3	-	-	3

**19ME5T03 : THERMAL ENGINEERING**

**COURSE OBJECTIVES:**

- To understand the different processes of Actual Cycles
- To interpret the working principle and various components of IC engine
- To analyze the combustion phenomenon of CI and SI engines and their impact on engine variables.
- To demonstrate the performance of an I.C. Engine.
- To interpret the working principles and various components of Reciprocating and Rotary Air Compressors.

**COURSE OUTCOME:** Students are able to

**CO1:**Differentiate the air standard cycles and actual cycles with reference to engine performance [K2]

**CO2:** Explain the working of I. C. Engines and its components [K2]

**CO3:** Distinguish and discuss the effect of engine variables on combustion phenomenon in S.I and C.I. engines.[K2]

**CO4:** Evaluate the performance of I. C. Engines. [K4]

**CO5:** Describe the working and analyze the performance of reciprocating and rotary air compressors.[K3]

**UNIT – I**

**ACTUAL CYCLES AND THEIR ANALYSIS:** Introduction, Comparison of Air Standard and Actual Cycles, Time Loss Factor, Heat Loss Factor, Exhaust Blow down-Loss due to Gas exchange process, Volumetric Efficiency, Loss due to Rubbing Friction, Actual and Fuel-Air Cycles of CI Engines.

**UNIT – II**

**I.C. ENGINES :**Classification - Working principles, Valve and Port Timing Diagrams, Engine systems – Fuel, Carburettor, Fuel Injection, Ignition, Cooling and Lubrication, principle of Wankle engine, principles of super charging and turbo charging.

**UNIT – III**

**COMBUSTION IN S.I. ENGINES:** Stages of Combustion Flame Front Propagation, Factors Influencing the Flame Speed, Abnormal Combustion – Knocking, Knock Limited Parameters, anti knock additives, fuel rating, Combustion chamber – requirements - types.

**COMBUSTION IN C.I. ENGINES:** Four stages of combustion – Delay period and its importance, Effect of engine variables, Diesel Knock, Need for air movement- suction,

compression and combustion induced turbulence, open and divided combustion chambers and nozzles used, Fuel requirements and fuel rating.

#### **UNIT – IV**

**TESTING AND PERFORMANCE :** Parameters of performance - measurement of cylinder pressure, fuel consumption, air intake, exhaust gas composition, indicated power, determination of frictional losses and brake power, Performance test, Heat balance sheet and chart.

#### **UNIT – V**

##### **AIR COMPRESSORS:**

Classification, Reciprocating compressor - principle of operation, work required, isothermal efficiency, volumetric efficiency, effect of clearance, multi stage compression - saving of work, minimum work condition for two stage compression. Rotary compressor - working principles of roots blower, vane sealed compressor, Lysholm compressor, centrifugal compressor, axial flow compressor.

##### **TEXT BOOKS:**

1. V. Ganesan, Internal Combustion Engines, Tata McGraw Hill, 4<sup>th</sup> Edition, 2017
2. R.K.Rajput, Thermal Engineering, Lakshmi Publications, 10<sup>th</sup> Edition, 2018

##### **REFERENCES:**

1. Mahesh M Rathore. Thermal Engineering-I, Tata McGraw Hill, 4<sup>th</sup> Edition, 2018
2. Rudramoorthy, Thermal Engineering, Tata McGraw-Hill Education India, 4<sup>th</sup> Edition, 2010 Thermal Engineering,
3. R. S Khurmi and J. S. Gupta, Thermal Engineering, S. Chand Company limited, 2009.



V SEMESTER	L	T	P	C
	1	-	2	2

**19ME5T04 MACHINE DRAWING**

**COURSE OBJECTIVES:**

- To provide basic understanding and drawing practice of various joints, simple mechanical parts.
- To provide hands on practice on selection of views, additional views for various machine elements and parts with every drawing proportion.
- To impart the knowledge on assembly drawing from the individual part drawing.

**COURSE OUTCOMES:** Students are able to

CO1. Draw different types of mechanical components.[K2]

CO2. Draw and represent standard dimensions of different mechanical fasteners and Couplings. [K2]

CO3. Draw different types of Joints.[K2]

CO4. Draw the assembled view and sectional view of machine components with all the dimensions. [K3]

**I. DRAWING OF MACHINE ELEMENTS AND SIMPLE PARTS**

- a) Screw threads, bolts, nuts, stud bolts, tap bolts, set screws.
- b) Keys, Cotter joints and knuckle joint.
- c) Riveted joints for plates.
- d) Shaft coupling, spigot & socket pipe joint.
- e) Journal, pivot, collar and foot step bearings.

**II. ASSEMBLY DRAWINGS:**

- a) **ENGINE PARTS:** Stuffing box, Cross head, Petrol engine connecting rod, Piston assembly.
- b) **OTHER MACHINE PARTS:** Screws jack, Machine Vice, Plummer block, Tailstock.
- c) **VALVES:** Steam stop valve, Spring loaded safety valve, Feed check valve, Air cock.

**TEXTBOOKS**

1. K.L.Narayana, P.Kannaiah& K. Venkata Reddy , Machine Drawing, 3<sup>rd</sup> edition, New Age Publishers, 2019.
2. N.D Bhatt, V. M. Panchal, Machine Drawing, 20<sup>th</sup> edition, Charotar Publishing House Pvt. Ltd, 2014.

**REFERENCES**

1. P.S.Gill ,A Text book of Machine Drawing, 18<sup>th</sup> edition, S.K.Kataria & Sons, 2013.

V SEMESTER (ELECTIVE-I)	L	T	P	C
	3	-	-	3

**19ME5E01 - FINITE ELEMENT ANALYSIS**

**COURSE OBJECTIVES:**

1. To learn basic principles and procedure of finite element analysis
2. To introduce the concepts of mathematical modeling of Engineering problems.
3. To learn and apply finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses performed by others.
4. Learn to model complex geometry problems and solution techniques.

**COURSE OUTCOMES:** Students are able to

**CO1:** Explain the basic concept and application of FEM and compare with other method. [K2]

**CO2:** Solve the displacement, stress and reactions in trusses and beams. [K4]

**CO3:** Solve two dimensional problems using CST and higher order elements and apply numerical integration for higher order element problem analysis. [K3]

**CO4:** Apply finite element analysis to solve steady state heat transfer problems.[K3]

**CO5:** Determine the natural frequencies and mode shapes for bar and beams. [K4]

**UNIT – I****Introduction to FEM**

Basic concept, Historical background, Application of FEM, Comparison of FEM with other methods. Basic equations of elasticity, Stress- Strain relations, Strain- Displacement relations.

**One Dimensional Problem:** Finite element modeling, Coordinates and shape functions for one dimensional bar element. Potential Energy approach: formulation and assembly of Global stiffness matrix and load vector. Finite element equations, Treatment of boundary conditions using elimination and penalty approaches.

**UNIT –II**

**Analysis of Trusses:** Stiffness Matrix for plane truss element, Assembly consideration, calculations of displacement and reactions.

**Analysis of Beams:** Hermite shape functions - Element stiffness matrix for simple beam element, Load vector, Calculations of displacement and stresses.

**UNIT – III**

**Two Dimensional Problems:** CST-Stiffness matrix and load vectors, Iso-parametric element representation, Shape functions, Convergence requirements -Problems, Quadrilateral elements, Numerical integration.

**UNIT – IV**

**Steady State Heat Transfer Analysis:** One dimensional analysis of a fin, one and two dimensional analysis of conduction in plates with convective boundary conditions, Analysis of a uniform shaft subjected to torsion.

## UNIT – V

**Dynamic Analysis:** Formulation of finite element model, Element matrices – Lumped, Consistent mass matrices, Evaluation of Eigen values and Eigen vectors for a stepped bar and a beam, Free Vibration analysis.

## TEXTBOOKS

1. S.S.Rao, The Finite Element Methods in Engineering, Elsevier, India, 6<sup>th</sup> Edition, 2019.
2. R. Tirupathi Chandrapatla, Introduction to Finite Elements in Engineering, Pearson Education, India.4<sup>th</sup> edition, 2015.

## REFERENCES

1. J N Reddy, Introduction to Finite Element Method, McGraw Hill Education, India Pvt Ltd, 4<sup>th</sup> edition, 2020.
2. Daryl L Logan, A First Course in the Finite Element Method, Cengage Learning, India, 5<sup>th</sup> edition, 2012.

V SEMESTER (ELECTIVE-I)	L	T	P	C
	3	-	-	3
<b>19ME5E02- HYDROGEN AND FUEL CELLS</b>				

**COURSE OBJECTIVE**

- The student will acquire essential knowledge about hydrogen and its properties.
- Make the student to understand about Hydrogen Storage technologies.
- The student to know working of various fuel cells, applications and economics.

**COURSE OUTCOMES:** Students are able to

**CO1.** Explain the fundamental concept of hydrogen source of energy. [K2]

**CO2.** Explain the concepts of hydrogen generation and storage technologies [K2]

**CO3.** Explain the applications, safety management of hydrogen. [K2]

**CO4.** Explain the working of various fuel cells. [K2]

**CO5.** Explain the applications and economics of fuel cell. [K2]

**UNIT I**

**Hydrogen:** Hydrogen as a source of energy, physical and chemical properties, salient characteristics, relevant issues and concerns.

**UNIT II**

**Hydrogen Generation:** Production of hydrogen, steam reforming, water electrolysis, gasification and woody biomass conversion, biological hydrogen production, photo dissociation, direct thermal or catalytic splitting of water.

**UNIT III**

**Hydrogen Storage:** Hydrogen storage options, compressed gas, liquid hydrogen, hydride, chemical storage, safety and management of hydrogen, applications of hydrogen.

**UNIT IV**

**Fuel Cells:** Types, brief history, principle, working, thermodynamics and kinetics of fuel cell process, types of fuel cells; AFC, PAFC, SOFC, MCFC, DMFC, PEMFC – relative merits and demerits, performance evaluation of fuel cell, comparison of battery and fuel cell.

**V UNIT**

**Fuel Cells -Applications and Economics:** Fuel cell usage for domestic power systems, large scale power generation, automobile, space applications, economic and environmental analysis on usage of fuel cell, future trends of fuel cells.

**TEXT BOOKS:**

1. Bent Sorensen, Hydrogen and Fuel Cells: Emerging Technologies and Applications, 3<sup>rd</sup>ed. Elsevier Academic Press, 2018
2. Dmitri Bessarabov, PEM Electrolysis for Hydrogen Production: Principles and Applications, CRC press 2017
3. Andrzej Wieckowski, Jens K. Nørskov, Fuel Cell Science: Theory Fundamentals, and Bio catalysis, John Wiley & Sons, 2010

**REFERENCES:**

1. Shripad T. Revankar Pradip Majumdar, **Fuel Cells: Principles, Design, and Analysis 6<sup>th</sup>ed**, Scrivener Publishing, **2014**
2. Basile A, Hydrogen Production Separation and Purification for Energy, 8<sup>th</sup> ed , Institution of Engineering & Technology, , 2017
3. Mehmet Sankir, NurdanDemirciSankir, **Hydrogen Production Technologies**, 6<sup>th</sup>ed ,Scrivener Publishing, 2019.

<b>V SEMESTER (ELECTIVE-I)</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>-</b>	<b>-</b>	<b>3</b>
<b>19ME5E03 - TOOL DESIGN</b>				

**COURSE OBJECTIVES:**

1. Implement the tool design process when designing tooling for the manufacturing of a product.
2. Design, develop, and evaluate cutting tools and work holders for a manufactured product.
3. Design, develop, and evaluate appropriate systems to define limits and specifications of a work piece during the manufacturing process.

**COURSE OUTCOMES: students are able to**

**CO1:** Explain the design requirements of single point and multi-point cutting tools.[K2]

**CO2:** Describe the importance of cutting tools and work holding device in design.[K2]

**CO3:** Explain jigs, illustrate the function of jigs for several operations and simple design of jigs.[K2]

**CO4:** Illustrate the design principles of fixtures and describe the application of fixtures for machine tools and NC Machine. [K3]

**CO5:** Explain the fundamentals of die cutting operations and design of simple progressive and sets. [K2]

**UNIT – I: DESIGN OF CUTTING TOOLS:**

Metal cutting process, Selection of tool materials, Design of single point tool, multipoint cutting tool-form tool, drill, milling cutter, broaches and chip breaker.

**UNIT – II: LOCATING AND CLAMPING METHODS:**

Basic Principles of Location, Locating methods and devices, Principles of clamping - Mechanical, Pneumatic and Hydraulic actuation, Clamping force analysis – Design problems.

**UNIT – III: DESIGN OF JIGS:**

Types of drill jigs, General considerations in the design of drill jigs, Drill bushings -types, methods of construction ,Simple designs of Plate, Channel, Boxes, Angle plate.

**UNIT – IV: DESIGN OF FIXTURES:**

Design principles, Types of fixtures, Fixtures for lathe, milling, boring, broaching, Fixture design for NC Machine.

**UNIT – V: DESIGN OF DIES:**

Fundamentals of die cutting operations - Cutting action in punch and die operations, Die clearance, Design of simple die, progressive die.

**TEXT BOOKS:**

1. R.K. Jain and S.C. Gupta, Production Technology, Khanna Publishers, 16<sup>th</sup> edition, 2007
2. Cyril Donaldson ,Tool design, 5<sup>th</sup> Edition, McGraw hill Publications, 2017.
3. S Kalpak Jian S R. Schmidt, Manufacturing- Engineering and Technology, Pearson publications, 7th Edition, 2014

**REFERENCES**

1. Elanchezhian & M. Vijay an, ,Machine Tools, Anuradha Publications, 1<sup>st</sup> edition, 2008
2. Bhattacharya A and Sen, Principles of Machine Tools, New Central Book Agency, 1<sup>st</sup> edition, 2009.

<b>V SEMESTER (ELECTIVE-I)</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>-</b>	<b>-</b>	<b>3</b>
<b>19ME5E04- PRODUCTION PLANNING AND CONTROL</b>				

**COURSE OBJECTIVES:**

- To understand functions of production planning and control.
- To crack the forecasting problems.
- To solve the inventory problems using ABC, VED and EOQ models.
- To find the new facility location and layout using Algorithms and understand the recent trends
- To prepare the production schedule for different types of scheduling.

**COURSE OUTCOMES:** Students are able to

- CO1. Explain the objectives and functions of production planning and control. [K2]
- CO2. Solve the various forecasting problems in production planning. [K3]
- CO3. Calculate the required quantities of materials by using ABC, VED and EOQ models. [K3]
- CO4. Determine the new facility location and layout problems and explain the recent trends. [K3]
- CO5. Apply scheduling techniques to solve the scheduling problems. [K3]

**UNIT I**

**Production Planning and Control:** Objectives, Functions, Elements, Types of production, Organization of production planning and control department, internal organization of department.

**UNIT II**

**Forecasting:** Importance of forecasting, general principles of forecasting, Forecasting Techniques- Qualitative methods, and Quantitative methods.

**UNIT III**

**Inventory Management:** Functions of inventories, relevant inventory costs, ABC analysis, VED analysis, EOQ model, Inventory control systems, P–Systems, Q-Systems.

**UNIT IV**

**Facility Location and Layout**

Facility location, Factors influencing plant location, Location Alternatives, Facility layout-objectives, functions, layout types.

**Recent Trends in PPC**

Master Production Schedule, Material Requirement Planning, Introduction to Lean Manufacturing.

**UNIT V**

**Sequencing & Scheduling**

Sequencing: Priority Rules, Performance measures, Gantt chart, Scheduling: Objectives, Terminologies, Types of scheduling, Standard scheduling methods: One-machine n job problem, Two-machine n job problem, Three-machine n job problem.

**TEXTBOOKS**

1. Martand T Telsang, Industrial Management and Production Management, 5<sup>th</sup> Edition, S Chand Publishers, 2016.

2. S.N. Chary, Production and Operations Management, 6<sup>th</sup> Edition, McGraw Hill Education Pvt. Ltd, 2019.
3. S.K. Mukhopadhyay, Production Planning and Control, 3<sup>rd</sup> Edition, PHI Learning Pvt. Ltd, 2015.

#### **REFERENCES**

1. Samuel Ellian, Elements of Production Planning and Control, 3<sup>rd</sup> Edition, McGraw Hill Education Pvt. Ltd, 2018.
2. R.Panneerselvam, Production and Operation Management, 3<sup>rd</sup> Edition, PHI Learning Pvt. Ltd, 2012.



V SEMESTER (ELECTIVE-I)	L	T	P	C
	3	-	-	3

**19CS5E19 - PRINCIPLES OF OPERATING SYSTEMS**

**COURSE OUTCOMES:**

At the end of the course student are able to

1. Define the Basic concepts about Operating System and its functions.
2. Describe Process management, CPU scheduling and Deadlocks.
3. Analyze Memory management
4. Describe and Implement File systems & Disk Structures .
5. Perform Case Study on LINUX,WINDOWS and Android OS

**UNIT – I**

**OPERATING SYSTEMS OVERVIEW**

Introduction-OS Concepts – Evolution of OS, OS Structures- Kernel, Shell. Operating-System Services, System Calls, Types of System Calls, System Structure. UNIX- Introduction-Architecture, Logging In, Files and Directories, Input and Output, Programs and Processes, Error Handling, User Identification, Time Values, System Calls and Library Functions, Command-Line Arguments, UNIX File API'S.

**UNIT – II**

**PROCESS MANAGEMENT**

**Process:** Concept, Operations on Processes, Inter process Communication. Threads-Multithreading Models, Threading Issues, threads .

**Synchronization:** The Critical-Section Problem, Peterson's Solution, Synchronization Hardware, Semaphores, Critical Regions, Monitors, Classic Problems of Synchronization,

**Process Scheduling:** Basic Concepts, Scheduling Criteria, Scheduling Algorithms- CPU (Uniprocessor) scheduling algorithms, Multiprocessor and Real-time scheduling algorithms.

**Deadlocks:** Characterization – Prevention – Avoidance - Detection and Recovery

**UNIT – III**

**MEMORY MANAGEMENT**

Basic Memory Management, Swapping, Contiguous Memory Allocation, Virtual Memory Concept, Demand Paging - Page Interrupt Fault, Page Replacement Algorithms, Segmentation – Simple, Multi-level, Segmentation with Paging, Memory Management.

**UNIT – IV**

**INFORMATION MANAGEMENT**

**File system Interface:** The concept of a file, Access Methods, Directory structure, File system mounting, file sharing, protection.

**File System implementation:** File system structure, allocation methods, free-space management

**Mass-storage structure:** Overview of Mass-storage structure, Disk structure, disk attachment, disk scheduling, Disk Management, Swap-Space Management, RAID Structure.

**UNIT – V**

**CASE STUDY**

The Linux System, Microsoft Windows 7, Android Software Platform: Android Architecture, Operating System Services, Android Runtime Application Development, Application Structure.

**TEXT BOOK:**

1. Operating System Concepts, Abraham Silberschatz, Peter Baer Galvin and Greg Gagne 10th Edition, John Wiley and Sons Inc., 2018.
2. Operating Systems – Internals and Design Principles, William Stallings, 7th Edition, Prentice Hall, 2016.
3. Operating Systems-S Halder, Alex A Aravind,Second Edition,Pearson Education,2016 .

**REFERENCE BOOKS:**

1. "Understanding Operating Systems" Ann McIver McHoes Ida M. Flynn, Sixth Edition, Course Technology-Cengage Learning ,2011.
2. Modern Operating Systems, Andrew S. Tanenbaum, Second Edition, Addison Wesley, 2001.
3. Operating Systems Design and Implementation, Andrew S. Tanenbaum , Albert S. Woodhull - Amherst, Third Edition Prentice Hall, 2006.
4. Advanced Programming in UNIX Environment, by W. Richard Stevens: 2nd Ed, Pearson Education, 2005.
5. UNIX System Programming Using C++, by Terrence Chan: Prentice Hall India, 1999.
6. [http://nptel.iitm.ac.in/courses/Webcourse-contents/IIScBANG/Operating%20Systems/New\\_index1.html](http://nptel.iitm.ac.in/courses/Webcourse-contents/IIScBANG/Operating%20Systems/New_index1.html)

V SEMESTER	L	T	P	C
	-	-	3	1.5

**19ME5L01- MACHINE TOOLS LAB****COURSE OBJECTIVES:**

1. To study the working system, important parts and functions of the machines like Lathe, Drilling, Milling, Shaping and Slotting Machine.
2. To study the material and geometry of tools used in metal cutting like single point, multi point cutting tools.
3. To impart hands on experience on lathe, drilling, shaping, milling, slotting, grinding and grinding machines.

**COURSE OUTCOMES:**

1. Students are able to describe the various operations performed in Lathe, drilling, shaping, milling, slotting, and grinding machines.
2. Students are able to perform various operations like turning, drilling, shaping, milling, slotting, and grinding.

**COURSE CONTENT:**

1. Study of general purpose machines – lathe machine, drilling machine, milling machine, shaper machine, slotting machine, and grinding machine.
2. Step turning on lathe machine.
3. Taper turning on lathe machine
4. Thread cutting on lathe machine.
5. Knurling on lathe machine.
6. Drilling and tapping.
7. Shaping operations.
8. Slotting operations.
9. Milling operations.
10. Surface grinding operations.

**REFERENCE**

1. Bruce Black. J, Workshop processes practices and materials. Routledge, 5th Edition 2015.

V SEMESTER	L	T	P	C
	-	-	3	1.5
<b>19ME5L02 - THERMAL ENGINEERING LAB</b>				

**COURSE OBJECTIVES:**

- To provide hands on experience in operating various types of internal combustion engines and understands their functioning and performance and applying for proper valve timing in IC engines.

**COURSE OUTCOMES:** Students will be able to

- CO1: Explain working of various types of boilers. [K2]
- CO2: Explain working of IC engine and draw valve timing diagram. [K2]
- CO3: Evaluate performance of Diesel and petrol engines.[K4]
- CO4: Analyze heat balance in I.C. Engine. [K4]
- CO5: Evaluate the performance of Reciprocating Air Compressor.[K4]

**LIST OF EXPERIMENTS:**

1. Study of Boilers.
2. I.C. Engine Valve timing Diagram.
3. Performance test on single cylinder four stroke Diesel Engine.
4. Performance test on single cylinder four stroke Petrol Engine
5. Morse test on multi cylinder, four stroke Petrol Engine.
6. Motoring test on single cylinder four stroke Petrolengine.
7. I.C.Engine heat balance on single cylinder four stroke Diesel Engine.
8. Performance test on Multi cylinder four stroke Petrol Engine.
9. Performance test on Reciprocating Air Compressor.
10. Disassembly / Assembly of I.C. Engine.

V SEMESTER	L	T	P	C
	2	-	-	-

**19CE0M01: ENVIRONMENTAL SCIENCE**

**UNIT-I:**

**MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES:**

Definition, Scope and Importance –Sustainability: Stockholm and Rio Summit–Global Environmental Challenges: Global warming and climate change, acid rains, ozone layer depletion, population growth and explosion, effects;. Role of information technology in environment and human health.

Ecosystems: Concept of an ecosystem. - Structure and function of an ecosystem; - Energy flow in the ecosystem - Ecological succession. - Food chains, food webs and ecological pyramids; Introduction, types, characteristic features, structure and function of Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems.

**UNIT-II:**

**NATURAL RESOURCES:**

Natural resources and associated problems. Forest resources: Use and over – exploitation, deforestation – Timber extraction – Mining, dams and other effects on forest and tribal people.

Water resources: Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems.

Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources.

Food resources: World food problems, changes caused by non-agriculture activities-effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity.

Energy resources: Growing energy needs, renewable and non-renewable energy sources use of alternate energy sources.

Land resources: Land as a resource, land degradation, Wasteland reclamation, man induced landslides, soil erosion and desertification; Role of an individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles.

**UNIT-III:**

**BIODIVERSITY AND ITS CONSERVATION:**

Definition: genetic, species and ecosystem diversity-classification - Value of biodiversity: consumptive use, productive use, social-Biodiversity at national and local levels. India as a mega-diversity nation - Hot-spots of biodiversity - Threats to biodiversity: habitat loss, man-wildlife conflicts. - Endangered and endemic species of India – Conservation of biodiversity: conservation of biodiversity.

**UNIT – IV**

**ENVIRONMENTAL POLLUTION:**

Definition, Cause, effects and control measures of Air pollution, Water pollution, Soil pollution, Noise pollution, Nuclear hazards. Role of an individual in prevention of pollution. - Pollution case studies, Sustainable Life Studies. Impact of Fire Crackers on Men and his wellbeing.

Solid Waste Management: Sources, Classification, effects and control measures of urban and industrial solid wastes. Consumerism and waste products, Biomedical, Hazardous and e – waste management.

**UNIT – V**

**SOCIAL ISSUES AND THE ENVIRONMENT:**

Urban problems related to energy -Water conservation, rain water harvesting-Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Environmental Protection Act -Air (Prevention and Control of Pollution) Act. –Water (Prevention and control of Pollution) Act -Wildlife Protection Act -Forest Conservation Act-Issues involved in enforcement of environmental legislation. -Public awareness.

Environmental Management: Impact Assessment and its significance various stages of EIA, preparation of EMP and EIS, Environmental audit. Ecotourism, Green Campus – Green business and Green politics.

The student should Visit an Industry / Ecosystem and submit a report individually on any issues related to Environmental Studies course and make a power point presentation.

**Text Books:**

1. K. V. S. G. Murali Krishna , Environmental Studies, VGS Publishers, Vijayawada, 2010
2. R. Rajagopalan, Environmental Studies, 2nd Edition, Oxford University Press, 2011
3. P. N. Palanisamy, P. Manikandan, A. Geetha, and K. Manjula Rani, Environmental Studies, 2nd Edition , Pearson Education, Chennai, 2015

**Reference:**

1. Deeshita Dave & P. Udaya Bhaskar Text Book of Environmental Studies, Cengage Learning, 2011
2. Shaashi Chawla, A Textbook of Environmental Studies, TMH, New Delhi, 2017
3. Benny Joseph, Environmental Studies, Tata McGraw Hill Co, New Delhi, 2006
4. Anubha Kaushik, C P Kaushik , Perspectives in Environment Studies, New Age International Publishers, 2014.

VI SEMESTER	L	T	P	C
	3	-	-	3

**19ME6T01: DESIGN OF MECHANICAL TRANSMISSION SYSTEMS****COURSE OBJECTIVES:**

- To impart design knowledge about various machine members such as bearings, engine parts, gears, clutches and brakes.
- To solve numerical problems in design of various mechanical drives.
- To understand the design principles and procedures for various mechanical transmission drives based on standard data and catalogues.
- To learn to use the design standards and catalogues.

**COURSE OUTCOMES:** Students are able to

**CO1:** Design the journal bearing using different empirical relation [K4].

**CO2:** Design suitable power transmission system like belt drives, chain drives. [K4]

**CO3:** Design of spur, helical, bevel, and worm gears based on contact and beam strength. [K4]

**CO4:** Design of Engine parts like connecting rod, crank shaft, piston. [K4]

**CO5:** Design of the clutches based on torque. [K4]

**UNIT – I**

**BEARINGS:** Sliding contact bearings: Types, Bearing materials, Lubrication modes, Temperature effect on viscosity, Bearing modulus, McKee equations, Journal bearings design. Rolling contact bearings: Ball and Roller bearings, Static load and dynamic load capacity, Load factor, Equivalent load, Selection of suitable bearings from manufacturer's catalogue.

**UNIT – II**

**BELT AND CHAIN DRIVES:** Types, Design of Flat and V belt, Power transmission by flat and V belt drives-transmission efficiencies, Design of Chain drives and Sprockets.

**UNIT – III**

**GEARS:** Classifications, Gear materials, Design of Spur gear & helical gear based on strength and wear considerations, Gear tooth failures, Beam strength of Gear teeth, Lewis and Buckingham equations, Thermal design considerations of gears, Design of Bevel and Worm gears.

**UNIT – IV**

**I.C ENGINE PARTS DESIGN:** Design of cylinder and head, Piston, Cylinder cross-head, Cylinder liners, Connecting rod.

**UNIT- V**

**CLUTCHES AND BRAKES:** Friction clutches- torque capacity of single plate and multi plate clutch, design considerations, Centrifugal clutches. Cone clutches. Brakes: Types, Energy equations, Brake design- Band and block brake, internal expanding shoe brake, self-locking.

**TEXT BOOKS:**

1. R.S. Khurmi, S.Chand, A Text Book of Machine Design, 25<sup>th</sup> edition, 2020.

2. V.B.Bandari, Design of Machine Elements, McGraw Hill, 5<sup>th</sup> edition, 2020
3. Dr.P.C. Sharma., D.K. Agarwal,A Text book of Machine Design, S.K.Kataria& Sons, 2013.
4. Design Data: Data Book of Engineers- PSG College – Kalaikathir Achchaga, Coimbatore, 2012.

**REFERENCES:**

1. Joseph Edward Shigley, Mechanical Engineering Design, McGraw-Hill, Tenth Edition in SI units, 2017.
2. Robert L. Norton, Machine Design, Pearson Paperback, 2018.
3. Robert C. Juvinall and Kurt M. Marshek, Machine Component Design, Wiley Publishers, 2016.
4. V.B. Bhandari, Design of Machine Elements Paperback, McGraw Hill, 2017.
5. Linda C. Schmidt, George Dieter, Engineering Design, McGraw Hill, 2017.



<b>VI SEMESTER</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>19ME6T02- HEAT TRANSFER</b>				

**COURSE OBJECTIVES:**

- To impart knowledge on various modes of heat transfer (conduction, convection & radiation).
- To get knowledge on heat transfer through extended fin and transient heat conduction.
- To get knowledge on forced and natural convection heat transfer.
- To understand various regimes of boiling and types of condensation heat transfer.
- To impart knowledge on radiation heat transfer.

**COURSE OUTCOMES:** Students are able to

- CO1. Describe modes of heat transfer and solve one-dimensional heat conduction problems without and with heat generation. [ K3]
- CO2. Develop heat transfer relations for different fin configurations and solve one dimensional transient heat conduction problems. [K3]
- CO3. Apply different correlations developed for estimation of forced and natural convection heat transfer.[K3]
- CO4. Describe various regimes of boiling and types of condensation heat transfer and also analyze different heat exchangers [K4].
- CO5. State and apply laws of radiation and estimate radiation heat transfer between bodies. [K3]

**UNIT – I****INTRODUCTION TO HEAT TRANSFER AND CONDUCTION:**

Basic modes of heat transfer, laws of heat transfer, multi-mode heat transfer-simple problems, General conduction equation in Cartesian, cylindrical, spherical coordinates, Initial and boundary conditions. One dimensional conduction heat transfer with and without heat generation-Cartesian and cylindrical coordinates only, Thermal contact resistance, Overall heat transfer coefficient, Conduction shape factor.

**UNIT – II****CONDUCTION AND CONVECTION SYSTEMS**

Extended surface (fins) Heat Transfer –types, General fin heat transfer equation for long Fin, fin with insulated tip, Short Fin, Fin effectiveness, Fin efficiency.

**ONE DIMENSIONAL TRANSIENT CONDUCTION HEAT TRANSFER:** Systems with negligible internal resistance, Significance of Biot and Fourier Numbers, Chart solutions of transient conduction systems.

**UNIT –III**

**CONVECTIVE HEAT TRANSFER:** Classification of convective heat transfer, Dimensional analysis – Buckingham Pi Theorem for forced and free convection, Significance of non-dimensional numbers, differential mass, momentum and energy equations of laminar boundary layer on a flat Plate, Reynold's and Colburn analogy, Empirical relations of laminar and turbulent flows over geometries of different shapes.

Flow through pipes: Concepts about hydrodynamic and thermal entry lengths - Use of empirical relations for horizontal pipe flow and annulus flow.

Natural convection heat transfer- Laminar Free Convection on a vertical surface, effects of turbulence, Empirical correlations -Vertical Plate, Inclined and Horizontal Plates, long Horizontal Cylinder, Spheres.

#### **UNIT – IV**

##### **Boiling and Condensation & Heat Exchangers**

Boiling– Pool boiling, different regimes of pool boiling, empirical relation for heat flux in nucleate boiling, maximum or critical heat flux and Leiden frost point.

**Condensation** - Film wise and drop wise condensation, Nusselt theory of film condensation, applications of boiling and condensation.

**Heat Exchangers:** Parallel and counter flow double pipe heat exchanger- LMTD, effectiveness- NTU method, Cross flow heat exchanger, Shell and tube heat exchanger.

#### **UNIT – V**

##### **Radiation Heat Transfer**

Plank's theory of radiation, Stefan – Boltzmann's law of radiation, Wein's displacement law, Emissivity, Absorbvity, Transmissivity, Kirchof's law, Shape factor algebra, Radiation heat transfer between infinite and finite surfaces, Radiation shields.

#### **TEXT BOOKS:**

1. R.C. Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, 5<sup>th</sup> edition, New Age Internationals, 2017
2. R K Rajput, Heat and Mass Transfer, Revised 5<sup>th</sup> Edition, S Chand- 2012
3. D.S. Kumar, Heat Transfer, 8<sup>th</sup> Edition, S. K. Kataria, & Sons, 2015.
4. J. P. Holman, Heat Transfer, 9<sup>th</sup> Edition, Tata McGraw-Hill publishing Company Limited, 2008.

#### **REFERENCES:**

1. P. K. Nag, Heat and Mass Transfer, 3<sup>rd</sup> Edition, Tata McGraw-Hill Education, 2011.
2. S. C Arora, S. Domkundwar and Anand V. Domkundwar, Heat and Mass Transfer, 2<sup>nd</sup> Edition, , Dhanpat Rai & co, 2007
3. S. P. Sukhatme, Heat Transfer, 4<sup>th</sup> Edition, Orient Longman Private Limited, 2005

#### **DATA BOOK:**

1. C. P. Kothandaraman, S. Subramanyam, Heat and Mass Transfer Data Book ,6<sup>th</sup> Edition, New Age International Publishers, 2009.

<b>VI SEMESTER</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>19ME6T03 – METROLOGY AND INSTRUMENTATION</b>				

**COURSE OBJECTIVES:**

- To provide knowledge on various Metrological equipments available to measure the dimension of the components.
- To learn the working principle and applications of various linear and angular measuring instruments
- To learn the principles and methods of form and surface metrology.
- To improve the knowledge on advances in measurements for quality control in manufacturing Industries.

**COURSE OUTCOMES:** Students are able to

CO1. Explain the basic concepts of metrology and measurements. [K3]

CO2. Explain the principles of linear and angular measurement various methods. [K2]

CO3. Relate the principles and working of Interferometer & CMM. [K2]

CO4. Infer the working of straightness, Flatness, screw thread and gear teeth, surface finish, Roundness. [K4]

CO5. Explain the principles of Power, pressure and flow measurement through various methods [K2]

**UNIT I****Basics of Metrology**

Measurement – Need, process, role in quality control, Factors affecting measurement – SWIPE, Errors in Measurements – types, Measurement uncertainty – types, estimation, problems on estimation of uncertainty, Statistical analysis of measurement data, Measurement system analysis, Calibration of measuring instruments, ISO standards, Introduction to Systems of limits and fits- normal size, tolerance& limits, deviations, allowance, fits and their types.

**UNIT II****Linear and Angular Measurements**

Linear Measuring Instruments –vernier calipers, micrometer, telescopic gauge, height gauge, and depth gauge, Gauge blocks – use and precautions, Angular measuring instruments – bevel protractor, clinometers, angle gauges, angle dekkor, sine bar, angle alignment telescope, autocollimator.

**UNIT III****Advances in Metrology**

Lasers in metrology - advantages of lasers, laser scan micrometers, laser interferometers, Straightness, alignment, Ball bar tests, Computer Aided Metrology, Basic concept of CMM – Types of CMM, constructional features ,probes, accessories, software, applications, multi sensor CMMs, Machine Vision - Basic concepts of Machine Vision System, Elements, Applications, On-line and in-process monitoring in production, Computed tomography, White light Scanners.

#### **UNIT IV**

##### **Form Measurement**

Principles and Methods of straightness, Flatness measurement, Thread measurement, gear measurement, surface finish measurement, Roundness measurement.

#### **UNIT V**

##### **Measurement of Power, Displacement, Pressure and Temperature**

Force, torque, power - mechanical, pneumatic, hydraulic and electrical type, Displacement – inductive, capacitance, resistance, Pressure - Bourdon pressure gauges, bellows, diaphragm gauges, Temperature - bimetallic strip, thermocouples, electrical resistance thermometer.

#### **TEXTBOOKS**

1. Jain R.K. “Engineering Metrology”, 21<sup>st</sup> edition, Khanna Publishers, 2018.
2. Gupta. I.C., “Engineering Metrology”, 4<sup>th</sup> edition, Dhanpatrai Publications, 2018.

#### **REFERENCES**

1. R.K.Rajput, “Mechanical Measurements and Instrumentation”, 5<sup>th</sup> edition, S.K. Kataria & Sons, 2013.
2. Beckwith G and Thomas G, Mechanical Measurements, 6th Edition, Pearson Education, 2013.
3. M Mahajan, “Metrology” 2<sup>nd</sup> edition, Dhanpath Rai & Co, 2014.
4. Smith G T, Industrial Metrology, 1st Edition, Springer London, 2013.

<b>VI SEMESTER (ELECTIVE-II)</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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<b>19ME6E05: MECHANICAL VIBRATIONS</b>				

**COURSE OBJECTIVES:**

- To understand various levels of vibrations and remedies for each of them.
- To understand the fundamental knowledge on vibrating systems.
- To understand how to model the physical vibrating systems mathematically and the basic behavior of vibration measuring instruments and their industrial applications.

**COURSE OUTCOMES:** Students are able to

**CO1:** Summarize the basic concepts of vibrations and analyze simple free damped and undamped vibrations. [K4]

**CO2:** Analyze the response of damped and undamped systems subjected to harmonic excitation. [K4]

**CO3:** Analyze the response of systems subjected to forced vibrations with different kinds of loads. [K4]

**CO4:** Evaluate the vibration response of multi degrees of freedom systems. [K3]

**CO5:** Evaluate the vibration response of continuous systems. [K3]

**UNIT – I****FUNDAMENTALS OF VIBRATIONS AND FREE VIBRATIONS**

Basic concepts of vibration, Classification of vibrations, Vibration analysis procedure, spring elements, Mass or inertia elements, damping elements, Harmonic analysis. Free vibration of an undamped translational system, free vibration of an undamped torsional system, Stability conditions, Raleigh's energy method, free vibration with viscous damping, coulomb damping, hysteretic damping.

**UNIT – II****HARMONICALLY EXCITED VIBRATIONS**

Introduction, Equation of motion, Response of an undamped system under harmonic force, Response of a damped system under harmonic force, Response of a damped system under harmonic motion of the base, Response of a damped system under rotating unbalance, Forced vibration with coulomb damping, hysteresis damping.

**UNIT – III****FORCED VIBRATION AND TWO DEGREES OF FREEDOM**

Vibration Under General Forcing Conditions: Introduction, Response under a general periodic force, Response under a periodic force of irregular form, Response under a non-periodic force, Convolution integral. Vibration Measurement: Vibrometers, velocity meters & accelerometers

Two Degree of Freedom Systems: Introduction, Equation of motion for forced vibration, Free vibration analysis of an undamped system, Torsional system, Coordinate coupling and principal coordinates, Forced vibration analysis.

**UNIT – IV****MULTI-DEGREE OF FREEDOM SYSTEMS AND NUMERICAL METHODS**

Introduction, Modeling of Continuous systems as multi degree of freedom systems, Using Newton's second law to derive equations of motion, Influence coefficients, Free and Forced vibration of undamped systems, Forced vibration of viscously damped systems. Introduction to experimental model analysis.

Determination of Natural Frequencies and Mode Shapes: Introduction, Dunkerley's formula, Rayleigh's method, Holzer's method, Matrix iteration method, Jacobi's method.

**UNIT – V**

**CONTINUOUS SYSTEMS**

Exact and approximate solutions, Transverse vibration of a spring or a cable, Longitudinal vibration of bar or rod, Torsional vibration of a bar or rod, Lateral vibration of beams, critical speed of rotors. Case studies on formulation and response calculation.

**TEXT BOOKS:**

1. Singiresu S Rao , “Mechanical Vibrations ”, 4<sup>th</sup> Edition, Pearson education , 2011.

**REFERENCES:**

1. G.K. Grover, “Mechanical Vibrations ”, 7<sup>th</sup> Edition, Nem Chand & Bros , 2014.
2. W.T. Thomson, “Theory of Vibrations ”, 5<sup>th</sup> Edition, Addison-Wesley Publishing, 2003.

VI SEMESTER (ELECTIVE-II)	L	T	P	C
	3	-	-	3

**19ME5E06: AUTOMOBILE ENGINEERING**

**COURSE OBJECTIVE:** The main objectives of this course are

- To make the student familiar with fundamentals of automobiles.
- To gain knowledge about transmission systems and steering systems used in automobiles.
- To understand the important functions of braking and suspension systems.
- To inculcate the knowledge about various components of electrical systems, lubrication systems and safety systems used in automobiles.

**COURSE OUTCOMES:** The Students are able to

**CO1:** Classify and describe the different parts of an automobile engine. [ K2]

**CO2:** Explain working principle of transmission system and describe parts of transmission system. [K2].

**CO3:** Distinguish different steering components and steering [K2].

**CO4:** Explain working principle of various parts of automobile such suspension and braking systems. [K2 ]

**CO5:** Explain the various components of electrical systems, lubrication systems and safety systems used in automobiles. [K2]

#### UNIT I

**Introduction:** Classification of automobiles, Major components of four wheeler automobile – chassis and body , power plant, power transmission, Types of drives - rear wheel drive, front wheel drive, four wheel drive, Car body styles. Super charger and Turbo Charger - Crank case ventilation.

**Engine Specifications:** Engine Specifications with regard to power, speed, torque, number of cylinders and arrangement, lubrication and cooling systems.

#### UNIT II

**Transmission System:**

Clutches – single plate, multi plate, magnetic, centrifugal, semi centrifugal clutches, Fluid fly wheel, Gear boxes – sliding mesh, constant mesh, synchromesh gear boxes, epicyclic gear box, Torque Converter, Propeller shaft, Universal joint, Differential, Rear axle. Rear axle drives – hotchkiss drive, torque tube drive. Rear axle shaft supporting – semi floating, full floating, and three quarter float axles.

#### UNIT III

**Steering System:**

Steering geometry – camber, castor, king pin rake, combined angle toe-in, toe-out, Center point steering, Steering mechanism – Ackerman steering mechanism, Davis steering mechanism, Steering gears, Steering linkages.

#### UNIT IV

**Braking System:**

Braking Requirements, Types of Brakes - drum Brakes, disc Brakes, mechanical brakes, hydraulic brakes - master cylinder, wheel cylinder, Tandem master cylinder, Bleeding of hydraulic brakes, Pneumatic brakes, Vacuum brakes.

**Suspension System:**

Object of suspension systems, Types of suspension springs - Steel springs, Leaf springs, tapered leaf spring, coil spring and torsion bar, Telescopic shock absorber, Rigid axle suspension system, Independent axle suspension system – Wishbone type, MacPherson strut type, vertical guide type and swinging half axle type.

## **UNIT V**

### **Electrical System:**

Charging circuit, Generator circuit, Need for cut-out, Current voltage regulator, Bendix drive mechanism (Starting System), Solenoid switch, Horn, Wiper, Fuel gauge indicator, Lighting system.

### **Engine Lubrication:**

Engine lubrication- splash and pressure lubrication systems, Oil filters – Cartridge type, edge type and centrifugal type, Oil pumps – gear pump, rotor pump, vane pump and plunger pump.

### **Safety Systems:**

Introduction, Seat belt, Air bags, Bumper, Anti-lock brake system (ABS), Wind shield, Suspension sensors, Traction control, Speed control, Mirrors, Central locking, Electric windows.

### **TEXT BOOKS:**

1. Kirpal Singh, Automobile Engineering – Volume-1 and Volume-2, 12<sup>th</sup> Edition, Standard Publications, 2012.
2. R. K. Rajput, A Text book of Automobile Engineering, 2<sup>nd</sup> Edition, Lakshmi Publications, 2015.

### **REFERENCES:**

1. G. B. S. Narang, Automobile Engineering, 5<sup>th</sup> Edition, Khanna Publishers, 2015.
2. R.B. Gupta, Automobile Engineering, 7<sup>th</sup> Edition, Satya Prakashan Publications, 2010.
3. P.S Gill, Automobile Engineering, Volume 1&2, 2<sup>nd</sup> Edition, S.K. Kataria& Sons, 2012.



VI SEMESTER (ELECTIVE-II)	L	T	P	C
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**19ME5E07 - UNCONVENTIONAL MACHINING PROCESSES**

**COURSE OBJECTIVE:**

- To learn about various unconventional machining processes, the various process parameters and their influence on performance and their applications.

**COURSE OUTCOMES: Students are able to**

- CO1 Explain the need for unconventional machining processes and its classification [K2]  
 CO2 Compare various mechanical energy based processes. [K4]  
 CO3 Summarize various chemical and electro-chemical energy based unconventional machining processes. [K2]  
 CO4 Illustrate about electrical based unconventional machining processes.[K2]  
 CO5 Describe various Nano abrasives based unconventional machining processes. [k2]

**UNIT – I****Introduction**

Need for non-traditional machining methods-Classification of modern machining processes, considerations in process selection, materials, applications, comparison of traditional and non-traditional machining methods

**Recent Developments** Non-traditional machining processes, working principles, equipments, effect of process parameters, applications, advantages and limitations.

**UNIT – II****Cold cutting Process**

Abrasive Jet Machining (AJM), Water Jet Machining (WJM) and Abrasive Water Jet Machining (AWJM) - Basic principles, process variables, process Mechanism of metal removal, applications and limitations. Ultrasonic Machining - Elements of the process, mechanics of metal removal process parameters, economic considerations, applications and limitations, recent development.

**UNIT – III****Chemical and Electro-chemical energy based processes**

Chemical machining and Electro-Chemical machining (CHM and ECM), Etchants, Maskant, techniques of applying maskants, Process Parameters, surface finish and MRR, Applications. Principles of ECM - equipment, Surface Roughness and MRR Electrical circuit, process Parameters, ECG and ECH - Applications.

**UNIT – IV****Electric discharge machining:**

General Principle and applications of Electric Discharge Machining, Electric Discharge Grinding and electric discharge wire cutting processes, Power circuits for EDM, Mechanics of metal removal in EDM, Process parameters, selection of tool electrode and dielectric fluids, methods surface finish and machining accuracy, characteristics of spark eroded surface and machine tool selection. Wire EDM, principle, applications.

**UNIT – V****High energy beam machining:**

Laser Beam Machining (LBM), Electron Beam Machining (EBM), Plasma Beam Machining (PBM) - Mechanism of metal removal, process characteristics, accuracy and surface quality, application

**Advanced Nano finishing processes**

Abrasive flow machining, chemo-mechanical polishing, magnetic abrasive finishing their working principles, equipments, effect of process parameters, applications, advantages and limitations.

**TEXT BOOKS:**

1. Vijay.K. Jain “Advanced Machining Processes” Allied Publishers Pvt. Ltd., New Delhi, 1<sup>st</sup> edition, 2010
2. Gary F. Benedict. “Nontraditional Manufacturing Processes” CRC Press, 1<sup>st</sup> edition, 2017.

**REFERENCES:**

1. Suneev Anil Bansal “Advances in Nonconventional Machining Processes”, Bentham Science Publishers, 1<sup>st</sup> edition, 2020.
2. J. Paulo Davim “Nontraditional Machining Processes Research Advances”, Springer London, 1<sup>st</sup> edition, 2013.
3. J. Paulo Davim, Kaushik Kumar, Nisha Kumari, “Non-Conventional Machining in Modern Manufacturing Systems” IGI Global., 3<sup>rd</sup> Edition , 2018.

<b>VI SEMESTER (ELECTIVE-II)</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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<b>19ME6E08 - INDUSTRIAL ENGINEERING AND MANAGEMENT</b>				

**COURSE OBJECTIVES**

1. To impart fundamental knowledge and skill sets required in the Industrial Management and Engineering profession, which include the ability to apply basic knowledge of mathematics, probability and statistics, and the domain knowledge of Industrial Management and Engineering.
2. To produce graduates with the ability to adopt a system approach to design, develop, implement and innovate integrated systems that include people, materials, information, equipment and energy.
3. To enable students to understand the interactions between engineering, business, technological and environmental spheres in the modern society.
4. To enable students to understand their role as engineers and their impact to society at the national and global context.

**COURSE OUTCOMES**

Students are able to

CO1. Explain management principles and integrate these principles into job situations.[K2]

CO2. Interpret the techniques of work study, and time study. [K2]

CO3. Explain layouts of manufacturing operations.

CO4. Explain the principles of material handling and materials management.[K2]

CO5. Explain the quality control techniques and decision-making concept.[K2]

**UNIT - I**

**MANAGEMENT SCIENCE:** Basic concepts of Management, Contribution of Taylor and Fayol to Scientific Management, Motivation and Control, Maslow's hierarch of needs, Leadership styles, Managerial Grid.

**UNIT - II**

**WORK STUDY:** Introduction, Techniques of work study, Method study- procedure, recording techniques, Principles of motion economy, Micro-motion analysis, Work measurement – Time study, work/activity sampling, Predetermined motion time standards, Job evaluation and Merit rating- Procedure and Methods.

**UNIT - III**

**PLANT LOCATION:** Importance and factors affecting plant location, Single and Multi- facility plant location problems.

**PLANT LAYOUT:** Need, Importance, Objectives and Principles of good plant layout, Types of layout and applications.

#### **UNIT-IV**

**MATERIAL HANDLING:** Principles of material handling, Types of material handling equipment and selection.

**MATERIALS MANAGEMENT:** Objectives, Inventory control- Purpose, types, functions, basic EOQ, safety stock inventory control systems, selective control of inventory ABC and VED analysis, Inventory control system-periodic review system, Store Management and stores record, purchase management.

#### **UNIT - V**

**DECISION MAKING:** Introduction, Decision making environments, Decision tree analysis.

**INSPECTION AND QUALITY CONTROL:** Types of Inspections, Statistical Quality Control techniques, acceptance sampling plan, Introduction to Total Quality Management, Quality Circles, ISO 9000 series procedures.

#### **TEXT BOOKS**

1. Kumar Pravin, Industrial Engineering and Management, 2<sup>nd</sup> edition, Pearson India, 2015.
2. S.C. Sharma, T.R. Banga, Industrial Engineering and Management, 1<sup>st</sup> edition, Khanna publishing house, India, 2019.

#### **REFERENCE BOOKS**

1. Kaushik Kumar, Divya Zindani, Industrial Engineering and Management, 1<sup>st</sup> edition, I K. International pvt. ltd, 2021.
2. O. P. Khanna, Industrial Engineering and Management, Revised edition, Dhanpat Rai Publications, 2018.

SEMESTER-VI (ELECTIVE-II)	L	T	P	C
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**19CS5E22 - INTERACTIVE COMPUTER GRAPHICS**

**COURSE OUTCOMES:**

1. Define the operations of Display Devices and develop algorithms for graphics primitives
2. Draw lines, circles, ellipse and Design 2D-object Transformations and Viewing.
3. Illustrate 3D-object representations, Transformations and Viewing.
4. Analyze different Visibility Detection methods
5. Develop simple Graphics Animation Applications.

**UNIT- I:**

**Introduction:** Application areas of Computer Graphics, Overview of Graphics Systems: video-display devices, raster-scan systems, random scan systems, storage tube graphics display, Raster scan display and input devices.

**Output primitives :** Points and lines, line drawing algorithms: DDA, Bresenham's, Mid-point circle and ellipse algorithms. Filled area primitives: Scan line polygon fill algorithm, boundary-fill and flood-fill algorithms.

**UNIT- II:**

**2-D geometrical transforms:** Translation, scaling, rotation, reflection and shear transformations homogeneous coordinates, composite transforms, transformations between coordinate systems.

**2-D viewing :** The viewing pipeline, viewing coordinate reference frame, window to view-port coordinate transformation, Cohen-Sutherland and Liang-Barsky line clipping algorithms, Sutherland –Hodgeman polygon clipping algorithm

**UNIT- III:**

**3-D Object Representation:** Polygon surfaces, quadric surfaces, spline representation, Hermite curve, Bezier curve and Surfaces. 3-D Geometric transformations: Translation, Rotation, Rotation about an arbitrary axis in space, scaling, reflection and shear transformations, composite transformations

**UNIT- IV:**

**3-D Viewing :** Viewing pipeline, Viewing Coordinates, View Volume, Projections: Parallel Projection, Perspective Projections Clipping.

**Visible Surface Detection Methods:** Classification, back-face detection, depth-buffer, scan-line, depth sorting, BSP-tree methods, Area Sub-division and Octree methods

**UNIT –V:**

**Computer Animation:** Design of Animation Sequence, General Computer Animation Functions, Raster Animation, Computer Animation Languages, Key Frame, Motion Specifications. Introduction to Multimedia.

**TEXT BOOKS:**

1. Computer Graphics C version, Donald Hearn, M. Pauline Baker, Pearson
2. Z. Xiang, R. Plastock – “Schaum’s outlines Computer Graphics (2nd Ed.)” – TMH

**REFERENCE BOOKS:**

1. Computer Graphics Principles & practice, 2/e, Foley, VanDam, Feiner, Hughes, Pearson .
2. Computer Graphics, Zhigandxiang, Roy Plastock, Schaum's outlines, 2/E, TMH.
3. Procedural elements for Computer Graphics, David F Rogers, 2/ e, TMH.
4. Principles of Interactive Computer Graphics, Neuman ,Sproul, TMH Principles of Computer Graphics, ShaliniGovil, Pai, 2005, Springer

VI SEMESTER (ELECTIVE-III)	L	T	P	C
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**19ME6E09 - VEHICLE DYNAMICS AND CONTROL**

**COURSE OBJECTIVES:**

- To develop the basic knowledge of the students in automotive field in the areas of vehicle vibrations.
- To develop the skills of the students in the tire dynamics with respect to force & moments.
- To acquire knowledge on different effects on the dynamic characteristics of the vehicle
- To gain knowledge on aerodynamic forces & moments, load distribution in the various vehicles
- To develop knowledge on testing of effective steering geometry, vehicle handling & directional control of vehicle

**COURSE OUTCOMES:** Students are able to

- CO1:** Explain the basics of vibration when the vehicle is at dynamic condition. [K2]
- CO2:** Explain the tire dynamics with respect to force & moments. [K2].
- CO3:** Derive the effective cornering stiffness when considering the elastic elements in the wheel suspension and be able to analyze effect on the dynamic characteristics of the vehicle [K3]
- CO4:** Explain the aerodynamic forces & moments, load distribution in the various vehicles [K2]
- CO5:** Explain the effective steering geometry, vehicle handling & directional control of vehicle [K3]

**UNIT – I: CONCEPT OF VIBRATION:**

Definitions, Modeling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Undamped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification Factor, Transmissibility, Vibration Absorber, Vibration Measuring Instruments, Torsional Vibration, Critical Speed.

**UNIT – II: TIRE DYNAMICS**

Tire Forces and Moments, Tire Structure, Longitudinal and Lateral Force at Various Slip Angles, Rolling Resistance, Tractive and Cornering Property of Tire. Performance of Tire on Wet Surface. Ride Property of Tires. Magic Formulae Tire Model, Estimation of Tire Road Friction. Test on Various Road Surfaces. Tire Vibration.

**UNIT – III: VERTICAL DYNAMICS**

Human Response to Vibration, Sources of Vibration. Design and Analysis of Passive, Semi-Active and Active Suspension Using Quarter Car, Half Car and Full Car Model. Influence of Suspension Stiffness, Suspension Damping, and Tire Stiffness. Control Law for LQR, H-Infinite, Skyhook Damping. Air Suspension System and Their Properties.

**UNIT – IV: LONGITUDINAL DYNAMICS**

Aerodynamic Forces and Moments. Equation of Motion. Resistance, Rolling Resistance, Load Distribution for Three Wheeler and Four Wheeler. Calculation of Maximum Acceleration, Reaction Forces for Different Drives. Braking and Driving Torque. Prediction of Vehicle Performance.

**UNIT – V: LATERAL DYNAMICS**

Steady State Handling Characteristics. Steady State Response to Steering Input. Testing of Handling Characteristics. Transient Response Characteristics, Direction Control Of Vehicles Roll Center, Roll Axis, Vehicle Under Side Forces. Stability of Vehicle Running on Slope, Banked Road and During Turn, Effect of

Suspension on Cornering, Latest Trends in Vehicle Dynamic Testing Like Four Poster, Multi Axis Simulator, etc.

### **TEXT BOOKS**

1. Singiresu S. Rao, Mechanical Vibrations, 5th Edition, Prentice Hall, 2010.
2. Martin Meywerk, Vehicle Dynamics, 1<sup>st</sup> edition, John Wiley, 2015 .
2. Wong. J. Y., Theory of Ground Vehicles, 3rd Edition, Wiley-Inter science, 2014.
3. Rajesh Rajamani, Vehicle Dynamics and Control, 1st edition, Springer, 2015.

### **REFERENCES**

1. Dean Karnopp, Vehicle Stability, 1st edition, Marcel Dekker, 2014.
2. Nakhaie Jazar. G., Vehicle Dynamics: Theory and Application, 1st edition, Springer, 2015.



VI SEMESTER (ELECTIVE-III)	L	T	P	C
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**19ME7E14 - STEAM AND GAS POWER SYSTEMS**

**COURSE OBJECTIVES:**

- To learn the working and performance of vapour power cycles
- To learn the different types of boilers and steam nozzles and their performance parameters.
- To learn the different types of steam turbines.
- To learn the types of condensers and their performance parameters.
- To understand the principle of jet propulsion and working principles of various jet engines and rocket engines.

**COURSE OUTCOME:** Students are able to

CO1: Analyze and compare the performance of different vapour power cycles [K4]

CO2: Describe working of high pressure boilers and analyze the performance steam nozzles. [K4]

CO3: Describe the working and analyze the performance of both impulse and reaction turbines. [K4]

CO4: Explain the working and analyze the performance of different condensers. [K4]

CO5: Describe the working of gas turbines and jet propulsion principles. [K2]

**UNIT – I**

**VAPOUR POWER CYCLES:**

Rankine cycle- schematic layout, thermodynamic analysis, Methods to improve cycle performance – regeneration, reheating, Binary vapour cycle, Fuels and combustion-classification of fuels, stoichiometric air fuel ratio, Exhaust gas analysis-Orsat apparatus, Adiabatic flame temperature.

**UNIT – II**

**STEAM BOILERS:**

Classification of steam boilers, Description of high and supercritical boilers -LaMont boiler, Benson boiler, Loeffler boiler, Use of various mountings and accessories of steam boiler.

**STEAM NOZZLES:**

Nozzle shapes, Thermodynamic analysis – assumptions, critical pressure ratio, nozzle efficiency, Super saturated flow- its effects, Degree of super saturation and degree of under cooling - Wilson line.

**UNIT – III**

**STEAM TURBINES:**

Classification, Impulse turbine - velocity diagram, effect of friction, power developed, axial thrust, blade or diagram efficiency, condition for maximum efficiency, Methods to reduce rotor speed-velocity compounding, pressure compounding, combined velocity diagram for a velocity compounded impulse turbine. 106

Reaction turbine-Principle of operation, Thermodynamic analysis of Parson's reaction turbine - degree of reaction, velocity diagram, condition for maximum efficiency, calculation of blade height.

**UNIT – IV**

**STEAM CONDENSERS:**

Classification - jet condenser, surface condensers, requirements, advantages, Daltons law of partial pressures, Measurement of vacuum in a condenser - vacuum efficiency, condenser efficiency, mass of cooling water required, Sources of air leakages into condenser, Effects of air leakage.

#### **UNIT – V**

**GAS TURBINES:** Simple gas turbine plant – ideal cycle, essential components, Parameters of performance– regeneration, inter cooling and reheating, Actual cycle, Closed and semi-closed cycles – merits and demerits, Types of combustion chambers.

**JET PROPULSION :** Principle of operation, Classification of jet propulsive engines – working principles with schematic diagrams and representation on T-s diagram, Thrust, thrust power and propulsive efficiency, Turbo jet engines – schematic diagram, thermodynamic cycle, Performance evaluation, Thrust augmentation – methods.

#### **TEXT BOOKS:**

1. Sadhu Singh, Thermal Engineering, Pearson India Publications, 3<sup>rd</sup> Edition, 2018
2. R. K. Rajput, Thermal Engineering, Lakshmi Publications, 10<sup>th</sup> Edition, 2018
3. Mahesh M Rathore . Thermal Engineering, Tata McGraw Hill, 4th Edition, 2010
4. V. Ganesan, Gas Turbines, TMH, 3<sup>rd</sup> Edition, 2010

#### **REFERENCES:**

1. Yunus A. Çengel, Michael A. Boles, Thermodynamics: An Engineering Approach, McGraw-Hill, 8<sup>th</sup> Edition, Reprint, 2014
2. P.K.Nag,“Engineering Thermodynamics” 6<sup>th</sup>edition,Tata McGraw Hill Education Private Limited,2017.
3. R. S Khurmi and J. S. Gupta , Thermal Engineering, 4<sup>th</sup>edition, S. Chand Company limited, 2009.

<b>VI SEMESTER (ELECTIVE-III)</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
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<b>19ME6E11- AUTOMATION IN MANUFACTURING</b>				

**COURSE OBJECTIVE:** The main objective of this course is

- To study the types and strategies and various components in Automated Systems.
- To understand the automated flow lines, line balancing, material storage and retrieval and inspection.
- To understand the automated assembly systems, part delivery, workstation, single and multi-station Assembly machines.
- To impart the necessary basic concepts of Automated Material Handling And Storage Systems, Types of equipment, functions, conveyor systems, automated guided vehicle systems.
- To impart the knowledge on application of adaptive control in machining operations, types of inspection methods and equipment.

**COURSE OUTCOMES:** Students are able to

- CO1.** Explain the types, strategies and various components in Automated Systems. (K2)
- CO2.** Solve the line balancing problems in the various flow line systems with and without use buffer storage. (K3)
- CO3.** List the various automated assembly systems, part delivery and workstation (K1)
- CO4.** Classify the different automated material handling, storage and retrieval systems (K2)
- CO5.** Understand the different automated inspection systems. Use of Adaptive Control principles and implement the same online inspection and control (K2)

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#### **UNIT-I:**

**Introduction:** Types and strategies of automation, pneumatic and hydraulic components, circuits, automation in machine tools, mechanical feeding and tool changing and machine tool control. Advantages and disadvantages of Automation in Manufacturing.

#### **UNIT-II:**

**Automated Flow Lines:** Methods of part transport, transfer mechanism, buffer storage, control function, design and fabrication considerations. Analysis of automated flow lines – General terminology and analysis of transfer lines without and with buffer storage, partial automation, implementation of automated flow lines.

#### **UNIT-III:**

**Automated Assembly Systems,** Fundamentals of Automated Assembly Systems, Design for Automated Assembly, and Quantitative Analysis of Assembly Systems - Parts Delivery System at Work Stations, Multi-Station Assembly Machines, Single Station Assembly Machines, Partial Automation

#### **UNIT-IV:**

**Automated material handling and storage systems:** Types of equipment, functions, analysis and design of material handling systems, conveyor systems, automated guided vehicle systems, Monorails and other Rail Guided Vehicles. Automated storage and retrieval systems; work in process storage, interfacing handling and storage with manufacturing.

**Automatic Identification methods:** Overview, bar code technologies, radio frequency identification, other technologies.

**UNIT-V:**

**Adaptive Control Systems:** Introduction, adaptive control with optimization, adaptive control with constraints, application of adaptive control in machining operations. Consideration of various parameters such as cutting force, temperatures, vibration in the adaptive controls systems.

**Automated Inspection:** Fundamentals, types of inspection methods and equipment, Coordinate Measuring Machines, Machine Vision,

**TEXT BOOK**

1. Mikell P. Groover, Automation Production Systems and Computer Integrated Manufacturing, 4<sup>th</sup> Edition, Pearson Education, 2016.
2. P.Radhakrishnan, S.Subramanyam, V.Raju, CAD / CAM/ CIM, 4<sup>th</sup> Edition, New Age International Pvt Ltd, 2018.
3. P. N. Rao, "CAD /CAM – Principles and Applications", 2nd Ed., Tata McGraw Hill, 2004.

**REFERENCES**

1. Ibrahim Zeid and R. Sivasubramanian, "CAD / CAM – Theory and Practice", 2<sup>nd</sup> Edition, Tata McGraw Hill, 2010.
2. Dr Chris McMahon and Prof Jimmie Browne, CAD/CAM: Principles, Practice and Manufacturing Management, 2<sup>nd</sup> Edition, Prentice Hall, 1998.

VI SEMESTER (ELECTIVE-III)	L	T	P	C
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**19ME6E12 - TOTAL QUALITY MANAGEMENT**

**COURSE OBJECTIVES:**

- To understand the concept of Quality
- To understand the principles of quality, customer focus and satisfaction.
- To understand statistical process control.
- To implement TQM tools and techniques.
- To implement quality systems.

**COURSE OUTCOMES:** Students are able to

CO1: Explain the concept of Total Quality Management and discriminate product and service quality (K2)

CO2: Analyze various principles of Total Quality Management that are practically applicable. (K4)

CO3: Illustrate different Statistical Quality Control methods. (K4)

CO4: Distinguish various tools and techniques of Total Quality Management and Recognize the importance of six sigma in Quality Management (K4)

CO5: Evaluate the various ISO standards that are used for testing the quality of a product in the present scenario (K4)

**UNIT I**

**INTRODUCTION**

Introduction - Need for quality, Evolution of quality, Definitions of quality, Dimensions of product and service quality, Basic concepts of TQM, TQM Framework, Contributions of Deming, Barriers to TQM.

**UNIT II**

**TQM PRINCIPLES**

Leadership, Strategic quality planning, Quality Councils, Employee involvement, Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal, Continuous process improvement, PDCA cycle, 5S, Kaizen

**CUSTOMER FOCUS AND SATISFACTION:**

The importance of customer satisfaction and loyalty- Crating satisfied customers, Understanding the customer needs, Process Vs. Customer, internal customer conflict, quality focus, Customer Satisfaction

**UNIT III**

**STATASTICAL PROCESS CONTROL**

Significance of statistical process control (SPC), Construction of control charts for variables and attributed, Process capability – significance and measurement, concepts of process capability. Business process Improvement (BPI)– principles, applications, reengineering process, benefits and limitations

**UNIT IV**

**TQM TOOLS AND TECHNIQUES**

The seven traditional tools of quality, New management tools, Six sigma- concepts, methodology, applications to manufacturing, service sector including IT, Bench marking- reason to benchmark, benchmarking process, FMEA - stages, types. Control Charts, Process Capability, Quality Function

Development (QFD), Taguchi quality loss function, Total Productive Maintenance (TPM)– concepts, terotechnology, improvement needs, performance measures.

## **UNIT V**

### **QUALITY SYSTEMS**

Need for ISO 9000, ISO 9001-2008 Quality System, Elements, Documentation, Quality Auditing, QS 9000, ISO 14000, Concepts, Requirements and Benefits, TQM Implementation in manufacturing and service sectors.

### **TEXTBOOKS**

1. Besterfield Dale H., Besterfield Carol., Besterfield Glen H., Besterfield Mary, Urdhwareshe Hemant, Urdhwareshe Rashmi, Total Quality Management (TQM), 5th Edition, Pearson Publication, 2018.
2. Dr. Gunmala Suri and Dr. Puja Chhabra Sharma, Total Quality Management, 1st Edition, Wiley India- - 2013.

### **REFERENCES**

1. Poornima M. Charantimath, Total Quality Management, 3<sup>rd</sup> Edition, Pearson Education, 2017.
2. Subburaj Ramasamy, Total Quality Management, 1<sup>st</sup> Edition, McGraw Hill, 2009.

VI SEMESTER (ELECTIVE-III)	L	T	P	C
	3	-	-	3
<b>19CS6E23 - OBJECT ORIENTED PROGRAMMING THROUGH JAVA</b>				

**COURSE OUTCOMES:**

At the end of the course student able to

1. Describe the differences between procedural oriented programming and object oriented programming (OOP) paradigms, Apply OOP Concepts.
2. Explain Java features and Java Concepts.
3. Illustrate the concepts of Inheritance and polymorphism.
4. State and Implement the Packages and Interfaces.
5. State and Apply Exception handling Concepts.
6. Apply the concepts of Multithreading.

**UNIT -I**

**Basics of Object Oriented Programming:** Introduction to OOP: Paradigms of Programming Languages - Basic concepts of Object Oriented Programming – Differences between Procedure Oriented Programming and Object Oriented Programming - Objects and Classes – Data abstraction and Encapsulation, Inheritance, Polymorphism, Dynamic binding, Message communication – Benefits of OOP – Application of OOPs. Introduction to Java: History – Java features, Creating and Executing a Java program – Java Tokens: Keywords, Character set, Identifiers, Literals, Comments in Java program Separator – Java Virtual Machine (JVM).

**UNIT -II**

**Java Basics** Data types, variables, scope and life time of variables, arrays, operators, expressions, control Statements, type conversion and casting, simple java program, classes and objects – concepts of classes, objects, constructors, methods, access control, this keyword, garbage collection, overloading methods and constructors, parameter passing, recursion and string handling methods.

**UNIT -III**

**Inheritance:** Defining a subclass – Deriving a sub class – Single Inheritance – Multilevel Inheritance – Hierarchical Inheritance – Overriding methods – Final variables and methods – Final classes - Abstract methods and classes – Visibility Control: public access, private access, protected. Member access rules, super keyword and abstract keyword.

**UNIT-IV****Packages and Interfaces:**

Packages: Defining, Creating and Accessing a Package, Understanding Class path, importing packages.

Interfaces: Defining an interface, implementing interface, Differences between classes and interfaces, variables in interface and extending interfaces.

**UNIT-V**

**Exception handling:** Concepts of exception handling, benefits of exception handling, exception hierarchy, usage of try, catch, throw, throws and finally keywords, built-in and user defined exceptions.

**Multithreading:** Define thread, Differences between multi-threading and multitasking, Creating Threads, Running Thread, Life Cycle of a Thread, Thread Methods, Thread Priority, Synchronization, Implementing runnable interface and thread groups.

**Text Books:**

1. Herbert Schildt: “Java The complete reference”, 7th Edition, Tata McGraw Hill, 2011.

2. E.Balaguruswamy: "Programming with Java A Primer", 4th Edition, Tata McGraw Hill, 2009.

**Reference Books:**

1. Programming in Java by saurabh chaudhary , sachin malhotra, oxford edition.
2. Java: How to Program, 8/e, Dietal, Dietal, PHI
3. JAVA Programming, K.Rajkumar, Pearson.
4. Core JAVA, Black Book, NageswaraRao, Wiley, Dream Tech.



VI SEMESTER	L	T	P	C
	-	-	4	2

**19ME6L01- HEAT TRANSFER LAB**

**COURSE OBJECTIVES:**

- To impart necessary skills to perform analysis and interpret results to draw valid conclusions on modes of heat transfer.
- To determine thermal properties and performance of radiation heat transfer, heat exchanger.

**COURSE OUTCOMES:** Students are able to

- CO1. Determine the thermal resistance, thermal conductivity of composite wall [K3]  
 CO2. Determine the temperature distribution, efficiency and effectiveness of a fin.[K3]  
 CO3. Determine the convective heat transfer co- efficient and the rate of heat transfer by natural and forced convection [K3]  
 CO4. Calculate LMTD, Effectiveness and overall heat transfer coefficient for the parallel flow and counter flow heat exchangers [K3]  
 CO5. Determine critical heat flux of given Nicrome wire and Emissivity of the given gray body.[K3]

**LIST OF EXPERIMENTS**

1. Determine the thermal resistance, thermal conductivity of composite wall.
2. Determine the thermal conductivity of lagged material for the given pipe.
3. Determine the thermal conductivity of given insulating powder.
4. Determine the thermal conductivity of given metal rod.
5. Determine the temperature distribution, efficiency and effectiveness of a pin fin.
6. Determine heat transfer co efficient and heat transfer rate for a heated vertical cylinder in natural convection.
7. Determine the convective heat transfer co- efficient and the rate of heat transfer by forced convection for flow of air.
8. Determine LMTD, Effectiveness and overall heat transfer coefficient for the parallel flow and counter flow heat exchangers.
9. Determine critical heat flux of given Nicrome wire.
10. Determine the Emissivity of the given gray body.

<b>VI SEMESTER</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	-	-	<b>3</b>	<b>1.5</b>
<b>19ME6L02 METROLOGY AND INSTRUMENTATION LAB</b>				

**COURSE OBJECTIVES**

1. Measurement of linear and angular dimensions
2. Measurement of pressure, flow, speed, displacement and temperature.

**COURSE OUTCOMES**

- CO1: Students are able to measure the given mechanical elements and assemblies using linear and angular measuring instruments.
- CO2: Students are able to select and measure variables using appropriate sensors and transducers.

**LIST OF EXPERIMENTS:**

1. Measurement of lengths and diameters by using vernier caliper and micrometer.
2. Measurement of central distance between two holes by using vernier height gauge.
3. Measurement of gear tooth profile using gear tooth vernier.
4. Angle and taper measurements by Bevel protractor, Sine bar.
5. Thread measurement by using Tool maker’s microscope.
6. Calibration Of Strain Gauge for Temperature Measurement
7. Study And Calibration of Photo and Magnetic Speed Pickups for The Measurement Of Speed
8. Calibration of hot wire anemometer for temperature measurement.
9. Calibration of Thermistor for Temperature Measurement.
10. Calibration of thermocouple for temperature measurement.
11. Study of resistance temperature detector for temperature measurement.
12. Study and calibration of LVDT transducer for displacement measurement
13. Calibration of capacitive transducer for angular displacement.
14. Pressure measurement using strain gauge setup.

**Note: Any 10 experiments from the above experiments to be conducted**

<b>VI SEMESTER</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	-	-	<b>2</b>	<b>1.0</b>
<b>19HS6L03: ADVANCED ENGLISH COMMUNICATION SKILLS</b>				

At the end of the course students will be able to prepare themselves for their career which may require them to listen and speak in English both for their professional and interpersonal communication in the globalized context.

## Course objectives

- Analyzing a topic of discussion and relating to it.
- Planning and executing an assignment creatively.
- Presenting ideas coherently within a stipulated time.
- Communicating ideas effectively in prescribed oral activities.
- Applying relevant writing formats for resume and presentations.
- Facing interviews with confidence.

## Course outcomes

At the end of the course students will be able to

- Gather ideas and organize information relevantly and coherently
- Participate in group discussions and face interviews with confidence
- Write Resume with covering letter
- Make oral presentations and public speaking
- Take part in social and professional communication.

## SYLLABUS

The following course content is prescribed for the **Advanced English Communication Skills Lab:**

### UNIT I

#### Communication Skills

- Introduce Yourself
- JAM
- J2M
- Identifying one's career objective, projecting strengths and skills, organization of ideas within given time.

### UNIT II

#### Interaction Skills

- Body Language
- Role- Plays
- Students start a conversation - Respond appropriately and relevantly in different situations with right body language.

### UNIT III

#### Oral Skills

- Presentations
- Public Speaking
- Planning preparation and presentation - organization of ideas with clarity , coherence and style.

#### **UNIT IV**

##### **Writing Skills**

- Covering Letter
- Resume Writing

➤ To communicate the ideas relevantly and coherently in writing.

#### **UNIT V**

##### **Team Work Skills**

- Group Discussion

➤ Dynamics of Group Discussion - Modulation of voice, Body language , relevance , fluency and coherence.

#### **UNIT VI**

##### **Interview Skills**

➤ Pre-interview planning, opening strategies, answering strategies, interview through tele and video conference.

#### **Reference Books:**

1. Ashraf Rizvi- Effective Technical Communication - McGraw Hill Education- 2017.
2. Madhavi Apte - A Course in English Communication – Prentice - Hall of India- 2007.
3. Dr. Shalini Verma - Body Language – Your Success Mantra- S. Chand- 2006.
4. Sunita Mishra & C.Murali Krishna- Communication Skills for Engineers - Pearson Education - 2007.

VI SEMESTER	L	T	P	C
	2	-	-	-
<b>19GE0M03: PROFESSIONAL ETHICS AND INTELLECTUAL PROPERTY RIGHTS</b>				

**COURSE OUTCOMES:**

**Students are able to**

- CO1.**Identify the professional roles played by an engineer and illustrate the process of Social experimentation
- CO2.**Determine Engineer’s responsibilities and rights towards the society
- CO3.**Analyze various aspects of Intellectual Property Rights and recognize the process of protecting the copyrights
- CO4.**Describe the registration process of Patents and trademarks and also demonstrate the concept of trade secrets and cybercrimes

**UNIT-I**

**ENGINEERING ETHICS:**

Importance of Engineering Ethics—Professional and Professionalism –Professional Roles to be played by an Engineer –Professional Ethics.

**UNIT-II**

**ENGINEERING AS SOCIAL EXPERIMENTATION :**

Role of engineering in knowledge society- Knowledge acquired – Conscientiousness – Relevant Information –Engineers as Managers, Consultants, and Leaders.

**ENGINEERS’ RESPONSIBILITY FOR SAFETY AND RISK:** Role and importance of Safety and risk-Types of Risks –Threshold Levels for Risk– RiskBenefit Analysis.

**UNIT-III**

**ENGINEERS’ RESPONSIBILITIES AND RIGHTS:**

Collegiality-Conflict of Interest-solving conflict problems – Ethical egoism-Collective bargaining - Confidentiality-Acceptance of Bribes/Gifts--Occupational Crimes-industrial espionage-Whistle Blowing-types of whistle blowing.

**UNIT IV**

**INTELLECTUAL PROPERTY AND COPY RIGHTS:**

Introduction to Intellectual Property Law - Types ofIntellectual Property – Infringement,Copyrights:Introduction to Copyrights – Principles of Copyright – Rights Afforded byCopyright Law –Copyright Formalities and Registration.

**UNIT-V**

**PATENTS AND TRADEMARKS:**

Introduction to Patent Law –Rights under Patent Law – Patent Requirements – Patent Application Process and Granting of Patent – Double Patenting – Patent Cooperation Treaty. Trademarks:Introduction to Trade Mark – Trade Mark Registration Process – Trade Markmaintenance – Likelihood of confusion

**TEXT BOOKS:**

1. M.Govindarajan, S.Natarajan and V.S.SenthilKumar- “Engineering Ethics and Human Values” by PHI Learning Pvt. Ltd-2009.
2. Deborah E.Bouchoux, “Intellectual Property”. Cengagelearning , NewDelhi, BS Publications (Press)
3. PrabhuddhaGanguli, ‘ Intellectual Property Rights” Tata Mc-Graw – Hill, New Delhi

VII SEMESTER	L	T	P	C
	3	-	-	3

**19ME7T01: 3D PRINTING AND DESIGN****COURSE OBJECTIVES:**

- To explore technology used in additive manufacturing.
- To acquire knowledge for selecting correct CAD formats in manufacturing process.
- To understand the operating principles and limitations of liquid, solid and laser based additive manufacturing system.
- To design the process of additive manufacturing including tools used for design.
- To acquire knowledge on important process parameters for bio-manufacturing

**COURSE OUTCOMES:** Students are able to

**CO1:** To impart the fundamentals of Additive Manufacturing Technologies for engineering applications. [K2]

**CO2:** Select and use correct CAD formats in the manufacture of a 3D printed part.[K2]

**CO3:** Explain the operating principles, capabilities, and limitations of liquid, solid and laser based additive manufacturing system. [K2]

**CO4:** Enumerate the design process for additive manufacturing including tools used for design and some features required for design. [K2]

**CO5:** Describe the important process parameters for bio-manufacturing and determine the suitable additive technique for bio-manufacturing, aerospace and manufacturing engineering.[K2]

**UNIT I****INTRODUCTION**

3D printing Overview, History , Need, Classification ,Additive Manufacturing Technology in product development, Materials for Additive Manufacturing Technology

**UNIT II****REVERSE ENGINEERING**

Basic Concept –3D Scanning Digitization techniques, Model Reconstruction, Data Processing for Additive Manufacturing Technology, Part Orientation and support generation, Model Slicing, Tool path Generation.

**UNIT III****ADDITIVE MANUFACTURING SYSTEMS**

**SOLID& LIQUID BASED-** Classification , Stereo lithography Apparatus (SLA) - Principle, process, advantages, Fused Deposition Modeling – Principle, process, advantages.

**LASER BASED** - Selective Laser Sintering – Principle, Process, advantages, Three Dimensional Printing – Principle, process, advantages - Laser Engineered Net Shaping (LENS)

**UNIT IV****DESIGN FOR AM**

Motivation, Design for Manufacturing and Assembly (DFMA)- concepts and objectives, AM unique capabilities, Exploring design freedoms, Design tools for AM - Part Orientation, Removal of Supports,

Hollowing out parts, Inclusion of Undercuts, Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers etc.

## **UNIT V**

### **APPLICATIONS OF 3D PRINTING.**

Customized implants and prosthesis: Design and development, Bio-Additive Manufacturing- Computer Aided Tissue Engineering (CATE), Applications of 3D Printing in Aerospace, Automotive, Manufacturing and Architectural Engineering.

### **TEXT BOOKS**

1. Chua C.K., Leong K.F., and Lim C.S., Rapid prototyping: Principles and applications, Third Edition, World Scientific Publishers, 2016.
2. Gebhardt A, Rapid prototyping, Hanser Gardener Publications, 2017.
3. Chee Kai Chua, Kah Fai Leong, 3D Printing and Additive Manufacturing: Principles and Applications, World Scientific Publishers, Fourth Edition of Rapid Prototyping, 2018.

### **REFERENCES**

1. Liou L.W. and Liou F.W., Rapid Prototyping and Engineering applications: A tool box for prototype development, CRC Press, 2017.
2. Kamrani A.K. and Nasr E.A., Rapid Prototyping: Theory and practice, Springer, 2016.
3. Hilton P.D. and Jacobs P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2015.

VII SEMESTER (ELECTIVE-IV)	L	T	P	C
	3	-	-	3

**19ME7E13 - INDUSTRIAL ROBOTICS**

**COURSE OBJECTIVE:**

1. Understand classification of robots and basic components
2. Get acquainted with performing spatial transformations and solve kinematics of the robot.
3. Get acquainted with performing spatial transformations and solve Dynamics of the robot.
4. Analysis skills associated with trajectory planning.
5. Understand the present & future applications of a robot.

**COURSE OUTCOMES:** Students will be able to

- CO1.** Explain the classification and basic components of robots. [K2]
- CO2.** Apply various motion analysis principles to solve problems involving Manipulator Kinematics. [K3]
- CO3.** Apply Jacobian and Lagrangian principles to solve manipulator Dynamics Problems. [K3]
- CO4.** Develop program a robot to perform tasks in industrial applications [K3]
- CO5.** Explain Applications of Robots in industry. [K2]

**UNIT – I**

**INTRODUCTION:** Robotics- Classification with respect to geometrical configuration (Anatomy), controlled system & chain type, Serial manipulator & Parallel Manipulator. Components of Industrial robotics, Precession of movement-resolution, accuracy & repeatability, Dynamic characteristics- speed of motion, load carrying capacity, speed of response, Sensors-Internal sensors: position sensors, velocity sensors, External sensors- proximity sensors, tactile Sensors, force or torque sensors.

**UNIT – II**

**MOTION ANALYSIS:** Homogeneous transformations as applicable to rotation and translation- problems, Euler Angles, Manipulator kinematics- D-H Notations, joint coordinates and world coordinates, forward and inverse kinematics, problems of simple robotic manipulators.

**UNIT – III**

**MANIPULATOR DYNAMICS:** Differential transformation of manipulators, Jacobians, Lagrange, Euler and Newton, Euler formulations- Problems.

**CONTROL:** Architecture- position, path velocity and force control systems, Computed torque control, Adaptive control and Servo system for robot control.

**UNIT – IV**

**TRAJECTORY PLANNING:** Joint space scheme, Cubic polynomial fit, Obstacle avoidance in operation space, Cubic polynomial fit with via point, blending scheme, Cartesian space scheme, Robot programming-languages and software packages.



**UNIT – V**

**ROBOT APPLICATIONS IN MANUFACTURING:** Material Transfer, Machine loading and un-loading Operations, Processing Operations, Spot and continuous arc welding , Spray painting, Assembly Operations , Inspection , Safety in Robotics, Training , Maintenance.

**TEXT BOOKS:**

1. John J. Craig , Introduction to Robotics , Pearson, 2019.
2. Mikell P. Groover , Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey, Industrial Robotics , 2<sup>nd</sup> edition, TATA McGraw-Hill Education, 2008.
3. R.K. Mittal, I. J. Nagrath , Robotics and Control , Tata Mc Graw Hill Publishing Company Ltd , 2003.

**REFERENCES:**

1. K.S. Fu, R.C.Gonzalez, C.S.G Lee , Robotics, control Sensing, vision and intelligence , Tata Mc Graw Hill Education.
2. Saeed B. Niku / Pearson , Introduction to Robotics – Analysis, Systems, Applications , Education, 2011
3. Lung-Wen Tsai , Robot Analysis – Mechanics of Serial and Parallel Manipulators , John-Wiley Publications, New York.

VII SEMESTER (ELECTIVE-IV)	L	T	P	C
	3	-	-	3
<b>19ME7E14 - REFRIGERATION AND AIR CONDITIONING</b>				

**COURSE OBJECTIVES:**

- To learn the various methods of refrigeration and working principle of Air Refrigeration cycles.
- To learn about the various components and working principle of vapour compression refrigeration system.
- To learn the operation of vapour absorption, steam jet and non conventional refrigeration systems.
- To learn air conditioning systems by cooling load calculations.
- To learn the requirements of comfort air conditioning, types of air conditioning systems and their equipments

**COURSE OUTCOME:** Students are able to

CO1: Identify the necessity and applications of refrigeration and analyze various air refrigeration cycles. [K4]

CO2: Illustrate the properties of refrigerants and analyze the performance of vapour compression refrigeration cycle [K4].

CO3: Explain the working of Vapour absorption system, Steam jet refrigeration system and other non conventional refrigeration systems [K3]

CO4: Apply psychometric properties & processes for estimating thermal load [K3]

CO5: Analyze the requirements of an air conditioning system for human comfort and industrial applications and also differentiate various Air Conditioning Systems and their components. [K4]

**UNIT – I**

**FUNDAMENTALS OF REFRIGERATION:** Introduction to refrigeration, Necessity and applications, Unit of refrigeration, C.O.P- Refrigerator and Heat pump, Methods of refrigeration.

**AIR REFRIGERATION SYSTEM:** Introduction, Working principle of air refrigeration system, Reversed Carnot cycle, Bell Coleman cycle, Open and dense air systems, Air craft refrigeration systems.

**UNIT – II**

**VAPOUR COMPRESSION REFRIGERATION (VCR) SYSTEM:** Working principle - Simple Vapour Compression Refrigeration cycle - T-s and P-h charts, COP, effect of sub cooling and superheating, Actual vapour compression cycle.

**REFRIGERANTS:** Classification, Desirable properties, thermodynamic properties, Commonly used refrigerants.

**VCR SYSTEM COMPONENTS:** Compressors, Condensers, Evaporators – Classification, Working, Working of flooded and dry expansion type evaporator, Expansion devices – Classification, working of automatic expansion valve, thermostatic expansion valve, Capillary tube.

### UNIT – III

**VAPOUR ABSORPTION REFRIGERATION (VAR) SYSTEM:** Simple absorption refrigeration system- Working principle, COP, Practical Aqua ammonia refrigeration system, Lithium Bromide Water refrigeration system, Electrolux refrigeration system.

**STEAM JET REFRIGERATION SYSTEM:** Principle of working, analysis, applications.

**NON- CONVENTIONAL REFRIGERATION METHODS:** Principle and operation of thermoelectric refrigeration and Vortex tube.

### UNIT – IV

**PSYCHROMETRY:** Introduction, Psychrometric properties and relations - Psychrometric chart, Air conditioning processes, Sensible, Latent and Total heat factors , Bypass factor, Load concepts of RSHF, GSHF problems, concept of ESHF and ADP temperature.

**LOAD CALCULATIONS:** Sources of load- internal heat gains, system heat gains, Cooling and heating load estimation.

### UNIT – V

**HUMAN COMFORT:** Thermal Comfort - effective temperature, comfort chart, Comfort and Industrial Air conditioning.

**AIR CONDITIONING SYSTEMS:** Classification, Central, Unitary systems, Summer, Winter, Year round systems.

**AIR CONDITIONING EQUIPMENT:** Air Cleaning-air filters, Construction and working of Humidifiers, Dehumidifiers, Fans, Blowers, Grills and Registers.

### TEXT BOOKS:

1. C. P. Arora, Refrigeration and air conditioning, 3<sup>rd</sup> edition, Tata McGraw Hill, 2013
2. S. C. Arora, Domkundwar, A course in Refrigeration and Air Conditioning, 8<sup>th</sup> edition, Dhanapat Rai and Sons 2017.
3. R. S. Khurmi and J. K. Gupta, Refrigeration and Air conditioning, 5<sup>th</sup> edition S. Chand Publications, 2018.

### REFERENCES:

1. Manohar Prasad, Refrigeration and Air Conditioning, 3<sup>rd</sup> edition, New Age International (P) Ltd Publishers, 2015
2. Roy J. Dossat, Principles of Refrigeration, 4<sup>th</sup> edition, Pearson Education 2010.
3. W. F. Stoecker and J. W. Jones, Refrigeration and Air Conditioning, 2<sup>nd</sup> edition, McGraw Hill, 2014

### DATA BOOK:

Refrigerants & Psychrometric Properties, M.L. Mathur & F.S. Mehta 2010.

VII SEMESTER (ELECTIVE-IV)	L	T	P	C
	3	-	-	3

**19ME5E15 - LEAN MANUFACTURING****COURSE OBJECTIVES:**

- To impart knowledge for facilitating worker environment to identify hidden manufacturing wastes.
- To understand the knowledge on systematic approach for implementing lean manufacturing practices.

**COURSE OUTCOMES:** Students are able to

- CO1. Explain the hidden manufacturing wastes in industries [K1]  
 CO2. Analyze the effectiveness of lean manufacturing tools [K4]  
 CO3. Describe the elements of just in time manufacturing. [K6]  
 CO4. Develop a roadmap for successful implementation of lean principles. [K3]  
 CO5. Explain various case studies of implementation of lean manufacturing at industries.[K5]

**UNIT I****Principles of Lean Manufacturing**

Review of manufacturing paradigm - Objectives of lean manufacturing, key principles and implications of lean manufacturing, traditional versus lean manufacturing characteristics, Value creation and waste elimination - major kinds of manufacturing waste, concept of takt time, continuous flow, continuous improvement, single piece flow.

**UNIT II****Lean Manufacturing Tools and Methodologies**

Value stream mapping - Current state and future state value stream mapping, Standard work - Communication of standard work to employees, visual controls, Quality at the source, 5S principles, Total Productive Maintenance, Changeover and setup time reduction, Production levelling - Failure mode and effect analysis, line balancing, mistake proofing.

**UNIT III****Cellular Manufacturing, JIT, TPM**

Cellular Manufacturing – Types of layout, principles of cell layout, implementation, JIT – Principles of JIT and implementation of Kanban, TPM – Pillars of TPM, principles and implementation of TPM.

**UNIT IV****Lean Manufacturing Implementation**

Road map for lean manufacturing implementation, Reconciling lean with other systems, Lean six sigma, integrating lean principles in ERP and PLM, Lean production in Industry 4.0, impact of industry 4.0 on lean production system.

**UNIT V**

**Case Studies:** Various case studies of implementation of lean manufacturing at industries.

**TEXTBOOKS**

1. Micheal Wader, “Lean Tools: A Pocket Guide to Implementing Lean Practices”, 2<sup>nd</sup> Edition, Productivity and Quality Publication, 2018.

2. Lonnie Wilson “How To Implement Lean Manufacturing” 2<sup>nd</sup> Edition, McGraw-Hill Education, 2015.
3. William M Feld, “Lean Manufacturing: Tools, Techniques and How to Use Them,” 1<sup>st</sup> Edition, CRC Press, 2001.

## REFERENCES

1. Beata Mrugalska, Magdalena K. Wyrwicka, “Towards Lean Production in Industry 4.0”, 2<sup>nd</sup> Editon, Springer international publishing, 2017.
2. S. R. Devadasan, V. Sivakumar, P. R. SHALIJ “Lean and Agile Manufacturing: Theoretical, Practical and Research futurities”, 1<sup>st</sup> Edition, PHI Learning, 2012.
3. Askin R G, Goldberg J B, “Design and Analysis of Lean Production Systems”, 3<sup>rd</sup> Edition, John Wiley and Sons Inc., 2007.

VII SEMESTER (ELECTIVE-IV)	L	T	P	C
	3	-	-	3

**19ME5E16 - SUPPLY CHAIN MANAGEMENT**

**COURSE OBJECTIVES:**

- To understand the fundamentals of concept of supply chain management.
- To find the sourcing and transportation in supply chain management.
- To make optimization models for supply chain management.
- To acquire the current trends in supply chain management.
- To discern the Supplier and customer relationship management.

**COURSE OUTCOMES:** Students are able to

- CO1. Explain fundamental supply chain management concepts. [K2]
- CO2. Apply strategically method to evaluate and manage an effective supply chain [K3]
- CO3. Develop optimization models for supply chain management [K3]
- CO4. Explain the current supply chain recent trends. [K2]
- CO5. Determine information system developments. [K3]

**UNIT I**

**INTRODUCTION TO SCM:** Supply Chain –Fundamentals, importance, decision phases, Process View of a Supply Chain: Push/Pull and Cycle Views, Supply Chain performance, Strategic Fit and Scope, Supply Chain Drivers and Metrics.

**UNIT II**

**SOURCING:** In-Sourcing and Out-Sourcing, Types of purchasing strategies, Supplier Evaluation Selection, Third Party Logistics, Supplier Quality Management, Creating a world-class supply base and World Wide Sourcing.

**TRANSPORTATION:** Modes of Transportation in a Supply Chain Management, Design option for Transportation Network, Role of IT in Transportation.

**UNIT III**

**NETWORK DESIGN IN SUPPLY CHAINS:** Factors Influencing the Network Design Decision, Framework for Network Design Decisions, Models for Facility Location and Capacity Location - Gravity Location Models, Supply Chain Network Optimization Models.

**UNIT IV**

**RECENT TRENDS:** E-Business, Framework and role of Supply Chain in e-business and b2b practices, Supply Chain IT Framework, Internal Supply Chain Management, Fundamentals of transaction management and Supply Chain in IT Practice.

**UNIT V**

**INFORMATION SYSTEM DEVELOPMENTS:** Role of IT in a Supply Chain, Supply Chain IT framework, Supplier relationship management, Customer Relationship Management, Future of IT in Supply Chain Management.

## **TEXTBOOKS**

1. Sunil Chopra and Peter Meindl, Supply Chain Management –Strategy Planning and Operation, 6<sup>th</sup> Edition Indian Reprint, Pearson Education, 2016.
2. Monczka et al., Purchasing and Supply Chain Management, 4<sup>th</sup> Edition, South-Western Cengage Learning, 2009.

## **REFERENCES**

1. Altekar Rahul V, Supply Chain Management –Concept and cases, 8<sup>th</sup> Edition, Prentice Hall India, 2012.
2. Ballou Ronald H, Business Logistics and Supply Chain Management, 5<sup>th</sup> Edition, Pearson Education, 2007.
3. Shapiro Jeremy F, Modeling the Supply Chain, 2<sup>nd</sup> Edition, Cengage Learning, 2006.

SEMESTER-VII (ELECTIVE-IV)	L	T	P	C
	3	-	-	3

**19CS7E25 - PRINCIPLES OF SOFTWARE ENGINEERING**

**COURSE OUTCOMES:**

At the end of the course, the student should be able to

1. Identify, formulate and solve software engineering problems
2. Elicit, analyze and specify software requirements with various stakeholders of a software development project and different software development process models.
3. Apply systematic procedure for software design and deployment.
4. Compare and contrast the various testing methods
5. Identify the key activities in managing a software project.

**UNIT I**

**INTRODUCTION AND SOFTWARE PROCESS:** Evolving Role of Software, Software Characteristics, Changing Nature of Software, Software Myths, Software Engineering- A layered Technology, a Process Framework, Capability Maturity Model Integration(CMMI), Process Assessment, Process Models – Waterfall Model, Incremental Process Models, Evolutionary Process Models, The Unifies Process.

**UNIT II**

**REQUIREMENTS ANALYSIS AND SPECIFICATION:** Software Requirements: Functional and Non-Functional, User requirements, System requirements, Software Requirements Document – Requirement Engineering Process: Feasibility Studies, Requirements elicitation and analysis, requirements validation, requirements management- Classical analysis: Structured system Analysis, Petri Nets- Data Dictionary.

**UNIT III**

**SOFTWARE DESIGN:** Design process – Design Concepts-Design Model– Design Heuristic – Architectural Design – Architectural styles, Architectural Design, Architectural Mapping using Data Flow- User Interface Design: Interface analysis, Interface Design –Component level Design: Designing Class based components, traditional Components.

**UNIT IV**

**TESTING AND IMPLEMENTATION:** Software testing fundamentals-Internal and external views of Testing-white box testing- basis path testing-control structure testing-black box testing- Regression Testing – Unit Testing – Integration Testing – Validation Testing – System Testing And Debugging – Software Implementation Techniques: Coding practices-Refactoring.

**UNIT V**

**PROJECT MANAGEMENT:** Estimation – FP Based, LOC Based, Make/Buy Decision, COCOMO II – Planning – Project Plan, Planning Process, RFP Risk Management – Identification, Projection, RMMM – Scheduling and Tracking –Relationship between people and effort, Task Set & Network, Scheduling, EVA – Process and Project Metrics.

**TEXT BOOK:**

1. Software Engineering, A practitioner's Approach- Roger S. pressman, 8th edition, McGraw-Hill International Edition, 2014.
2. Software Engineering, Ian Sommerville, 10th Edition, Pearson Education Asia, 2016.

**REFERENCE BOOKS:**

1. Software Engineering, Pankaj Jalote, A Precise Approach”, Wiley India, 2010.
2. Systems Analysis and Design- Shely Cash man Rosenblatt, 9th Edition, Thomson publications, 2016.
3. Software Project Management, Bob Hughes, Mike Cotterell and Rajib Mall, Fifth Edition, Tata McGraw Hill, New Delhi, 2012.
4. <https://nptel.ac.in/courses/106101061/>



VII SEMESTER	L	T	P	C
	-	-	3	1.5

**19ME7L01 - AUTOMATION AND ROBOTICS LAB**

**COURSE OBJECTIVE:**

The objective of this course is to impart knowledge about basic mathematics related to industrial robots for their control, design and application in robotics & automation Industries.

**COURSE OUTCOMES:** Students will be able to

- CO1.** Describe the concept of various configurations of robot. [K2]
- CO2.** Analyze the Forward and Inverse kinematics of robots. [K3]
- CO3.** Impart the practical skills sufficient to design and realize basic automation process. [K2]
- CO4.** Explain the Performance of PLC in automation process. [K2]
- CO5.** Develop knowledge in programming for performing various operations. [K3]

**LIST OF EXPERIMENTS****RoboAnalyzer**

1. Verification of transformation (Position and orientation) with respect to gripper and world Coordinate system.
2. Work space analysis for different configurations of robot.
3. To analyze Forward kinematics of robots by using RoboAnalyzer.
4. To analyze Inverse kinematics of robots by using RoboAnalyzer.

**PLC**

5. To develop the ladder logic diagram using Bit Instructions.
6. To identify encoder interfacing with PLC.
7. Performance of Stepper motor / Servo motor control using PLC.
8. Performance of PLC based parking station using Counter and Bit Instructions.

**CPRog**

9. Robot programming and simulation for pick and place operation.
10. Robot programming and simulation for machining (cutting, welding)

**ADD ON EXPERIMENT**

1. Robot Teaching Using VAL Programming.

VII SEMESTER	L	T	P	C
	-	-	3	1.5

**19ME7L02:CAD/CAM LAB**

**COURSE OBJECTIVES:**

- To impart the students with necessary computer aided modeling skills using standard CAD packages.
- To expose the students to different applications of simulation and analysis tools.
- To expose the students to the techniques of CNC programming and cutting tool path generation through CNC simulation software by using G-Codes and M-codes and writing part program for simple machine parts.

**COURSE OUTCOMES:** Students are able to

**CO1:**Modeling of simple machine parts and assemblies from the part drawings using standard CAD packages.[K3]

**CO2:**Analyze various machine parts by using analysis software.[K4]

**CO3:**Write CNC Turning and Milling codes for different operations using standard CAM packages. Write manual part programming using ISO codes for turning and milling operations. [K3]

**I. COMPUTER AIDED DESIGN**

1. **2D DRAFTING:** Introduction to CAD, Elements of Drawing, Development of 2D Drawings like Orthographic and Isometric Drawings, Applying Dimensions to the Drawings, Scanning and plotting procedures.
2. **3D MODELLING:** Sketching, Part drawing and Assembly process for the mechanical components.
3. **ANALYSIS:** Determination of Deflection and stresses in 2D and 3D Trusses and Beams, Determination of Stresses in 3D structure, Estimation of Natural Frequencies and Steady state heat transfer analysis of plane components.

**II. COMPUTER AIDED MANUFACTURING**

1. **CNC Lathe:** Machining of simple components like Step Turning, Taper Turning using CNC Lathe.
2. **CNC Milling:** Machining of simple components like Linear Interpolation and Circular Interpolation.

VIII SEMESTER (ELECTIVE-V)	L	T	P	C
	3	-	-	3
<b>19ME8E17: DESIGNING FOR THE HUMAN BODY</b>				

**COURSE OBJECTIVES:**

- To provide basic understanding to the students about the concept and significance of Human Factors Engineering.
- To gain knowledge about visual, auditory and cognitive aspects of human factors.
- To inculcate the skill among the students for analyzing human systems integration and improving overall decision making and the performance of the system.
- To inculcate analyzing skills among the students with respect to work place design, working postures and lifting tasks.
- To provide thorough knowledge about assessment about occupational exposure to heat stress, noise, vibrations and RSPM.

**COURSE OUTCOMES:**

Students will be able to

**CO1:** Apply the basic concept and significance of Human Factors Engineering.[K3]

**CO2:** Apply the basic knowledge of effect of factors like visual, auditory and cognitive on performance to design suitable work systems. .[K3]

**CO3:** Analyze the factors affecting decision making and improve the same. .[K4]

**CO4:** Analyze and calculate the level of risk in a job causing stress, fatigue and musculoskeletal disorders among the employees of an organization. .[K4]

**CO5:** Students shall be able to assess level of occupational environmental factors like heat stress, noise, vibration and RSPM in a company.[K5]

**UNIT – I**

**INTRODUCTION:** Introduction to Human Factors in Engineering, scope of human factors, the study of human factors as a science, Historical evolution of ergonomics, ergonomics and human factors engineering, Goals of human factors engineering, Introduction to research methods, overview of research methods, experimental research methods, Experimental design.

**UNIT – II**

**VISUAL SENSORY SYSTEMS:** The stimulus; light the receptor system; the eye ball and optic nerve, visual receptive system, contrast sensitivity, reading, colour sensation, night vision, Bottom-up vs top down processing, depth perception, Visual search, detection, discrimination.

**UNIT – III**

**DECISION MAKING:** Decision making models; normative and descriptive decision making models, Heuristics and biasness, Dependency of decision making on the decision context, Factors affecting decision making performance, improving human decision making

**UNIT – IV**

**BIOMECHANICS OF WORK:** The musculoskeletal system, Biomechanical models, Low back problems, NOISH lifting guide, Manual material handling, Seated work and chair design, Upper extremities cumulative trauma disorders. Causes & prevention of CTD, hand tool design. Strain index method for DUE

risk assessment. Work posture risk assessment using OWAS, Rapid Upper Limb Assessment and Rapid Entire Body Assessment tools.

#### **UNIT – V**

**WORK PHYSIOLOGY:** Muscle structure and metabolism, Circulatory and respiratory system, the respiratory system, Lung capacity, Lung capacity measurement using Spirometry. Measurement of workloads. Physical work capacity and whole body fatigue, causes and Control of whole body fatigue. Bio Energies. Stress and workloads. RSPM assessment.

#### **TEXT BOOKS**

1. Christopher D W, John D Lee. Gordon Becker, Human Factors Engineering, second edition, PHI, 2011.
2. MI Khan, Industrial Ergonomics, second edition, PHI, 2011.
3. Sanders Mark S and McCormick Ernert J, Human Factors in Engineering and Design, first edition McGraw- Hill Inc., 2013.

#### **REFERENCES**

1. John B West, Respiratory Physiology, Wolter Kulwer Lippincott Williams & Wilkins, 11<sup>th</sup> edition, 2015.
2. David J. Osborne, Ergonomics at Work, first edition, John Willey & Sons, 2014.

VIII SEMESTER (ELECTIVE-V)	L	T	P	C
	3	-	-	3
<b>19ME8E18 - POWER PLANT ENGINEERING</b>				

**COURSE OBJECTIVES:**

- To learn the working of different circuits of the steam power plant
- To learn the layout and auxiliaries of the diesel and Gas power plants
- To learn the different elements in the hydro electric power plants
- To learn the principal components and types of reactors in the Nuclear power plants
- To learn the concepts of power plant economics and pollution standards to be observed in the power plants.

**COURSE OUTCOMES:** Students are able to

- CO1: Describe the layout of steam power plant and various handling equipment of coal, ash etc. [K2]
- CO2: Describe the equipment used for combustion of coal and other supporting systems.[K2]
- CO3: Explain the working of diesel, gas turbine power plants and different hydro electric power plants.[K2]
- CO4: Distinguish different technologies adopted in nuclear power plants. [K2]
- CO5: Estimate various costs and load calculations involved in a power plant and identify environmental considerations.[K4]

**UNIT – I**

Introduction to the sources of energy –Resources and Development of Power in India.

**STEAM POWER PLANT:** General layout of modern thermal power Plant, Site selection, materials required for thermal power plants, Classification of coal - out-plant handling of coal, coal storage, in-plant handling of coal, Pulverized fuel handling system, Ash handling systems.

**BURNING OF COAL AND COMBUSTION NEEDS:** Coal burning methods – overfeed, underfeed stokers - chain grate, traveling grate, spreader stokers, single and multi retort stokers, Pulverized fuel burning system and its components, Draught system, Dust collectors, Cooling towers, Feed water treatment.

**UNIT – II**

**DIESEL ELECTRIC POWER PLANT:** Fields of use, General layout of diesel power plant, Different systems of diesel power plant – fuel supply system, air- supply system, water-cooling system, lubrication system , starting system, Super charging of diesel engines, Advantages and disadvantages of diesel power plants over thermal plants.

**GAS TURBINE PLANT:** Classification, construction layout with auxiliaries, Working principles of closed and open cycle gas turbines, combined cycle power plants .

**UNIT –III****HYDRO ELECTRIC POWER PLANT**

Hydrology, hydrological cycle, Rain fall and run-off its measurement, Hydrographs, Flow duration curves, mass curve and storage, Classification of dams, spill ways, Water hammer, Surge tanks. Classifications of hydro electric power plants, Typical layouts-plant auxiliaries, plant operation, Pumped storage plants.

#### **UNIT – VI**

**NUCLEAR POWER STATION:** Nuclear fuel, breeding and fertile materials, Nuclear reactor-construction, operation.

**TYPES OF REACTORS:** Pressurized Water Reactor (PWR), Boiling Water Reactor (BWR), Sodium-Graphite Reactor (SGR), Fast Breeder Reactor (FBR), Homogeneous Reactor, Gas cooled Reactor, Radiation hazards and shielding – radioactive waste disposal.

#### **UNIT –V**

##### **POWER PLANT ECONOMICS AND ENVIRONMENTAL CONSIDERATIONS:**

Capital cost- investment of fixed charges, operating costs, General arrangement of power distribution-load curves and load duration curve, Definitions of connected load, maximum demand, demand factor, average load, load factor, diversity factor – related exercises.

Effluents from power plants, Impact on environment, Pollutants, Pollution standards, Methods of pollution control.

##### **TEXTBOOKS:**

1. Subhash C. Arora, S. Domkundwar, Power Plant Engineering, Dhanpat Rai, 8<sup>th</sup> Edition, 2016.
2. R. K Rajput, Power Plant Engineering, Laxmi Publications, 3<sup>rd</sup> Edition, 2016.

##### **REFERENCES:**

1. P.K. Nag, Power Plant Engineering, Tata McGraw-Hill Education, 3<sup>rd</sup> Edition, 2014.
2. P.C. Sharma, Power plant Engineering, S. K. Kataria & Sons, 1<sup>st</sup> Edition, 2009.

<b>VIII SEMESTER (ELECTIVE-V)</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>-</b>	<b>-</b>	<b>3</b>
<b>19ME8E19 - MEMS</b>				

**COURSE OBJECTIVE:**

1. To introduce the students about the different materials used for MEMS.
2. To impart knowledge about various sensors and actuators.
3. Understand the micro-opto-electro mechanical systems
4. Explain the applications of MEMS to disciplines beyond Electrical and Mechanical engineering.
5. Get the knowledge of chemical and bio medical micro systems

**COURSE OUTCOMES:** Students will be able to

- CO1.** Understand various micro electro mechanical system components. [K2]
- CO2.** Demonstrate thermal sensors and actuators. [K2]
- CO3.** Explain micro-opto-electro mechanical systems. [K2]
- CO4.** Demonstrate Radio Frequency system [K3]
- CO5.** Understand chemical and bio medical micro systems [K2]

**UNIT – I**

**INTRODUCTION:** Definition of MEMS, MEMS history and development, micro machining, lithography principles & methods, structural and sacrificial materials, thin film deposition, impurity doping, etching, surface micro machining, wafer bonding, LIGA.

**MECHANICAL SENSORS AND ACTUATORS:** Principles of sensing and actuation: beam and cantilever, capacitive, piezo electric, strain, pressure, flow, pressure measurement by micro phone, MEMS gyroscopes, shear mode piezo actuator, gripping piezo actuator, Inchworm technology.

**UNIT – II**

**SENSORS AND ACTUATORS:** Thermal energy basics and heat transfer processes, thermistors, thermo devices, thermo couple, micro machined thermo couple probe, Peltier effect heat pumps, thermal flow sensors, micro hot plate gas sensors, MEMS thermo vessels, pyro electricity, shape memory alloys (SMA), U-shaped horizontal and vertical electro thermal actuator, thermally activated MEMS relay, micro spring thermal actuator, data storage cantilever.

**MAGNETIC SENSORS AND ACTUATORS:** Magnetic materials for MEMS and properties, magnetic sensing and detection, magneto resistive sensor, more on hall effect, magneto diodes, magneto transistor, MEMS magnetic sensor, pressure sensor utilizing MOKE, magnetic MEMS actuators, by directional micro actuator, feedback circuit integrated magnetic actuator, large force reluctance actuator, magnetic probe based storage device.

**UNIT – III**

**MICRO-OPTO-ELECTRO MECHANICAL SYSTEMS:** Principle of MOEMS technology, properties of light, light modulators, beam splitter, micro lens, micro mirrors, digital micro mirror device (DMD), light detectors, grating light valve (GLV), optical switch, wave guide and tuning, shear stress measurement.

#### **UNIT – IV**

**RADIO FREQUENCY (RF) MEMS:** RF – based communication systems, RF MEMS, MEMS inductors, varactors, tuner/filter, resonator, clarification of tuner, filter, resonator, MEMS switches, phase shifter.

**MICRO FLUIDIC SYSTEMS:** Applications, considerations on micro scale fluid, fluid actuation methods, dielectrophoresis (DEP), electro wetting, electro thermal flow, thermo capillary effect, electro osmosis flow, opto electro wetting (OEW), tuning using micro fluidics, typical micro fluidic channel, microfluid dispenser, micro needle, molecular gate, micro pumps.

#### **UNIT – V**

**CHEMICAL AND BIO MEDICAL MICRO SYSTEMS:** Sensing mechanism & principle, membrane transducer materials, chem.-lab-on-a-chip (CLOC) chemo resistors, chemo capacitors, chemo transistors, electronic nose (Enose), mass sensitive chemo sensors, fluorescence detection, calorimetric spectroscopy.

#### **TEXT BOOKS:**

1. Mahalik N P, MEMS, McGraw-Hill Education (India) Pvt Limited, 2008.
2. Rai - Choudhury P, MEMS and MOEMS Technology and Applications, PHI Learning Private Limited, 2009.
3. Nadim Maluf, An Introduction to Micro Electro Mechanical System Design, Artech House, 2000.

#### **REFERENCES:**

1. Chang Liu Foundation of MEMS, , Prentice Hall Ltd, 2005.
2. Gerald Urban, Bio-MEMS (Micro systems), Springer. 2006
3. Tai-Ran Hsu, MEMS and Micro Systems: Design and Manufacture, TMH Publishers. 2008
4. Mohamed Gad el Hak, MEMS Handbook, CRC Press, 2002.



<b>VIII SEMESTER (ELECTIVE-V)</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>-</b>	<b>-</b>	<b>3</b>
<b>19ME5E20 - OPTIMIZATION TECHNIQUES</b>				

**COURSE OBJECTIVES:**

- To impart the students to understand the concepts of optimization and their application.
- To get the knowledge of solving an engineering problem from a numerical point of view.
- To impart the students to understand the concept of genetic algorithms.
- To get knowledge of developing genetic programming to solve engineering problems.
- To develop applications of optimization in design and manufacturing.

**COURSE OUTCOMES:** Students are able to

**CO1:** understand the concepts of optimization and develop problem equation for a given scenario [K2]

**CO2:** understand, apply, solve an engineering problem from a numerical point of view. [K2]

**CO3:** Create the Genetic algorithms to solve a engineering problem. [K3]

**CO4:** Versed with Genetic programming methods to solve a engineering problem [K2]

**CO5:** Develop a problem formulation for a cantilever beam problem, and solve it.[K3]

**UNIT-I:**

**CLASSICAL OPTIMIZATION TECHNIQUES:** Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, KuhnTucker conditions, merits and demerits of classical optimization techniques.

**UNIT-II:**

**NUMERICAL METHODS FOR OPTIMIZATION:** Nelder Mead’s Simplex search method, Gradient of a function, Steepest descent method, Newton’s method, Pattern search methods, conjugate method, types of penalty methods for handling constraints, advantages of numerical methods.

**UNIT-III:**

**GENETIC ALGORITHM (GA) :** Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA

**UNIT-IV:**

**GENETIC PROGRAMMING (GP):** Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP.

**MULTI-OBJECTIVE GA:** Pareto’s analysis, Non-dominated front, multi – objective GA, Non dominated sorted GA, convergence criterion, applications of multi objective problems.

**UNIT-V:**

**APPLICATIONS OF OPTIMIZATION IN DESIGN AND MANUFACTURING SYSTEMS:** Some typical applications like optimization of path synthesis of a four bar mechanism, minimization of weight of a cantilever beam, optimization of springs and gears, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence.

**TEXT BOOKS:**

1. S.S.Rao, Engineering Optimization, 3<sup>rd</sup> Edition, New Age Publishers, 2017.
2. CE Ebeling, An Introduction to Reliability and Maintainability Engineering, 3<sup>rd</sup> Edition, Waveland Printers Inc, 2017.
3. Jasbir Arora, Optimal design, 3<sup>rd</sup> Edition, Mc Graw Hill (International) Publishers, 2018.

**REFERENCE BOOKS:**

1. D.E.Goldberg, Genetic algorithms in Search, Optimization, and Machine learning, 13<sup>th</sup> Edition, Addison Wesley Publishers, 2017.
3. Kalyanmoy Deb, Multi objective Genetic algorithms, 2<sup>nd</sup> Edition, PHI Publishers, 2013.

SEMESTER-VIII (ELECTIVE-V)	L	T	P	C
	3	-	-	3

**19CS8E28 - ARTIFICIAL INTELLIGENCE****COURSE OUTCOMES:**

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

1. Build intelligent agents for search and games
2. Solve AI problems through programming with Python
3. Learning optimization and inference algorithms for model learning
4. Design and develop programs for an agent to learn and act in a structured environment.

**UNIT I:**

**Introduction:** Concept of AI, history, current status, scope, agents, environments, Problem Formulations, Review of tree and graph structures, State space representation, Search graph and Search tree.

**UNIT II:**

**Search Algorithms:** Random search, Search with closed and open list, Depth first and Breadth first search, Heuristic search, Best first search, A\* algorithm, Game Search.

**UNIT III:**

**Probabilistic Reasoning:** Probability, conditional probability, Bayes Rule, Bayesian Networks-representation, construction and inference, temporal model, hidden Markov model.

**UNIT IV:**

**Markov Decision process:** MDP formulation, utility theory, utility functions, value iteration, policy iteration and partially observable MDPs.

**UNIT V:**

**Reinforcement Learning:** Passive reinforcement learning, direct utility estimation, adaptive dynamic programming, temporal difference learning, active reinforcement learning- Q learning.

**TEXT BOOKS**

1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", 3<sup>rd</sup> Edition, Prentice Hall
2. Elaine Rich and Kevin Knight, "Artificial Intelligence", Tata McGraw Hill
3. Trivedi, M.C., "A Classical Approach to Artificial Intelligence", Khanna Publishing House, Delhi.
4. Saroj Kaushik, "Artificial Intelligence", Cengage Learning India, 2011

VIII SEMESTER (ELECTIVE-VI)	L	T	P	C
	3	-	-	3

**19ME8E21 - ADVANCED MECHANICS OF SOLIDS**

**COURSE OBJECTIVES:**

- To understand the concepts of energy methods, fixed and continuous beams.
- To understand the concepts of unsymmetrical bending.
- To understand the concepts of columns and struts, stresses due to rotation and torsion of generalized elements.

**COURSE OUTCOMES:** Students are able to

CO1: Describe and evaluate the strain energy and energy theorems. [K4]

CO2: Calculate the Fixed moments, slope and deflection of the fixed beams of uniform and non-uniform sections and analyze the reaction supports of the continuous Beams. [K4]

CO3: Analyze stress and deflections in unsymmetrical sections due to Bending [K4]

CO4: Evaluate the loads and deflections in columns and struts. [K4]

CO5: Calculate the stresses in the wheel Rims and Analyze the Torsion of different types of Bars, thin walled tubes and closed sections. [K4]

**UNIT – I**

**Energy Methods:** Introduction, Principles of superposition, Strain energy, Reciprocal relations, Maxwell-Betti theorem, Elastic strain energy in tension and compression, Strain energy in beams subjected to bending and shafts to torsion, Impact loading in tension and bending, first & second theorem of Castigliano and its applications.

**UNIT – II****Fixed Beams:**

Fixing moments for a fixed beam of uniform and variable sections, Effect of sinking support, Slope and Deflection.

**Continuous Beams:** Analysis of continuous Beam, Reactions at the supports, Effect of sinking of supports.

**UNIT – III**

**Unsymmetrical Bending:** Bending stresses in Beams subjected to non-symmetrical bending; Deflection of straight beams due to non-symmetrical bending.

## UNIT – IV

### Columns and Struts:

Columns with one end free and the other fixed, both ends fixed, one end fixed and other end hinged, Limitation of Euler's formulae, Column carrying Eccentric load, Empirical formulae.

## UNIT – V

**Stresses due to Rotation:** Wheel Rim, Disc of Uniform Thickness, Disc of Uniform Strength.

**Torsion of generalized Element Section:** Introduction, Torsion of General Prismatic Bars–Solid Sections, Torsion of Circular and Elliptical Bars, Torsion of Equilateral Triangular Bar, Torsion of Rectangular Bars, Membrane Analogy, Torsion of Thin-walled Tubes, Torsion of Thin-walled Multiple-Cell Closed Sections.

### TEXT BOOKS:

1. R.K. Rajput, Strength of Materials, 7<sup>th</sup> Edition, S.Chand & Company 2018
2. J.M. Gere and S.P. Timoshenko, Mechanics of Material, 6<sup>th</sup> Edition, CBS publisher, 2004
3. L.S.Srinath, Advanced Mechanics of Solids, 2<sup>nd</sup> edition, India, Tata McGraw-Hill, 2003.

### REFERENCES:

1. F.P. Bear and E.E. Johnston, Mechanics of Material, 8<sup>th</sup> Edition, McGraw Hill, 2020.
2. S.P. Timo Shenko, Strength of Material, Vol. I and II, EWP Press 2004.
3. Dr. Sadhu Singh, Strength of Material, 11<sup>th</sup> Edition Khanna Publishers 2013.
4. R. K Bansal, Strength of Materials, 6<sup>th</sup> Edition, Laxmi Publications (P) Ltd, 2015.

<b>VIII SEMESTER (ELECTIVE-VI)</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
	<b>3</b>	<b>-</b>	<b>-</b>	<b>3</b>
<b>19ME8E22- COMPUTATIONAL FLUID DYNAMICS</b>				

**COURSE OBJECTIVE**

The course will equip the students with the necessary knowledge to use computational techniques to solve problems related to flow mechanics. In particular, students will have hands-on experience in using computational fluid dynamics to solve engineering problems.

**COURSE OUTCOMES:** Students are able to

**CO1.** Explain the differential equations for flow phenomena and numerical methods for their solution. [K2]

**CO2.** Explain the stability analysis in CFD [K2]

**CO3.** Estimate equipment error and fluid flow properties [K3]

**CO4.** Analyze the appropriate model equations to investigate fluid flow in steady flow cases. [K4]

**CO5.** Evaluate partial differential equations in the form of algebraic equations. [K4]

**UNIT I**

**INTRODUCTION:** History and Philosophy of computational fluid dynamics, CFD as a design and research tool, Applications of CFD in engineering, Programming fundamentals, MATLAB programming, Numerical Methods.

**UNIT II**

**REVIEW OF EQUATIONS GOVERNING FLUID FLOW AND HEAT TRANSFER:** Introduction, Conservation of mass, Newton's second law of motion, expanded forms of Navier-Stokes equations, Conservation of energy principle, Special forms of the Navier-Stokes equations.

**UNIT III**

**ERRORS AND STABILITY ANALYSIS:** Introduction, First order wave equation, Stability of hyperbolic and elliptic equations, Fundamentals of fluid flow modeling- conservative property, upwind scheme.

**UNIT IV**

**STEADY FLOW:** Dimensions form of momentum and energy equations, Navier-Stokes equation and conservative body force fields, Stream function, Vorticity formulation, Boundary layer theory, Buoyancy driven convection and stability.

**UNIT V**

**FINITE VOLUME METHOD:** Approximation of surface integrals, volume integrals, interpolation and differentiation practices, upwind interpolation, linear interpolation and quadratic interpolation.

**TEXT BOOKS:**

1. John .D. Anderson, Computational Fluid Dynamics: Basics with applications, 3<sup>rd</sup> edition, McGraw-Hill International Edition, India,2012.
2. J Chung, Computational Fluid Dynamics, 2<sup>nd</sup> edition, Cambridge University Press, India, 2010.

**REFERENCES:**

- John.F Wendt, Computational fluid dynamics: An introduction, 3<sup>rd</sup> edition, Springer publishers , 2018.
1. Pradip Majumdar, Computational Fluid Flow and Heat Transfer, CRC Press, 2021.
  2. Tapan K. Sengupta , Fundamentals of Computational Fluid Dynamics, Universities Press, 2004.

VIII SEMESTER (ELECTIVE-VI)	L	T	P	C
	3	-	-	3

**19ME8E23: FLEXIBLE MANUFACTURING SYSTEMS****COURSE OBJECTIVES:**

- To understand the role of Flexible Manufacturing Systems(FMS) in manufacturing,
- To understand the concept of manufacturing cell and just in time.
- To understand the automated features of machining centers.
- To understand the benefits of automation
- To understand the control of cutting tools and tool management.

**COURSE OUTCOMES:** Students are able to

**CO1:** Explain the basic components, various hardware and software requirements of Flexible Manufacturing Systems.[K2]

**CO2:** Explain the concepts of Manufacturing cell and Just In Time.[K2]

**CO3:** Classify the turning and machining centers and Explain their automated features. [K2]

**CO4:** Describe and Classify the Coordinate Measuring Machine and Explain about the Automated Material Movement and Storage Systems.[K2]

**CO5:** Explain about the control of cutting tool management, strategies and discuss the system hardware and general functionality.[K2]

**UNIT—I****FMS Introduction and Description**

Introduction, Definition, Basic Component of FMS, Significance of FMS, General layout and configuration of FMS, Principle Objectives of FMS, Benefits and limitations of FMS, Area of Application of a FMS in Industry, Various Hardware and Software required for an FMS, CIM Technology, Hierarchy of CIM, and FMS Justification.

**UNIT – II****Manufacturing Cell**

Introduction, Description and Classifications of Cell, Unattended Machining, Cellular versus Flexible Manufacturing.

**Just In Time (JIT):** Introduction, Concepts, Goals and Objectives, Ingredients, Quality and Quantity principles of JIT, Benefits and Implementation.

**UNIT – III****Turning and Machining Centre**

Introduction, Types, Construction and Operation Performed on Turning center, Automated Features and Capabilities of Turning Centres, General Advantages and Disadvantages of Vertical and Horizontal

Machining Centres, Pallet and Part Loading and Programming Options in Machining Centres, Automated features and capabilities of a Machining Centres

#### **UNIT – IV**

**Coordinate Measuring Machine:** Introduction, Construction, Types of CMM, Functions, Operational cycle description, Advantages & Limitations.

**Automated Material Movement and Storage System:** Introduction, Types of AGV and Their principle of working, Advantages, Limitation and General AGV Guide path, Robots, Benefits of using Industrial Robots, Basic components and benefits of Automated Storage and Retrieval Systems, Conveyors and Pallet Flotation System, Queuing Carrousel and Automatic Work Changers, Coolant and Chip Disposal and Recovery system.

#### **UNIT – V**

##### **Cutting Tools and Tool Management**

Introduction, Control of Cutting Tools, Tool Management, Tool Strategies, Tool Preset, Identification and Data Transfer, Tool Monitoring and Fault Detection

**System Hardware and General Functionality:** Introduction, Programmable logic controller, cell controllers, communication Networks.

**FMS Software Structure:** Introduction, General Structure and Requirements, Advantages Of Modular Software Design and Development, Types of FMS software Modules.

#### **UNIT – VI**

##### **TEXT BOOKS:**

1. Groover M.P, Zimmers E.W, CAD/CAM, Prentice Hall of India, 12<sup>th</sup> Edition, 2017
2. H. K. Shivanand, M. M. Benal, V. Koti, Flexible Manufacturing System, New Age Publishers, 16<sup>th</sup> Edition, 2014

##### **REFERENCE BOOKS:**

1. Groover M.P, Automation, Production Systems and Computer Integrated Manufacturing, Prentice Hall of India, 3<sup>rd</sup> Edition, 2016
2. Nanua Singh, Approach to Computer Integrated Design and Manufacturing, John Wiley and Sons, 4<sup>th</sup> Edition, 2015



VIII SEMESTER (ELECTIVE-VI)	L	T	P	C
	3	-	-	3

**19ME8E24 - STATISTICAL QUALITY CONTROL**

**COURSE OBJECTIVES:**

- To help students understand the concepts underlying statistical quality control.
- To know control charts and evaluate revised control limits.
- To develop their ability to apply those concepts to the design and management of quality control processes in industries.
- To Analyze process capability and operating characteristic curves for Statistical quality control
- The emphasis will be on ensuring that the students gain both a broad perspective of quality control as well as the technical skills necessary to implement quality control in any industrial setting.

**COURSE OUTCOMES:** Students are able to

- CO1. Explains the basic concept of Quality, Control Charts and Acceptance Sampling(K2)  
 CO2. Construct control charts and evaluate revised control limits.(K3)  
 CO3. Apply control chart for individual measurements and multi-vari chart.(K3)  
 CO4. Analyze process capability and operating characteristic curves (K4)  
 CO5. Determine whether to accept or reject a production lot of material (K3)

**UNIT I:****Introduction**

Quality Dimensions, Quality definitions, Inspection, Quality control, Quality Assurance, Quality planning, Quality costs, Economics of quality, Quality loss function.

**UNIT II:****Control Charts**

Chance and assignable causes of process variation, statistical basis of the control chart, control charts for variables- X , R and S charts, attribute control charts - p, np, c and u-Construction and application.

**UNIT III:****Special Control Procedures**

Warning and modified control limits, Control chart for individual measurements, Multi-vari chart, X - chart with a linear trend, Chart for moving averages and ranges, Cumulative-sum and exponentially weighted moving average control charts.

**UNIT IV:****Statistical Process Control**

Process stability, Process capability analysis using a Histogram or probability plots, Control chart, Gauge capability studies, Setting specification limits.

**UNIT V:****Acceptance Sampling**

The acceptance sampling fundamental, OC curve, sampling plans for attributes, simple, double, multiple and sequential, sampling plans for variables, MIL-STD-105D and MIL-STD-414E & IS2500 standards.

**TEXT BOOKS**

1. Douglas C Montgomery, Introduction to Statistical Quality Control, 7<sup>th</sup> Edition, John Wiley, 2012.
2. Grant E.L. and Leavenworth, Statistical Quality Control, 7<sup>th</sup> Edition, McGraw Hill Education, 2017.
3. Douglas C. Montgomery, Statistical Quality Control: A Modern Introduction 6<sup>th</sup> Edition, Wiley; 2010

4. O.P Khanna, Industrial Engineering and management, 6<sup>th</sup> Edition, Khanna Publishers, 2018.

**REFERENCE BOOKS:**

1. Martand Telsang, Industrial Engineering and Production Management, 3<sup>rd</sup> Edition, S.Chand & Company Ltd, 2018.
2. S. C. Sharma & TR. Banga, Industrial Engineering and Management, 1<sup>st</sup> Edition, Khanna Publishers, 2017.
3. N.V.SRaju, Industrial Engineering and Management, 1<sup>st</sup> Edition, Cengage Publishers, 2013.

SEMESTER-VIII (ELECTIVE-VI)	L	T	P	C
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**19CS8E29 - VIRTUAL REALITY AND AUGMENTED REALITY**

**COURSE OUTCOMES:**

At the end of the course student are able to

1. Adopt various principles and concepts of Virtual Reality and its Application.
2. Apply appropriate method of Geometric Modelling
2. Analyse various VR Hardware and Software
3. Describe the concepts of Augmented Reality.
4. Define Augmented Reality Contents and its Applications

**UNIT – I:**

**INTRODUCTION TO VIRTUAL REALITY**

Virtual Reality & Virtual Environment: Introduction – Computer graphics – Real time computer graphics – Flight Simulation – Virtual environments –requirement – Benefits of Virtual Reality - Historical development of VR : 3D Computer Graphics - Human Factors – Vision - Vision and Display Technology – Hearing – Tactile - Equilibrium.

**UNIT – II:**

**GEOMETRIC MODELING**

Geometric Modeling : Introduction – From 2D to 3D – 3D space curves – 3D boundary representation – Other modeling strategies – Geometrical Transformations: Introduction – Frames of reference – Modeling transformations – Instances – Picking – Flying – Scaling the VE – Collision detection – A Generic VR system : Introduction – The virtual environment – The Computer environment – VR Technology – Model of interaction – VR System.

**UNIT – III:**

**VR HARDWARE, SOFTWARE AND APPLICATIONS**

Introduction-Computers-Tracking-Input Devices-Output Devices-Glasses-Displays-Audio-VR-Software Features-Web-based VR-Division's dVISE, Blueberry 3D-Boston Dynamics-Multigen-Introduction-Industrial-Training Simulators-Entertainment-VR Centres.

**UNIT – IV:**

**INTRODUCTION TO AUGMENTED REALITY**

Introduction to Augmented Reality-Definition and Scope-A Brief History of AR-Examples-Related Fields-Augmented Reality Concepts-How does AR Work-Concepts Related AR-Ingredients of an AR-AR Hardware and Software-Major Hardware Components for AR Systems- Major Software Components for AR Systems.

**UNIT – V:**

**AR CONTENT, INTERACTION AND ITS APLICATIONS**

**AR Content**-Introduction-What is Content-Creating Visual Content-Creating Audio Content-Creating Content for Other Senses-Representation and Perceptual Issues-**AR Interaction**-Introduction-What is Interaction-Mobile AR-**AR Applications**-Introduction-Application Areas-Collaborative AR-Applying AR to a Problem-Evaluating AR Applications-Example AR Applications-The Future of Augmented Reality.

**TEXT BOOKS:**

1. Virtual Reality Systems, John Vince, Pearson Education Asia, 2016.
2. Introduction to Virtual Reality, John Vince, Springer London, 2016.
3. Augmented Reality, Principles and Practice, Dieter Schmalsteig, Tobias Hollerer, Pearson Education, 2016.
4. Understanding Augmented Reality Concepts and Applications, Alan B. Craig, Elsevier -Morgan Kaufmann Publications ,2013.

**REFERENCE BOOKS:**

1. Adams, “Visualizations of Virtual Reality”, Tata McGraw Hill, 2000.
2. Grigore C. Burdea, Philippe Coiffet , Virtual Reality Technology , Wiley-Interscience, First Edition, 1994
3. Alan B Craig, William R Sherman and Jeffrey D Will, “Developing Virtual Reality Applications: Foundations of Effective Design”, Morgan Kaufmann, 2009.
4. <https://nptel.ac.in/courses/106105195/13>  
<https://www.mooc-list.com/course/making-your-first-virtual-reality-game-coursera>

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**19EEXO01 :: ELECTRICAL SAFETY MANAGEMENT****COURSE OUTCOMES:**

*After successful completion of this course, students should be able to:*

- CO1 : Explain the Electrical Safety precautions and Prevention. (K2)
- CO2 : Illustrate Safety aspects during Installation of Plant and Equipment. (K2)
- CO3 : Estimate the electrical safety in residential, commercial and agricultural installations.(K5)
- CO4 : Categorize various Electrical Safety in Hazardous Areas (K4)
- CO5 : List the electrical systems safety management and IE rules.(K1)

**SYLLABUS****UNIT-I : ELECTRICAL SAFETY, SHOCKS AND THEIR PREVENTION**

Terms and definitions, objectives of safety and security measures, Hazards associated with electric current, and voltage, who is exposed, principles of electrical safety, Approaches to prevent Accidents, scope of subject electrical safety.

Primary and secondary electrical shocks, possibilities of getting electrical shock and its severity, medical analysis of electric shocks and its effects, shocks due to flash/ Spark over's, prevention of shocks, safety precautions against contact shocks, flash shocks, burns, residential buildings and shops.

**UNIT-II : SAFETY DURING INSTALLATION OF PLANT AND EQUIPMENT**

Introduction, preliminary preparations, preconditions for start of installation work, during, risks during installation of electrical plant and equipment, safety aspects during installation, field quality and safety during erection, personal protective equipment for erection personnel, installation of a large oil immersed power transformer, installation of outdoor switch yard equipment, safety during installation of electrical rotating machines, drying out and insulation resistance measurement of rotating machines.

**UNIT-III : ELECTRICAL SAFETY IN RESIDENTIAL, COMMERCIAL AND AGRICULTURAL INSTALLATIONS**

Wiring and fitting – Domestic appliances – water tap giving shock – shock from wet wall – fan firing shock – multi-storied building – Temporary installations – Agricultural pump installation – Do's and Don'ts for safety in the use of domestic electrical appliances.

**UNIT-IV : ELECTRICAL SAFETY IN HAZARDOUS AREAS**

Hazardous zones – class 0,1 and 2 – spark, flashovers and corona discharge and functional requirements – Specifications of electrical plants, equipments for hazardous locations – Classification of equipment enclosure for various hazardous gases and vapours – classification of equipment/enclosure for hazardous locations.

**EQUIPMENT EARTHING AND SYSTEM NEUTRAL EARTHING:** Introduction, Distinction between system grounding and Equipment Grounding, Equipment Earthing, Functional Requirement of earthing system, description of a earthing system, , neutral grounding( System Grounding), Types of Grounding, Methods of Earthing Generators Neutrals.

**UNIT-V : SAFETY MANAGEMENT OF ELECTRICAL SYSTEMS**

Principles of Safety Management, Management Safety Policy, Safety organization, safety auditing, Motivation to managers, supervisors, employees.

**REVIEW OF IE RULES AND ACTS AND THEIR SIGNIFICANCE:** Objective and scope – ground clearances and section clearances – standards on electrical safety - safe limits of current, voltage –Rules regarding first aid and fire fighting facility. The Electricity Act, 2003, (Part1, 2, 3,4 & 5)

**TEXT BOOKS:**

- 1 S. Rao, Prof. H.L. Saluja, “Electrical safety, fire safety Engineering and safety management”, Khanna Publishers. New Delhi, 1988.(units-I to V)
- 2 [www.apeasternpower.com/downloads/elecact2003.pdf](http://www.apeasternpower.com/downloads/elecact2003.pdf) (Part of unit-V)

**REFERENCE BOOKS:**

- 1 Pradeep Chaturvedi, “Energy management policy, planning and utilization”, Concept Publishing company, New Delhi, 1997.
2. The Electricity Act, 2003 MINISTRY OF LAW AND JUSTICE (Legislative Department) New Delhi, the 2nd June, 2003.Jyaistha 12, 1925 (Saka)

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**19EEXO02 :: NON CONVENTIONAL ENERGY SOURCES**

**COURSE OUTCOMES:**

*After successful completion of this course, students should be able to:*

- CO1 : Show the need of energy conversion and the analysis of solar radiation. (K1)
- CO2 : Analyze solar radiation data, extraterrestrial radiation, radiation on earth's surface and solar thermal systems. (K4)
- CO3 : Identify the methods and analysis of Wind energy generation and its maximum power point techniques. (K3)
- CO4 : Explain basic principle and working of hydro and tidal energy systems. (K2)
- CO5 : Explain the Biomass, Fuel cells and Geothermal energy, its mechanism of production and its applications (K2)

**SYLLABUS**

**UNIT-I : FUNDAMENTALS OF ENERGY SYSTEMS:**

Energy conservation principle – Energy scenario (world and India) – Solar radiation: Outside earth's atmosphere – Earth surface – Analysis of solar radiation data – Geometry – Radiation on tilted surfaces – Numerical problems.

**UNIT-II : SOLAR THERMAL SYSTEMS**

Liquid flat plate collections: Performance analysis –Introduction to solar air heaters – Concentrating collectors and solar pond– Numerical problems.

**Solar Photovoltaic Systems** :Solar Photovoltaic cell, Module,Array – Construction– Efficiency of solar cells – Developing technologies – Cell I-V characteristics – Applications and systems – Maximum power point tracking.

**UNIT-III : WIND ENERGY**

Sources of wind energy – Wind patterns – Types of turbines – Horizontal axis and vertical axis machines – Kinetic energy of wind – Betz coefficient – Tip–speed ratio – Efficiency – Power output of wind turbine – Selection of generator(synchronous, induction) – Maximum power point tracking.

**UNIT-IV : HYDRO AND TIDAL POWER SYSTEMS**

Basic working principle – Classification of hydro systems: Large, small, micro – measurement of head and flow – Energy equation – Types of turbines – Numerical problems. Tidal power – Basics – Kinetic energy equation – Numerical problems – Wave power – Basics – Kinetic energy equation.

**UNIT-V : BIOMASS, FUEL CELLS AND GEOTHERMAL SYSTEMS**

Biomass Energy: Fuel classification – Pyrolysis – Direct combustion of heat – Different digesters and sizing. Fuel cell: Classification of fuel for fuel cell – Fuel cell voltage – Efficiency – VI characteristics. Geothermal: Classification – Dry rock and hot aquifer – Energy analysis.

**TEXT BOOKS:**

- 1 Renewable Energy Resoures, John Twidell and Tony Weir, Taylor and Francis -second edition, 2013
- 2 Non conventional sources of Energy by G.D.Rai, Kanna Publications.
- 3 Renewable Energy Technologies /Ramesh & Kumar /Narosa.

**REFERENCE BOOKS:**

- 1 Energy Science: Principles, Technologies and Impacts, John Andrews and Nick Jelly, Oxford University Press, 2017.
- 2 Renewable Energy- Edited by Godfrey Boyle-oxford university, press, 3rd edition, 2013.
- 3 Handbook of renewable technology Ahmed and Zobaa, Ramesh C Bansal, World scientific, Singapore
- 4 Renewable energy technologies – A practical guide for beginners – Chetong Singh Solanki, PHI.
- 5 Non conventional energy source –B.H. Khan- TMH-2nd edition
- 6 Solar Energy: Principles of Thermal Collection and Storage, S. P. Sukhatme and J. K. Nayak, TMH, New Delhi, 3rd Edition



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**19EEXO03::ELECTRICAL VEHICLE**

**COURSE OUTCOMES:**

*After successful completion of this course, students should be able to:*

- CO1 : Explain the basics of electric vehicles fundamentals.(K2)  
 CO2 : Discuss different energy storage concepts used for electric vehicles.(K6)  
 CO3 : Explain about fundamental of electrical Machines .(K2)  
 CO4 : Analyze various drive trains suitable for electric vehicles .(K4)  
 CO5 : Explain about different types of EV Systems.(K2)

**SYLLABUS****UNIT-I : INTRODUCTION TO ELECTRIC VEHICLES**

Components of an EV ,EV History, EV Advantages ,EV mechanics , Roadway Fundamentals , Laws of Motion , Vehicle Kinetics , Dynamics of Vehicle Motion , Propulsion Power, Velocity and Acceleration, Propulsion System Design

**UNIT-II : BATTERY**

Basics – Types, Parameters – Capacity, Discharge rate, State of charge, state of Discharge, Depth of Discharge, Lead-Acid Battery, Alternative Batteries, Battery Parameters, Technical Characteristics, Targets and Properties of Batteries , Battery Modeling

**UNIT-III : DC & AC ELECTRICAL MACHINES**

Motor and Engine rating, Requirements, Fundamental concepts of DC machines- Three phase A/c machines- Induction machines- permanent magnet machines-switched reluctance machines

**UNIT-IV : ELECTRIC VEHICLE DRIVE TRAIN**

EV Transmission Configurations , Transmission Components, Ideal Gearbox, EV Motor Sizing

**UNIT-V : HYBRID ELECTRIC VEHICLES**

Types of Hybrids, Internal Combustion Engines , Design of an HEV ,Drive train, sizing of components.

**TEXT BOOKS:**

- 1 Iqbal Hussein, “Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press, 2003.

**REFERENCE BOOKS:**

- 1 James Larminie and John Lowry, “Electric Vehicle Technology Explained”, Wiley, 2003.
- 2 Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay and Ali Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals”, CRC Press, 2010.
- 3 Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRC Press, 2004.
- 4 Introduction to hybrid and electric vehicles: Dr Praveen Kumar & Dr S Majhi, IIT Guwahati , <https://nptel.ac.in/courses/108/103/108103009/> .

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**19EEXO04:: ELECTRICAL ENERGY CONSERVATION AND AUDITING****COURSE OUTCOMES:**

*After successful completion of this course, students should be able to:*

- CO1 : Explain energy efficiency, conservation and various technologies [K2]  
 CO2 : Identify the concepts of energy management and energy audit [K3]  
 CO3 : Explain energy conservation in HVAC systems.[K2]  
 CO4 : Analyze the concepts of different energy efficient devices [K4]  
 CO5 : Estimate life cycle costing analysis and energy efficient Technologies [K5]

**SYLLABUS****UNIT-I : BASICS OF ENERGY AND ITS VARIOUS FORMS**

Energy consumption –choice of fuels. Energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features Electricity tariff, load management and maximum demand control, power factor improvement, selection & location of capacitors, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity and humidity & heat transfer, units and conversion.

**UNIT-II : ENERGY MANAGEMENT & AUDIT**

Energy conservation schemes: Short term - Medium term - Long term energy conservation schemes – Industrial energy use - Energy index – Cost index. Representation of energy consumption: Pie charts - Sankey diagrams – Load Profile.

Energy auditing: General Auditing, Detailed Energy Audit. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.

**UNIT-III : ENERGY EFFICIENCY IN INDUSTRIAL & ELECTRICAL SYSTEMS**

Heat – Heat content – Rate of heat transfer – Heat transfer coefficient - Conduction – Convection and radiation. Thermal insulation & its importance - space heating – HVAC system – Heating of Buildings. Energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.

**UNIT-IV : ENERGY EFFICIENT INSTRUMENTS**

Digital Energy Meter – Data loggers – Thermo couples – Pyranometer – Lux meters – Tong testers – Power analyzers – Power factor – effects with non-linear loads – effect of harmonics on power factor – Power Factor Improvement – Capacitor rating - Effects of power factor improvements - Electric lighting – Types of lighting – Luminaries – Energy efficient lighting.

**UNIT-V : ECONOMICAL ASPECTS & FINANCIAL ANALYSIS**

Costing Techniques – cost factors – break-even charts – sources of capital and hire charges -capital recovery – depreciation – budgeting and standard costing – charging energy – cash flow diagrams and activity charts. Financial appraisal and profitability : investment decision- methods of investment appraisal discounted cash flow – summary of investment appraisal techniques – Cost optimization – optimization with one variable – optimization with more than one variable.

**TEXT BOOKS:**

- 1 Energy management by W.R. Murphy & G. McKay Butterworth, Elsevier publications.
- 2 Hand Book of Energy Audit by Sonal Desai- Tata McGraw Hill
- 3 Energy management hand book by W.C.Turner, John Wiley and sons.
- 4 Electric Energy Utilization and Conservation by S C Tripathy, Tata McGraw Hill publishing company Ltd. New Delhi.
- 5 Economic Analysis of Demand Side Programs and Projects - California Standard Practise Manual, June 2002 – Free download available online
- 6 Energy Efficiency And Management For Engineers, November 2020, TMH, by Mehmet Kanoglu , Yunus A. Cengel

**REFERENCE BOOKS:**

- 1 Energy management by Paul o' Callaghan, Mc-Graw Hill Book company–1st edition,1998.
- 2 Energy management and conservation –k v Sharma and pvenkatasshaiah-I K International Publishing House pvt.ltd,2011
- 3 Fundamentals of Energy Engineering by Albert Thumann, Prentice Hall Inc, Englewood Cliffs, New Jersey, 1984.
- 4 Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online)
- 5 Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online)

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**19CEXO01: DISASTER MANAGEMENT**

**Course Outcomes:**

Students are able to

1. identify the tools of integrating disaster management principles in disaster mitigation process.
2. discuss about different approaches needed to manage pre and post- disaster activities.
3. prepare the process of risk management and develop a basic understanding method for the role of public in risk management.
4. administer the role of technology in Disaster management.
5. conclude the planning strategies for education and community preparedness programmes.

**UNIT-I : Natural Hazards and Disaster management:**

Introduction of DM – Inter disciplinary nature of the subject- Disaster Management cycle- Five priorities for action. Case study methods of the following: floods, draughts -Earthquakes- global warming, cyclones & Tsunamis- Post Tsunami hazards along the Indian coast - landslides.

**UNIT-II: Man Made Disaster and their management along with case study methods of the following:**

Fire hazards - transport hazard dynamics -Solid waste management- post disaster – Bio terrorism -threat in mega cities, rail and air craft’s accidents, and Emerging infectious diseases & Aids and their management.

**UNIT-III: Risk and Vulnerability:**

Building codes and land use planning - social vulnerability - environmental vulnerability - Macroeconomic management and sustainable development, climate change risk rendition - financial management of disaster - related losses.

**UNIT-IV: Role of Technology in Disaster managements:**

Disaster management for infra structures, taxonomy of infrastructure - treatment plants and process facilities-electrical substations- roads and bridges- mitigation programme for earth quakes -flowchart, geospatial information in agriculture drought assessment-multimedia technology in disaster risk management and training transformable indigenous knowledge in disaster reduction.

**UNIT-V: Education and Community Preparedness**

Education in disaster risk reduction-Essentials of school disaster education-Community capacity and disaster resilience-Community based disaster recovery -Community based disaster management and social capital-Designing resilience- building community capacity for action.

**Textbooks:**

1. Rajib shah & R. Krishnamurthy, ‘Disaster Management - Global Challenges and Local Solutions’ Universities press-2009.
2. Tushar Bhattacharya, ‘Disaster Science & Management’, Tata McGraw Hill Education Pvt. Ltd., New Delhi.-2012
3. Jagbir Singh , ‘Disaster Management - Future Challenges and Opportunities’ , I K International Publishing House Pvt. Ltd-2017

**References:**

1. H K Gupta , ‘Disaster Management’, Universities press-2003
2. Prof. R.B. Singh , “Disaster Management and Mitigation”, World Focus 2016

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<b>19CEXO02: ENVIRONMENTAL POLLUTION AND CONTROL</b>				

**Course Outcomes:**

Students are able to

1. Identify the air pollutant causes and control devices
2. Differentiate the treatment techniques used for sewage and industrial wastewater treatment methods.
3. Understand the fundamentals of solid waste management, practices adopted in his town/village and its importance in keeping the health of the city.
4. know the causes for noise pollution and ISO14000 standards
5. Treatment and management of hazardous waste

**SYLLUBUS****UNIT – I : Air Pollution**

Air pollution causes-control methods-particulate control devices – methods of controlling Gaseous Emissions – Air quality standards.

**UNIT –II: Industrial wastewater Management**

Strategies for pollution control – Volume and Strength reduction – Neutralization – Equalization – Proportioning – Common Effluent Treatment Plants – Recirculation of industrial wastes – Effluent standards.

**UNIT – III : Solid Waste Management**

Solid waste characteristics-basics of on-site handling and collection-separation and processing – Incineration- Composting-Solid waste disposal methods – fundamentals of land filling.

**UNIT – IV: Noise Pollution**

Noise standards, Measurement and control methods – Reducing residential and industrial noise – ISO14000

**UNIT – V: Hazardous Waste**

Characterization – Nuclear waste – Biomedical wastes – Electronic wastes – Chemical wastes – Treatment and management of hazardous waste-Disposal and Control methods.

**Text/References books:**

1. Ruth F. Weiner and Robin Matthews , ‘Environmental Engineering’, 4th Edition Elsevier, 2003.
2. J.G. Henry and G.W. Heinke, ‘Environmental Science and Engineering’ – Pearson Education, 2002
3. Mackenzie L Davis & David A Cornwell, “Environmental Engineering ‘, McGraw Hill Publishing, 2002.
4. K. Sasi Kumar, S.A. Gopi Krishna ,”Solid Waste Management”, PHI New Delhi, 2014
5. D. Srinivasan, “Environmental Engineering”, PHI Learning Private Limited, New Delhi, 2011.
6. Howard S. Peavy, Donald R. Rowe, Teorge George Tchobanoglus, ”Environmental Engineering”, Mc-Graw-Hill Book Company, New Delhi, 1985.

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**19CEX003: SOLID WASTE MANAGEMENT**

**Course Outcomes:**

Students are able to

1. Understand classification of solid waste generated
2. know the collection systems of solid waste of a town
3. analyze the importance of transfer and transport of solid waste
4. apply the knowledge in processing of solid waste
5. design treatment of municipal solid waste and landfill

**SYLLUBUS:**

**UNIT- I**

**Introduction to Solid Waste Management:**

Goals and objectives of solid waste management, Classification of Solid Waste - Factors Influencing generation of solid waste - sampling and characterization – Future changes in waste composition, major legislation, monitoring responsibilities.

**UNIT- II**

**Collection of Solid Waste:**

Type and methods of waste collection systems, analysis of collection system - optimization of collection routes– alternative techniques for collection system.

**UNIT- III**

**Transfer and Transport:**

Need for transfer operation, compaction of solid waste - transport means and methods, transfer station types and design requirements.

**UNIT- IV**

**Processing and Treatment:**

Processing of solid waste – Waste transformation through combustion and composting, anaerobic methods for materials recovery and treatment – Energy recovery – biogas generation and cleaning– Incinerators.

**UNIT- V**

**Disposal of Solid Waste:**

Methods of Disposal, Landfills: Site selection, design and operation, drainage and leachate collection systems –designated waste landfill remediation.

**Text/ Reference books:**

1. George Tchobanoglous, Frank Kreith ,Integrated Solid Waste Management- McGraw Hill Publication, 1993.
2. R.Saravanan, R.Dinesh Kumar, A.Suriya , Muncipal solid waste management , Lakshmi publications- 2015.
3. Vesilind, P.A., Worrell, W., Reinhart, D.,“Solid Waste Engineering”, Cenage learning, New Delhi, 2004.
4. Charles A. Wentz, “Hazardous Waste Management”,; McGraw Hill Publication, 1995.

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**19CEX004: BUILDING PLANNING AND DRAWING**

**COURSE OUTCOMES**

Students are able to

1. Understand the building bye-laws, plan various buildings as per the building by-laws.
2. Plan the individual rooms with reference to functional and furniture requirements.
3. prepare different sign conventions and bonds
4. Learn the skills of drawing building elements like doors and windows.
5. Develop the skills of Drawing Plans, Sections and Elevations of different buildings.

**SYLLABUS:**

**UNIT-I**

**BUILDING BYELAWS AND REGULATIONS:** Introduction - terminology - objectives of building Bye laws - floor area ratio - floor space index - principles under laying building bye laws - classification of buildings - open space requirements - built up area limitations- height of buildings- wall thickness - lightening and ventilation requirements.

**UNIT -II**

**RESIDENTIAL AND PUBLIC BUILDINGS**

**Residential buildings:** Minimum standards for various parts of buildings -requirements of different rooms and their grouping- characteristics of various types residential buildings.

**Public buildings:** Planning of educational institutions, hospitals, dispensaries, office buildings, banks, industrial buildings, hotels & motels, buildings for recreation.

**UNIT-III**

**SIGN CONVENTIONS AND BONDS :** Brick, stone, plaster, sand filling, concrete, glass, steel, cast iron, copper alloys, aluminum alloys etc., lead, zinc, tin etc., earth, rock, timber and marbles. English bond and Flemish bond- odd and even courses for one, one-half, two and two & half brick walls in thickness at the junction of a corner.

**UNIT- IV**

**DOORS, WINDOWS, VENTILATORS AND ROOFS:** Panelled door, panelled and glassed door, glassed windows, paneled windows, swing ventilators, fixed ventilators, coupled roof, collar roofs. King Post truss, Queen Post truss Sloped and flat roof buildings: drawing plans, Elevations and Cross Sections of given sloped roof buildings.

**UNIT-V**

**PLANNING AND DESIGNING OF BUILDINGS:** Draw the Plan, Elevation and sections of a Residential & Public buildings from the given line diagram.

**Text /Reference Books:**

1. Y.S. Sane., Planning and Design of buildings, 2010.
2. Gurucharan Singh and Jagadish Singh , Planning, designing and scheduling, 2015.
3. M. Chakravarthi., Building planning and drawing, 2015.
4. 'A' Series & 'B' Series of JNTU Engineering College, Anantapur.
5. Shah and Kale , Building drawing, 2013.

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**19MEXO01: 3D PRINTING****COURSE OBJECTIVES:**

- To explore technology used in additive manufacturing
- To acquire knowledge for selecting correct CAD formats in manufacturing process.
- To understand the operating principles and limitations of liquid, solid and laser based additive manufacturing system.
- To understand the operating principles and limitations of laser based additive manufacturing system.
- To acquire knowledge on important process parameters for bio-manufacturing

**COURSE OUTCOMES:** Students are able to

**CO1:** Explain the fundamentals of Additive Manufacturing Technologies for engineering applications. [K2]

**CO2:** Select and use correct CAD formats in the manufacture of a 3D printed part [K2]

**CO3:** Describe the operating principles, capabilities, and limitations of liquid and solid based additive manufacturing system, including fused deposition modeling and stereo lithography [K2]

**CO4:** Describe the operating principles, capabilities and limitations of laser based additive manufacturing system. [K2]

**CO5:** Describe the important process parameters for bio-manufacturing and determine the suitable additive technique for bio-manufacturing, aerospace and manufacturing engineering. [K2]

**UNIT I****INTRODUCTION**

Overview, History, Need, Classification, Additive Manufacturing Technology in product development - Materials for Additive Manufacturing Technology

**UNIT II****REVERSE ENGINEERING**

Basic Concept –3D Scanning Digitization techniques , Model Reconstruction, Data Processing for Additive Manufacturing Technology, Part Orientation and support generation, Model Slicing, Tool path Generation.

**UNIT III****LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS**

Classification, Stereo lithography Apparatus (SLA) - Principle, Process, advantages, Fused Deposition Modeling – principle, process, advantages.

**UNIT IV****LASER BASED ADDITIVE MANUFACTURING SYSTEMS**

Selective Laser Sintering - Principle, Process, advantages, Three Dimensional Printing – Principle, process, advantages, Laser Engineered Net Shaping (LENS).

**UNIT V****APPLICATIONS OF 3D PRINTING**

Customized implants and prosthesis: Design and development, Bio-Additive Manufacturing, Computer Aided Tissue Engineering (CATE), Applications of 3D Printing in Aerospace, Automotive, Manufacturing and Architectural Engineering.

**TEXT BOOKS**



1. Chua C.K., Leong K.F., and Lim C.S., Rapid prototyping: Principles and applications, Third Edition, World Scientific Publishers, 2016.
2. Gebhardt A, Rapid prototyping, Hanser Gardener Publications, 2017.
3. Chee Kai Chua, Kah Fai Leong, 3D Printing and Additive Manufacturing: Principles and Applications, World Scientific Publishers, Fourth Edition of Rapid Prototyping, 2016.

## **REFERENCES**

1. Liou L.W. and Liou F.W., Rapid Prototyping and Engineering applications: A tool box for prototype development, CRC Press, 2017.
2. Kamrani A.K. and Nasr E.A., Rapid Prototyping: Theory and practice, Springer, 2016.
3. Hilton P.D. and Jacobs P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2015.

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**19MEXO02 - FARM MACHINERY****COURSE OBJECTIVES:**

- To impart the students to understand the fundamentals of machinery in farming.
- To enable the students to acquire knowledge on tillage and equipment used.
- To introduce the students about various types of earth moving equipment.
- To enable the students to acquire knowledge on seeding and spraying equipment.
- To introduce the fundamentals of transplanting machinery and fertilizer equipment.

**COURSE OUTCOMES:** Students will be able to

CO1. Explain various types of machinery in farming. [K2]

CO2. Illustrate different types of farm operation for craft cultivation with scientific understanding. [K2]

CO3. Explain various types of earth moving equipment. [K2]

CO4. Summarize various seeding methods and sprayer types. [K2]

CO5. Explain transplanting methods and fertilizer equipment. [K2]

**UNIT I**

**Farm Mechanization:** Objectives of Farm Mechanization, sources of farm power, classification of farm machines. Materials of construction and heat treatment. Principles of operation and selection of machines used for production of crops - Field capacities of different implements and their economics. Problems on field capacities and cost of cultivation

**UNIT II**

**Tillage and Equipment:** Classification and types of tillage, Primary tillage implements-Mould board plough and its parts, Disc plough, and other ploughs, Secondary tillage equipment- Disc harrows, implements- Cultivators, and intercultural implements. Forces acting on tillage tools, Problems on forces analysis, Draft measurement of tillage equipment, Draft and unit draft related problems.

**UNIT III**

**Earth Moving Equipment:** Earth moving equipment-terminology, Earth moving equipment, construction and their working principles, Earth moving equipment- shovels, Bulldozers, Earth moving equipment- Trenches and elevators.

**UNIT IV****Seed Drills and Sprayer:**

Seeding methods, Different types of seed metering mechanism, different types of furrow openers. Calibration of Seed drills. Adjustment of Seed Drills - Objectives and uses of plant protection equipment. Types of sprayers and dusters. Sprayer calibration and selection. Constructional features of different components of sprayers and dusters and their adjustments.

**UNIT V**

**Transplanting and Fertilizer:** Transplanting methods, different types of Transplanting machinery and their working principle, adjustments in Transplanting equipment. Fertilizer application equipment – fertilizer metering mechanism calibration of fertilizer equipment.

### **TEXTBOOKS**

1. Triveni Prasad Singh, Farm Machinery. India, Prentice Hall India Pvt., Limited, 2016.
2. Jagadeshwar Sahay, Elements of Agricultural Engineering, Agro Book agency, Patna, 1992.
3. Borshahov Mansurov Sergecy, Land Reclamation Machinery, Mir Publishers, Moscow, 1988.
4. Kepner R A, Bainer R and Barger E L, Principles of Farm Machinery, CBS Publishers and Distrubutors, New Delhi, 1987.
5. Michael A M and Ojha T P, Principles of Agricultural Engineering, Jain Brothers, New Delhi, 1985, Vol.I.
6. Smith H P, Farm Machinery and Equipment, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1971.
7. Stone A A, Farm Machinery, John Wiley & Sons, New York.

### **REFERENCES**

1. Srivastaba A.C, Elements of Farm Machinery, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi, 1990.
2. Krutz, Gary, Thompson Lester and Claar, Paul, Design of Agricultural Machinery", John Wiley and Sons, 1984.
3. Lal, Radhey and Dutta, A.C. Agricultural Engineering through solved examples, Saroj Prakashan Publishers, Allahabad, 1971

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**19MEXO03 - BIO-MECHANICAL ENGINEERING**

**COURSE OBJECTIVES:**

The student should be made to:

- Explain the principles of mechanics.
- Discuss the mechanics of musculoskeletal system.
- Explain the linear kinetics and angular kinetics
- Illustrate the mathematical models used in the analysis of biomechanical systems

**COURSE OUTCOMES: Students are able to**

- CO1** Infer the introduction of Bio mechanics. [K4]
- CO2** Learn about mechanics of musculoskeletal system. [K2]
- CO3** Relate the concept of kinetics with human motion. [K3]
- CO4** Develop knowledge on mechanical analysis of human motion. [K3]
- CO5** Analyze human movements. [K4]

**UNIT-I**

**INTRODUCTION TO BIO MECHANICS**

Principles of mechanics in human movement, Qualitative and quantitative Analysis, Key mechanical concepts of mechanics and basic units, Nine fundamentals of biomechanics, Nine principles for application of Biomechanics.

**UNIT-II**

**MECHANICS OF MUSCULOSKELETAL SYSTEM**

Principles of joint motions, Muscle structures, Mechanical method of muscle action analysis, Tissue loads and forces, Biomechanics of bones and ligaments, Three mechanical characters of muscle, SSC.

**UNIT-III**

**LINEAR KINETICS AND ANGULAR KINETICS**

Vector analysis of angle of pull and muscle angle pull, Contact forces, Impulse-Momentum Relationship, Force-Time Principle, Work-Energy relationship, Segmental interaction principle, Torque, Equilibrium, Center of gravity and Principle of balance.

**UNIT-IV**

**MECHANICAL ANALYSIS OF HUMAN MOTION**

Linear kinematics - linear kinematic analysis, position and displacement, velocity and speed, acceleration, differentiation and integration, kinematics of running, kinematics of projectiles, equations of constant acceleration. Angular kinematics - angular motion, measurements of angles, types of angles, representation of angular motion vectors, lower extremity joint angles, relationship between angular and linear motion, angular kinematics of running.

**UNIT-V**

**APPLICATIONS OF ENGINEERING EDUCATION & MEDICAL REHABILITATION**

Qualitative analysis of Kicking technique, batting, catching, throwing techniques, Injury risk assessment, Equipment design for strength training, Injury mechanics, Injury prevention.

**TEXT BOOKS:**

1. Ronald L.Huston, Principles of Biomechanics,1<sup>st</sup> edition CRC Press, 2019
2. Joseph E.Muscolino, “ Kinesology”, 3rd edition, Mosby, 2016.
3. Subrata Pal, “Textbook of Biomechanics”, 1<sup>st</sup> edition, Springer US, 2016.

**REFERENCE BOOKS:**

1. Duane Knudson, “Fundamentals of Biomechanics”, 2<sup>nd</sup> edition, Springer, 2013.
2. Ajay Bahl, “Basics of Biomechanics”, 1<sup>st</sup> edition, Jaypee Brothers Medical Publishers, 2010.
3. Robert frost, “Applied Kinesiology”, 1<sup>st</sup> edition, North Atlantic Books; 2013
4. David A. Winter, “Biomechanics and Motor Control of Human Movement”, John Wiley & sons,Inc., 2009.

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**19MEXO04- WASTE TO ENERGY CONVERSION****COURSE OBJECTIVES:**

- To enable students to understand of the concept of Waste to Energy.
- To link legal, technical and management principles for production of energy form waste.
- To learn about the best available technologies for waste to energy.
- To facilitate the students in developing skills in the decision making process.

**COURSE OUTCOMES:** Students will be able to

- CO1. Describe of the concept of Waste to Energy, classifications and principles.[K2]  
 CO2. Explain the Technical and management principles for production of energy form waste.[K2]  
 CO3. Explain the best available technologies for waste to energy.[K2]  
 CO4. Describe the Waste to Energy Options Landfill gas, RDF,AFR andenergy from Plastics.[K2]  
 CO5. Apply the knowledge in planning and operations of Waste to Energy plants[K3]

**UNIT-I**

**Introduction:** Principles of Waste Management and Waste Utilization, Waste Management Hierarchy and 3R Principle of Reduce, Reuse and Recycle, Waste as a Resource and Alternate Energy source.

**UNIT-2**

**Waste Sources & Characterization:** Waste production in different sectors such as domestic, industrial, agriculture, postconsumer, waste etc. Classification of waste – agro based, forest residues, domestic waste, industrial waste (hazardous and non-hazardous), Characterization of waste for energy utilization, Waste selection criteria.

**UNIT- 3**

**Technologies for Waste:**Energy Biochemical Conversion – energy production from organic waste through anaerobic digestion and fermentation, Thermo-chemical Conversion – combustion, incineration, heat recovery, pyrolysis, gasification, Plasma Arc Technology, other newer technologies.

**UNIT- 4**

**Waste to Energy Options:** Landfill gas, collection and recovery, Refuse Derived Fuel (RDF) – fluff, briquettes, pellets, Alternate Fuel Resource (AFR) – production and use in cement plants, thermal power plants, Industrial boilers, Conversion of wastes to fuel resources for other useful energy applications, Energy from Plastic Wastes – non-recyclable plastic wastes for energy recovery, Energy recovery from wastes and optimization of its use, benchmarking and standardization, Energy Analysis.

**UNIT-5:****Waste to Energy Plants**

Waste management activities – collection, segregation, transportation and storage requirements, Location and Siting of ‘Waste to Energy’ plants, Industry Specific Applications – In-house use

**Waste to Energy & Environmental Implications:** Environmental standards for Waste to Energy Plant operations and gas clean-up. Savings on non-renewable fuel resources, Carbon Credits- carbon foot calculations, carbon credits transfer mechanisms.

**TEXT BOOKS:**

1. B.T. Nijaguna, Biogas Technology, 1<sup>st</sup> Edition, New Age International Pvt Ltd, 2002.

2. Marc Rogoff Francois Screve, Waste-to-Energy, 3<sup>rd</sup> Edition, William Andrew,2019.
3. Vishal Prasad, BarkhaVaish, Advances in Waste-to-Energy Technologies, 1<sup>st</sup>Edition, CRC Press, 2019
4. Dev Vrat Kamboj, Manoj Kumar Solanki, Waste to Energy: Prospects and Applications, 1<sup>st</sup> Edition, Springer,2021

**REFERENCE BOOKS:**

1. Khandelwal, K. C. and Mahdi.S.S, Biogas Technology - A Practical Hand Book, 1<sup>st</sup> Edition, 1986.
  2. Challal,D.S, Food Feed and Fuel from Biomass, 1<sup>st</sup> Edition, IBH Publishing Co. Pvt. Ltd, 1991.
  3. C. Y. WereKo-Brobby and E. B. Hagan, Biomass Conversion and Technology, 1<sup>st</sup> Edition, John Wiley& Sons, 1996.
- Desai, Ashok V, Non-Conventional Energy, 1<sup>st</sup> Edition, Wiley Eastern Ltd, 1990

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**19CSXO01 - INTERNET OF THINGS AND APPLICATIONS**

**Course Outcome:****At the end of the course students are able to**

1. Explain Arduino IDE tool and Arduino Programming concept.
2. Illustrate concept hardware configuration with Firmata protocols.
3. Explain the knowledge Arduino pin configuration.
4. Differentiate various sensors configuration and workflows.
5. Define architecture of IoT.
6. Explain the knowledge in cloud based web application.

**UNIT-I (Introduction to Arduino)**

Introduction to Arduino, history of Arduino, variants, Uno board block diagram, installation of Arduino, Arduino IDE, Arduino programming, functions and statements.

**UNIT-II (Configuration)**

Connecting Arduino board, introducing the Firmata Protocol, uploading a Firmata sketch to the Arduino board, testing the Firmata protocol.

**UNIT-III (Components)**

List of components, software flow design, hardware flow design, hardware prototyping software, designing the hardware prototype, Arduino sketch default functions and custom function, setting Arduino board, pin configuration, working with pins.

**UNIT-IV (Prototype)**

Potentiometer-continuous observation from an analog input connection, Buzzer-generating sound alarm pattern, DC motor-controlling motor speed using PWM, LED- controlling LED brightness using PWM, Servomotor- moving the motor to a certain angle.

**UNIT-V (Networking and cloud)**

Arduino and computer networking, networking fundamentals, Obtaining the IP address, Networking extensions for Arduino with libraries and class, architecture of IoT web applications, IoT cloud platforms, develop cloud-based IoT applications.

**Textbooks:**

1. Python programming for Arduino by Pratik desai, Packt Publishing.
2. Internet of Things with Arduino Cookbook by Marco Schwartz.
3. Introduction to Arduino by Alan G. Smith.

**References**

1. Beginning Arduino by Michael McRoberts, 2e.
2. Getting Started with Arduino Massimo Banzi Second Edition.



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**19CSXO02 - FOUNDATION TO DATA ANALYTICS**

**COURSE OUTCOMES:**

1. To understand the basics of Excel as business analytics.
2. To use of basic functions and statistical functions in Excel
3. To obtain knowledge about using of pivot tables and charts
4. To understand the advanced business analytics related charts
5. To know about statistical concepts for data analysis and basics of Power BI.

**UNIT – I**

**Introduction to spreadsheets:** reading data, manipulating data. Basic spreadsheet operations and functions.

**Introduction to Business analytics:** Introduction, Types of Analytics, Area of Analytics.

**UNIT – II**

**Spreadsheet Functions to Organize Data:** Conditional formatting, Logical functions: Lookup and reference functions, IF, Nested IF, VLOOKUP, HLOOKUP, MATCH, INDEX and OFFSET functions in Excel.

**Statistical functions:** Introduction, SUMIFS, COUNTIF, PERCENTILE, QUARTILE, STDEV, MEDIAN and RANK Function

**UNIT – III**

**Introduction to Filtering, Pivot Tables, and Charts:** Introduction to the data filtering capabilities of Excel, the construction of Pivot Tables to organize data and introduction to charts in Excel.

**Pivot Table Introduction:** Creating a Pivot Table, Grouping in Pivot Table, Custom Calculated Field and Calculated Item, Slicer Introduction, Creating a Slicer

**UNIT – IV:**

**Advanced Graphing and Charting:** Constructing various Line, Bar and Pie charts. Using the Pivot chart features of Excel. Understanding and constructing Histograms and Scatterplots.

**Business analytics with Excel:** Introduction, Histogram, Data Table, Descriptive Statistics.

**UNIT – V:**

**Data Analysis Using Statistics:** Introduction, Moving Average, Hypothesis Testing, ANOVA, Covariance, Correlation, Regression, Normal Distribution.

**Power BI:** Introduction, Power Pivot, Power View, Power Query, Power Map.

**Reference Books:**

1. Advanced Analytics with Excel 2019: Perform Data Analysis using Excel's Most Popular Features (English Editions), 2020
2. Beginning Excel What-If Data Analysis Tools: Getting Started with Goal Seek, Data Tables, Scenarios, and Solver – Illustrated, Paul Cornell, 2005.

**Website Link for Reference:**

1. <https://www.excel-easy.com/data-analysis.html>

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<b>19CSXO03 - DATA ENGINEERING</b>				

**COURSE OUTCOMES:**

1. At the end of the course Students will be able to:
2. Apply the skills of data inspecting and cleansing.
3. Determine the relationship between data dependencies using statistics
4. Can handle data using primary tools used for data science in Python
5. Represent the useful information using mathematical skills
6. Can apply the knowledge for data describing and visualization using tools.

**UNIT I INTRODUCTION**

Need for data science – benefits and uses – facets of data – data science process – setting the research goal – retrieving data – cleansing, integrating, and transforming data – exploratory data analysis – build the models – presenting and building applications

**UNIT II DESCRIBING DATA I**

Frequency distributions – Outliers – relative frequency distributions – cumulative frequency distributions – frequency distributions for nominal data – interpreting distributions – graphs – averages – mode – median – mean – averages for qualitative and ranked data – describing variability – range – variance – standard deviation – degrees of freedom – interquartile range – variability for qualitative and ranked data

**UNIT III PYTHON FOR DATA HANDLING**

Basics of Numpy arrays – aggregations – computations on arrays – comparisons, masks, boolean logic – fancy indexing – structured arrays – Data manipulation with Pandas – data indexing and selection – operating on data – missing data – hierarchical indexing – combining datasets – aggregation and grouping – pivot tables

**UNIT IV DESCRIBING DATA II**

Normal distributions – z scores – normal curve problems – finding proportions – finding scores – more about z scores – correlation – scatter plots – correlation coefficient for quantitative data – computational formula for correlation coefficient – regression – regression line – least squares regression line – standard error of estimate – interpretation of  $r^2$  – multiple regression equations – regression toward the mean

**UNIT V PYTHON FOR DATA VISUALIZATION**

Visualization with matplotlib – line plots – scatter plots – visualizing errors – density and contour plots – histograms, binnings, and density – three dimensional plotting – geographic data – data analysis using statmodels and seaborn – graph plotting using Plotly – interactive data visualization using Bokeh

**TEXT BOOKS:**

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, “Introducing Data Science”, Manning Publications, 2016. (first two chapters for Unit I)
2. Robert S. Witte and John S. Witte, “Statistics”, Eleventh Edition, Wiley Publications, 2017. (Chapters 1–7 for Units II and III)

3. Jake VanderPlas, “Python Data Science Handbook”, O’Reilly, 2016. (Parts of chapters 2–4 for Units IV and V)

**REFERENCES:**

1. Allen B. Downey, “Think Stats: Exploratory Data Analysis in Python”, Green Tea Press, 2014.

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**19CSXO04 - MACHINE LEARNING**

**Course outcomes:****At the end of the course students are able to**

1. Define basic concepts of machine learning.
2. Evaluate and compare the performance or, other qualities of regression and logistic regression.
3. Describe concepts of artificial intelligence.
4. Design a supervised or unsupervised learning system.
5. Define the knowledge about SVM.
6. Demonstrate Instance based learning algorithms.

**UNIT I: Introduction**

Well-posed learning problems, designing a learning system, Perspectives and issues in machine learning. Concept learning and the general to specific ordering – Introduction, a concept learning task, Concept learning as search, Find- S: finding a maximally specific hypothesis, Version spaces and the candidate elimination algorithm, Remarks on version spaces and candidate elimination, Inductive bias.

**UNIT II: Linear Regression & Logistic Regression**

Predicting numeric values: regression – Finding the best fit lines with linear regression, locally weighted linear regression, Shrinking Coefficients, The bias / Variance tradeoff. Logistic Regression: Classification with logistic regression and the sigmoid function, using optimization to find the best regression coefficients.

**UNIT III: Artificial Neural Networks**

Introduction, Neural network representation, Appropriate problems for neural network learning, Perceptions, Multilayer networks and the back propagation algorithm, Remarks on the back propagation algorithm, An illustrative example face recognition, Advanced topics in artificial neural networks.

**UNIT IV: Evaluation Hypotheses**

Motivation, Estimation hypothesis accuracy, Basics of sampling theory, a general approach for deriving confidence intervals, Difference in error of two hypotheses, Comparing learning algorithms.

**UNIT V: Support vector machines & Dimensionality Reduction techniques**

Separating data with the maximum margin, finding the maximum margin, efficient optimization with SMO algorithm, speeding up optimization with full Platt SMO, Using Kernels for more Complex data. Dimensionality Reduction techniques: Principal Component analysis, Example.

**Instance-Based Learning**

Introduction, k -Nearest Neighbor Learning, Locally Weighted Regression, Radial Basis Functions, Case-Based Reasoning, Remarks on Lazy and Eager Learning.

### **TEXT BOOKS**

1. Machine Learning, Tom M. Mitchell, MGH
2. Machine Learning in Action, Peter Harington, 2012, Cengage.`

### **REFERENCE BOOKS**

1. Introduction to Machine Learning, Ethem Alpaydin, PHI, 2004

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**19ECXO01: NANO TECHNOLOGY AND APPLICATIONS****COURSE OUTCOMES:****Students are able to**

- CO1.** Define Nano materials and Nano Technology with properties  
**CO2.** Explain Synthesis as Fabrication methods of Nano Technology  
**CO3.** Demonstrate Characterization techniques of Nano Materials  
**CO4.** Analyze carbon Nano technology and application of Nano technology.

**UNIT-I**

**INTRODUCTION:** History of nano science, definition of nano meter, nano materials, nano technology, Classification of nano materials, Applications in material science, biology and medicine, surface science, energy and environment, Crystal symmetries, crystal directions, crystal planes, Band structure,

**UNIT-II**

**PROPERTIES OF MATERIALS:** Mechanical properties, electrical properties, dielectric properties, thermal properties, magnetic properties, opto electronic properties. Effect of size reduction on properties, electronic structure of nano materials.

**UNIT-III**

**SYNTHESIS & FABRICATIONMETHODS:** Synthesis of bulk polycrystalline samples, growth of single crystals. Synthesis techniques for preparation of nano particle – Bottom Up Approach – sol gel synthesis, hydro thermal growth, thin film growth, PVD and CVD; Top Down Approach – Ball milling, micro fabrication, lithography.

**UNIT-IV**

**CHARECTERIZATION TECHNIQUES:** X-Ray diffraction and Scherrer method, scanning electron microscopy, transmission electron microscopy, scanning probe microscopy, atomic force microscopy, piezoresponse microscopy, X-ray photoelectron spectroscopy, XANES and XAFS, angle resolved photoemission spectroscopy, diffuse reflectance spectra, photoluminescence spectra, Raman spectroscopy.

**UNIT-V**

**CARBON NANO TECHNOLOGY:** Characterization of carbon allotropes, synthesis of diamond – nucleation of diamond, growth and morphology. Applications of nanocrystalline diamond films, grapheme, applications of carbon nanotubes, carbon nanotubes for nanoelectronics devices.

**TEXT BOOKS:**

1. Nano science and nano technology by M.S RamachandraRao, Shubra Singh, Wiley publishers.  
(UNITS-I,II&III)
2. Fundamentals of nano electronics by George W Hanson Pearson publications, India 2008  
(Unit- I, IV&V)

**REFERENCE BOOKS:**

1. Introduction to Nano Technology by Charles P. Poole, Jr., Frank J.Owens, Wiley publishers.
2. Principles of Nanotechnology by Phani Kumar, Scitech.

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**19ECX002 - GLOBAL POSITIONING AND NAVIGATION SATELLITE SYSTEMS**

**COURSE OUTCOMES:**

Upon completion of this course, the student would be able to

**CO1:** Describe the concepts of GNSS based positioning methods, the core components of a satellite navigation system and their purposes.

**CO2:** Estimate and represent the GPS coordinate frames and GPS orbits.

**CO3:** Analyze the impact of various error sources on the precision of positioning.

**CO4:** Dramatize the examples of their role of goods and services based on the GSP in sustainable development.

**UNIT - I**

Overview of GPS: Basic concept, system architecture, space segment, user segment, services of GPS, applications of GPS.

**UNIT - II**

GPS Signals: Signal structure, anti spoofing (AS), selective availability, Difference between GPS and GALILEO satellite construction.

**UNIT - III**

GPS coordinate frames, Time references: Geodetic and Geo centric coordinate systems, ECEF coordinate world geodetic 1984 (WGS 84), GPS time.

**UNIT - IV**

GPS orbits and satellite position determination: GPS orbital parameters, description of receiver independent exchange format (RINEX)–Observation data and navigation message data parameters, GPS position determination.

**UNIT - V**

GPS Errors: GPS error sources – clock error, ionospheric error, tropospheric error, multipath, ionospheric error estimation using dual frequency GPS receiver.

**TEXT BOOKS:**

1. G. S. RAO, Global Navigation Satellite Systems, 2<sup>nd</sup> Edition, McGraw-Hill publications, New Delhi, 2010. (UNIT-I-V)

**REFERENCE BOOKS:**

1. B. Hoffman – Wellenhof, H. Liehtenegger and J. Collins, ‘GPS – Theory and Practice’, 4<sup>th</sup> Edition, Springer – Wien, New York , 2001. (UNIT-I-III)
2. Sateesh Gopi, “Global Positioning System: Principles and Applications”, 3<sup>rd</sup> Edition, TMH, 2005. (UNIT-I-II)
3. James Ba – Yen Tsui, ‘Fundamentals of GPS receivers – A software Approach’, 3<sup>rd</sup> Edition, John Wiley & Sons, 2001. (UNIT-IV-V)
4. Elliot D. Kaplan, “Understanding GPS Principles and Applications”, 2<sup>nd</sup> edition, Artech House, 2005. (UNIT-I-III)

**E-REFERENCES:**

1. <http://www.unoosa.org/oosa/sk/ourwork/psa/gnss/gnss.html>  
[https://www.faa.gov/about/office\\_org/headquarters\\_offices/ato/service\\_units/techops/navservices/gnss/gps/howitworks/](https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/navservices/gnss/gps/howitworks/)
2. <https://www.princeton.edu/~alaink/Orf467F07/GNSS.pdf>
3. <https://www.euspa.europa.eu/european-space/eu-space-programme/what-gnss>  
<https://www.gps.gov/systems/gnss/>



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**19ECX003 - REMOTE SENSING**

**COURSE OUTCOMES:**

**After Completion of this course, students are able to**

**CO1:** Understand the subject of satellite communication and remote sensing with the core knowledge of space and satellite, communication and the international space laws.

**CO2:** Comprehend different remote sensing signaling techniques, capable of interpreting signature of satellite communication from bodies like soil, vegetation and ocean.

**CO3:** Analyze various components used in satellite communication and remote sensing applications.

**CO4:** Acquire and keep abreast of designing satellite remote sensing system and also analyze the sensor data for drawing inference and conclusions.

**UNIT I**

Introduction: Historical background, International space laws, Advantages of space based observations, Global coverage, Multiscale observation, repeat observation immediate transmission and digital format, Source of information on remote sensing region.

**UNIT II**

Principles of remote sensing: Fundamentals of remote sensing signals, The electromagnetic spectrum, Terms and units of measurements, EM radiation laws, Spectral signature in the solar spectrum, vegetation reflectance, soil reflectance, water in the solar spectrum, The thermal infrared domain, characteristics of EM radiation in thermal infrared, Thermal properties of vegetation, Soils thermal domain, thermal signature of water and snow, The microwave region, Atmospheric interaction.

**UNIT III**

Sensors and remote sensing satellite: Type of sensors, Resolution of sensor systems, spatial, spectral, radiometric, temporal, angular - resolution, passive sensors, photographic cameras, cross and along track - scanners, active sensors, Radar and Lidar, satellite remote missions, Satellite orbits, Landsat programs, SPOT satellites, IRS program, High resolution commercial satellites, Polar orbiting meteorological satellites, Terra Aqua, Geostationary meteorological satellites.

**UNIT IV**

Basis for interpretations of remote sensing images: Constraints in using remote sensing data, types of interpretation, Costs of data acquisitions, end-user requirements, Thematic classification, Generation of biophysical variables, Change detection, spatial patterns, organization of remote sensing project, interpretation phase, presentation of study cases.

**UNIT V**

Characteristic of photographic images, Feature identification, criteria for visual interpretation, Brightness, color, texture, spatial contexts, shadows, spatial patterns, shape and size, stereoscopic view, period of acquisition, elements of visual analysis, Geometric characteristics of satellite image, Color composites, Multitemporal approaches.

**TEXTBOOKS:**

1. Emilio Chuvieco, "Fundamentals of Satellite Remote Sensing", CRC press, Edition, 2009.

**REFERENCES:**

1. C. H. Chen, "Signal Processing for Remote Sensing", CRC press, Edition-2007.

2. R. N Mutagi, "Satellite Communication Principles and Applications", Oxford University press, 2016.

3. Enrico Del Re, and Marina Ruggieri, "Satellite communications and navigation systems", Springer.

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**19ECX004 - MOBILE COMMUNICATION AND APPLICATIONS**

**COURSE OUTCOMES:**

**Students are able to**

- CO1.** Design Hexagonal shaped cells and how these are implemented in real world.
- CO2.** Explain different types of antenna systems in mobile communication.
- CO3.** Analyze Handoffs and different types of handoffs and Dropped call rates and their evaluation.
- CO4.** Describe the Parameters of Mobile multipath channels, Types of small scale fading.

**UNIT-I**

**INTRODUCTION :**

Evolution of Mobile Communications, Mobile Radio Systems around the world, First, Second, Third Generation Wireless Networks, Wireless Local Loop(WLL), Wireless LANs, Bluetooth, Personal Area Networks(PANs), A Simplified Reference Model, Applications.

**UNIT-II**

**ELEMENTS OF MOBILE COMMUNICATIONS:**

General description of the problem, concept of frequency channels, Co-channel Interference Reduction Factor, desired C/I from a normal case in a Omni directional Antenna system, Cell splitting, consideration of the components of Cellular system.

**UNIT-III**

**THE MOBILE CONCEPT :**

Introduction, Frequency reuse, Handoff strategies, Interference and System Capacity: Co- Channel Interference, Channel Planning, Adjacent Channel Interference, Power control for reducing interference, Trunking and Grade of Service, Cell Splitting, Sectoring.

**UNIT-IV**

**MOBILE RADIO PROPAGATION :**

Introduction, Free space propagation model, The three basic propagation models-Reflection, Diffraction and Scattering, Two-ray model, Outdoor propagation models, Indoor propagation models, Signal Penetration into building, Small scale multipath Propagation, Parameters of Mobile multipath channels, Types of small scale fading.

**UNIT-V**

**FREQUENCY MANAGEMENT AND CHANNEL ASSIGNMENT:**

Numbering and grouping, setup access and paging channels channel assignments to cell sites and mobile units, channel sharing and borrowing, sectorization, overlaid cells, non fixed channel assignment.

**TEXTBOOKS:**

1. Wireless Communications by Theodore S. Rappaport, principles and practice, 2<sup>nd</sup> Editions. **(Unit-I, III, IV & V)**
2. Mobile Cellular Communication by Gottapu Sasibhushana Rao, Pearson International, 2012.

**(UNIT - I, II, III & IV)**

3. Mobile Cellular Telecommunications – W.C.Y. Lee, Tata McGraw Hill, 2<sup>nd</sup> Edn., 2006. **(UNIT - V & VI)**

**REFERENCES:**

1. Wireless and Mobile Communications-Lee, McGraw Hill, 3<sup>rd</sup> Edition, 2006.

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**19ITXO01 : SOFTWARE ENGINEERING PRINCIPLES**

## COURSE OUTCOMES

After the completion of the course the students are able to

1. Identify, formulate, and solve software engineering problems.
2. Elicit, analyze and specify software requirements with various stakeholders of a software development project.
3. Implement the techniques for project planning and estimation.
4. Participate in design, development, deployment and maintenance of a medium scale software development project.
5. Evaluate the impact of potential solutions to software engineering problems in a global society, using the knowledge of models, tools, and techniques.

### UNIT-I

**Introduction to Software Engineering:** The evolving role of software, Software Characteristics, Changing Nature of Software, Software myths.

**A Generic view of Process:** Software engineering- A layered technology, a Process framework, The Capability Maturity Model Integration (CMMI), Process assessment, Product and Process.

### UNIT-II

**Process models:** The waterfall model, Incremental process models, Evolutionary process models, The Unified process.

**Software Requirements:** User requirements, System requirements, Functional and non-functional requirements, the Software Requirements Document (SRS).

### UNIT-III

**Requirements Engineering Process:** Feasibility studies, Requirements elicitation and analysis, Requirements validation, Requirements management.

**Project planning and estimation:** Project Planning Activities, Software Metrics and Measurements, Project Size Estimation, Effort Estimation Techniques: COCOMO, PERT/CPM method.

### UNIT-IV

**Design Engineering:** Design process and Design quality, Design concepts, Software Architecture, Architectural Styles and Patterns.

**Object-Oriented Design:** Objects and object classes, An Object-Oriented design process, Design evolution

### UNIT-V

**Performing User Interface Design:** Golden Rules, User interface analysis and design, interface design steps, Design evaluation.

**Testing Strategies:** A strategic approach to software testing, test strategies for conventional software, Validation testing, System testing, the art of Debugging, Black-Box and White-Box testing.

**Text Books:**

1. Software Engineering, A practitioner's Approach- Roger S. Pressman, 6<sup>th</sup> edition, McGrawHill International Edition.
2. Software Engineering- Sommerville , 9th edition, Pearson education.

**References Books:**

1. Software Engineering- K.K. Agarwal & Yogesh Singh, New Age International Publishers
2. Software Engineering, an Engineering approach- James F. Peters, WitoldPedrycz, John Wiely.
3. Systems Analysis and Design- ShelyCashman Rosenblatt, Thomson Publications.
4. Software Engineering principles and practice- Waman S Jawadekar, The McGraw-Hill Companies.

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**19ITXO02 : CLOUD COMPUTING PRINCIPLES**

**COURSE OUTCOMES**

After the completion of the course the students are able to

1. Explain basics of cloud computing technology.
2. Demonstrate the concept of virtualization and the development of Cloud Computing.
3. Analyze various cloud services and service providers.
4. Explain and Uses cloud scalability, security and disaster management.
5. Understand the different cloud platforms and its application.

**UNIT-I**

**Introduction to Cloud:** Cloud Computing at a Glance, the Vision of Cloud Computing, Defining a Cloud, A Closer Look, Cloud Computing Reference Model. Characteristics and Benefits, Challenges Ahead, Historical Developments.

**UNIT-II**

**Virtualization:** Introduction, Characteristics of Virtualized Environment, Classification of Virtualization Techniques, Virtualization and Cloud computing, Pros and Cons of Virtualization, Technology Examples-VMware and Microsoft Hyper-V.

**Before the Move into the Cloud:** Know Your Software Licenses, The Shift to a Cloud Cost Model, Service Levels for Cloud Applications.

**UNIT-III**

**Cloud Computing Architecture :** Introduction, Architecture, Infrastructure / Hardware as a Service, Platform as a Service, Software as a Service, Types of Clouds, Public Clouds, Private Clouds, Hybrid Clouds, Community Clouds, Economics of the Cloud, Open Challenges, Cloud Interoperability and Standards, Scalability and Fault Tolerance.

**UNIT-IV**

**Defining the Clouds for Enterprise:** Storage as a service, Database as a service, Process as a service, Information as a service, and Integration as a service and Testing as a service. Scaling cloud infrastructure - Capacity Planning, Cloud Scale. Disaster Recovery: Disaster Recovery Planning, Disasters in the Cloud, Disaster Management.

**UNIT-V**

**Cloud Applications:** Scientific Applications – Health care, Geo science and Biology. Business and Consumer Applications- CRM and ERP, Social Networking, Media Applications and Multiplayer Online Gaming.

**Cloud Platforms in Industry:** Amazon Web Services- Compute Services, Storage Services, Communication Services and Additional Services. Google AppEngine-Architecture and Core Concepts, Application Life-Cycle, cost model. Microsoft Azure- Azure Core Concepts, SQL Azure.

**Text Books:**

1. “Mastering Cloud Computing” by Rajkumar Buyya, Christian Vecchiola, S.Thamarai Selvi from TMH 2013.
2. George Reese “Cloud Application Architectures”, First Edition, O’Reilly Media 2009.

**Reference Books:**

1. Cloud Computing and SOA Convergence in Your Enterprise, *A Step-by-Step Guide* by David S. Linthicum from Pearson 2010.
2. Cloud Computing, 2<sup>nd</sup> Edition by Dr. Kumar Saurabh from Wiley India 2012.
3. Cloud Computing, – web based Applications that change the way you work and collaborate Online – Micheal Miller. Pearson Education.

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**19ITXO03 : E-COMMERCE**

**COURSE OUTCOMES**

After the completion of the course the students are able to

1. Define the fundamentals E-commerce framework.
2. Explain the basics of Consumer Oriented Electronic models.
3. Distinguish different electronic payment systems and their issues.
4. Demonstrate Inter-organizational and intra-organizational electronic commerce.
5. Explain advertising and marketing on the Internet, consumer search and resource discovery and key multimedia concepts.

**UNIT-I**

Electronic Commerce-Frame work, anatomy of E-Commerce applications, E-Commerce Consumer applications, E-Commerce organization applications.

**UNIT-II**

Consumer Oriented Electronic commerce - Mercantile Process models, Electronic payment systems - Digital Token-Based, Smart Cards, Credit Cards, Risks in Electronic Payment systems.

**UNIT-III**

Inter Organizational Commerce - EDI, EDI Implementation, Value added networks. Intra Organizational Commerce - work Flow, Automation Customization and internal Commerce, Supply chain Management.

**UNIT-IV**

Corporate Digital Library - Document Library, digital Document types, corporate Data Warehouses. Advertising and Marketing - Information based marketing, Advertising on Internet, on-line marketing process, market research.

**UNIT-V**

Consumer Search and Resource Discovery - Information search and Retrieval, Commerce Catalogues, Information Filtering.

Multimedia - key multimedia concepts, Digital Video and electronic Commerce, Desktop video processing, Desktop video conferencing.

**Text Books:**

1. Frontiers of electronic commerce – Kalakata, Whinston, Pearson.

**References Books:**

1. E-Commerce fundamentals and applications Hendry Chan, Raymond Lee, TharamDillon,Elizabeth Chang, John Wiley.
2. E-Commerce, S.Jaiswal – Galgotia.E-Commerce, Efrain Turbon, Jae Lee, David King, H.Michael Chang.
3. Electronic Commerce – Gary P.Schneider – Thomson.
4. E-Commerce – Business, Technology, Society, Kenneth C.Taudon, Carol GuyericoTraver.

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**19ITXO04 : WEB TECHNOLOGY PRINCIPLES**

### COURSE OUTCOMES

After the completion of the course the students are able to

1. Basic Knowledge about World Wide Web.
2. Develop Simple HTML Web Pages
3. Create Style Sheets for HTML Pages.
4. Acquire Knowledge about Client – side validation through Java Script.
5. Basic Knowledge about XML Documents.

### UNIT-I

**Introduction to WWW:** Protocols and programs, secure connections, application and development tools, the web browser, What is server, choices, setting up UNIX and Linux web servers, Logging users, dynamic IP.

**Web Design:** Web site design principles, planning the site and navigation.

### UNIT- II

**HTML5:** Introduction, Basic Formatting Tags, Block and inline elements, Lists, Image, Hyperlink, Table, Iframe, Form Elements, Layout Elements and Miscellaneous.

### UNIT-III

**CSS3:** Introduction, CSS Syntax, Selectors, Add CSS to HTML : External, Internal and Inline, CSS Styling : Backgrounds, Text, Fonts, Links, Lists, Tables, CSS Box Model.

### UNIT-IV

**Javascript :** Client side scripting, What is Javascript, How to develop Javascript, simple Javascript, variables, functions, conditions, loops and repetition, Javascript own objects, the DOM and web browser environments, forms and validations.

### UNIT-V

**XML EXTENSIBLE MARKUP LANGUAGE:** XML- Document type Definition, XML schemas, Document object model.

### TEXT BOOKS:

1. Internet and World Wide Web – How to program by Dietel and Nieto PHI/Pearson Education Asia.
2. Web Technologies – Black Book, Kogent Learning solutions Inc sol. Dreamtech press.

### REFERENCE BOOKS:

- W3Schools Online Web Tutorials (<https://www.w3schools.com/>)



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<b>19BMXO01 : INNOVATIONS AND ENTREPRENEURSHIP</b>				

**UNIT-I INNOVATION MANAGEMENT:** Concept–Objectives-types of Innovation-process of Innovation- sources of Innovation-Levels of Innovation -barriers of Innovation--Open and Closed Innovation-challenges faced while managing innovation.

**UNIT-II CREATIVE INTELLIGENCE:** Concept of Creativity-Importance-Characteristics-Types of Creativity-Traits Congenial to Creativity-Triarchic theory of Intelligence – Creative thinking –Types-process of creative thinking-Sources and techniques for generating ideas.

**UNIT-III ENTREPRENEURSHIP:** Concept- characteristics-Importance-classification-Theories of Entrepreneurship-entrepreneurship development-entrepreneurial process- challenges-Women Entrepreneurs.

**UNIT-IV PROJECT FORMULATION AND APPRAISAL:** Concept -Need-Significance-steps - Economic Analysis; Financial analysis; Market analysis; Technical feasibility-project Appraisal-techniques of project appraisal.

**UNIT-V INSTITUTIONS PROMOTING SMALL BUSINESS ENTERPRISES:** Central level Institutions; SIDBI, NSIC, KVIC, SSIDC - State level Institutions- DICs – SFC- SSIDC- other financial assistance, Government policy and taxation benefits- government policy for SSIs

**TEXT BOOKS:**

1. Vasanth Desai, —Entrepreneurship, Himalaya Publishing House, New Delhi, 2012
2. Arya Kumar: —Entrepreneurship, Pearson, Publishing House, New Delhi, 2012.
3. Keith Goffin and Rick Mitchell-Innovation Management, Springer, 2016

**REFERENCES BOOKS:**

1. Pradip N Khandwalla, Lifelong Creativity, An Unending Quest, Tata McGraw Hill, 2004.
2. Vinnie Jauhari, Sudanshu Bhushan, Innovation Management, Oxford Higher Education, 2014

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**19BMXO02 : INDUSTRIAL SOCIOLOGY AND PSYCHOLOGY**

**UNIT I: Industrial Sociology:** Nature and Scope of Industrial Sociology-Development of Industrial Sociology, Factors of social change – the technological factors, the cultural factors, effects of technology on major social institutions, social relations in industry.

**UNIT II: Group Dynamics:** Concept- factors influencing individual behaviour- Work Teams & Groups, Group Behavior, Group formation & development, Decision Making by Individuals, Groups Decision making process-techniques.

**UNIT III Industrial Psychology:** Nature and Meaning of Industrial Psychology, Role of Industrial Psychology, Organizational Attitude, Motivation at work-Theories of Motivation (Theory X and Y, McClelland's Theory, Maslow's Need Theory, Herzberg's Two Factor Theory), Cultural Differences in Motivation.

**UNIT IV: Organizational Design and Leadership:** Organizational Design & Structure- organizational design- process, Structural differentiations, factors influencing design of organizations, Leadership-concept, types, Leadership vs. Management, Leadership Theories, Emerging issues in Leadership.

**UNIT V Organizational Conflicts and Change management:** Concept - Causes and Consequences of Conflict-Conflict handling techniques, Managing Change, Forces for change in Organization, Resistance to change.

**TEXT BOOKS:**

1. Nelson, Quick and Khandelwal, ORGB : An innovative approach to learning and teaching Organizational Behaviour. A South Asian Perspective, Cengage Learning, 2012
2. Luthans, Fred, Organizational Behavior, McGraw Hill, 2008.
3. Stephen P. Robins, Organisational Behavior, PHI Learning / Pearson Education, 11th edition, 2008.

**REFERENCES BOOKS:**

1. Gisbert Pascal, Fundamentals of Industrial sociology, Tata McGraw Hill Publishing Co., New Delhi, 1972.
2. Schneider Engno V., Industrial Sociology 2nd Edition, McGraw Hill Publishing Co., New Delhi, 2011.
3. Ivancevich, Konopaske & Maheson, Organisational Behaviour & Management, 7th edition, Tata McGraw Hill, 2008.

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**19BMXO03 : DIGITAL MARKETING**

**UNIT I- Introduction to Digital Marketing:** Concept – scope- importance of digital marketing - Traditional marketing versus digital marketing – Types of digital marketing-marketing mix and its implications for digital marketing--Challenges and opportunities for digital marketing

**UNIT II- Content Marketing:** Understanding Content Marketing, Content Creation Framework, Content marketing strategy and planning- Types of content marketing -Measuring and Analysing Your Content-Viral Marketing-Blog Marketing.

**Unit III- Search Engine Optimization (SEO):** What is SEO? SEO Importance and Its Growth in recent years, Ecosystem of a search Engine , kinds of traffic, Keyword Research & Analysis (Free and Paid tool & Extension), Recent Google Updates

**UNIT IV-Email and Mobile Marketing:** Introduction, process, design, content,email marketing metrics. Mobile Marketing: Concept, Process-tools-opportunities and challenges.

**UNIT V-Social Media Marketing:** Concepts- Process - Tools- Google and the Search Engine, Facebook, Twitter, YouTube and LinkedIn- Issues: Credibility, Fake News, Paid Influencers; social media and Hate/ Phobic campaigns.

**TEXT BOOKS:**

1. Puneet Singh Bhatia, “Fundamentals of Digital Marketing”, Pearson Education Publications, 2<sup>nd</sup> edition 2019
2. Seema Gupta, “Digital Marketing”, McGraw Hill Publications”, 2<sup>nd</sup> edition 2020
3. Ryan Deiss, Russ Henneberry, “Digital Marketing For Dummies”, Wiley Publications, 2020

**REFERENCES BOOKS:**

1. Joe Pulizzi, “Epic Content Marketing”, McGraw Hill Education, 2019
2. Puneet Singh Bhatia , “Social Media & Mobile Marketing”, Wiley Publications, 2019

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**19BMXO04 : BUSINESS ENVIRONMENT**

**Unit-I Business Environment:** Components and Significance – Economic Scope – Factors Influencing Business Environment – Dimensions of International Business Environment – Challenges.

**Unit-II: Structure of Indian Economy:** Economic systems- Economic planning with special reference to last three plans, public, private joint and cooperative sectors - Industrial Policy - Policy Resolutions of 1991- Economic Reforms-PPP

**Unit-III Indian Business Environment:** Competitiveness, Changes and Challenges, Sustainable Development, Social Responsibilities, Ethics in Business- Competition Act 2002 - Emerging Trend in Indian Business Environment

**Unit-IV: International Trade:** Balance of Payments – Concepts, Disequilibrium in BOP: Methods of Correction - Trade Barriers and Trade Strategy - Free Trade vs. Protection -World Financial Environment: Foreign Exchange Market Mechanism, Exchange Rate Determination, and Euro Currency.

**Unit-V: Globalisation:** International Economic Integration, Country Evaluation and Selection, Foreign Market Entry Methods, International Trading Blocks – WTO Origin, Objectives, Organisation, Structure and Functioning – WTO and India.

**TEXT BOOKS:**

1. Chidambaram, Indian Business Environment, Vikas, New Delhi
2. Suresh Bedi: Business Environment, Excel, New Delhi.
3. K.V.Sivayya and VBM Das: Indian Industrial Economy, Sultan Chand Publishers, Delhi.

**REFERENCES BOOKS:**

1. Pandey G.N., Environmental Management, Vikas Publishing House.
2. Sundaram & Black, International Business Environment – The Text and Cases, Prentice Hall of India.
3. Ghosh PK., Business Environment, Sultan Chand & Sons, New Delhi
4. Daniel John D and Redebough, Lee. H., International Business, Addison Wesley India
5. Saleem, Business Environment, Pearson, New Delhi.
6. Bhalla, V.K., & S. Sivaramu, International Business Environment and Business, Annual Publications

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**19MAXO01 : OPERATIONS RESEARCH**

**COURSE OBJECTIVES:**

1. Ability to understand and analyze managerial problems in industry so that they are able to use resources (capitals, materials, machines etc) more effectively.
2. Knowledge of formulating mathematical models for quantitative analysis of managerial problems in industry

**UNIT—I**

**LINEAR PROGRAMMING:**

Introduction-General formulation LPP- Formulation of LP problems - Graphical solution –Slack and Surplus and Artificial variables-simplex method (simple problems) - artificial variable techniques – twophase method, Big-M-method(simple problems) –Concept of Duality-general rules for converting any primal into its dual.

**UNIT – II**

**TRANSPORTATION PROBLEM:**

Introduction-mathematical formulation-Feasible, Basic Feasible and Optimum solution -Methods for initial basic feasible solution to transportation problem-optimal Test by u, v method(MODI)-Degeneracy in Transportation problems –.Unbalanced Transportation problems

**UNIT – III**

**SEQUENCING PROBLEM:**

Introduction –Johnson’s Algorithm for n jobs 2 machines- Optimal Solution for processing n jobs through two machines- processing n jobs through three machines - processing n jobs through m machines - processing two jobsthrough m machines

**UNIT – IV**

**REPLACEMENT PROBLEMS:**

Introduction – replacement policy for items whose maintenance cost increases with time, and money value is constant – Money value, present worth Factor and Discount Rate- replacement policy when maintenance cost increases with time and money valuechanges with constant rate – Individual Replacement Policy-group replacement of items that fail completely.

**UNIT – V**

**WAITING LINES:**

Introduction- transient and steady states-Probability Distributions in Queuing systems-Kendall’s notation for Representing Queuing models- Single channel-Poisson arrivalsExponential service times-with infinitepopulation model (M/M/1: FIFO/∞/∞)

**INVENTORY:**

Introduction – types of inventory models – Costs involved in Inventory problems-Variables in inventory problem-Classification of Inventory Models-Concept of EOQ-The EOQ model without shortage – Quantity Discounts-purchase inventory models with one price break - purchase inventory models with two price breaks- purchase inventory models with any number of price breaks-shortages are not allowed

**COURSE OUTCOMES:** Students can able to

- CO1: Formulate** the resourcemanagement problem andidentify appropriate methods to solve them. [K3]
- CO2: Apply**transportation model to optimize the industrial resources. [K3]
- CO3: Solve** sequencing problems using operation research techniques. [K3]
- CO4: Apply** thereplacement model to increase the efficiency of the system. [K3]
- CO5: Apply** theinventory and queuingmodel to increase the efficiency of the system. [K4]

**TEXT BOOKS:**

1. Operations Research / S.D.Sharma, Ramnath co,Meerut
2. Operations Research, P.K.Gupta, D.S.Hira,S.Chand

**REFERENCE BOOKS:**

1. Operations Research /A.M.Natarajan,P.Balasubramani, A.Tamilarasi/PearsonEducation.
2. Operations Research / R. Pannerselvam, PHI Publications.

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**19MAXO02 : OPTIMIZATION MODELS**

**COURSE OBJECTIVES:**

1. Ability to understand and analyze managerial problems in industry so that they are able to use resources (capitals, materials, machines etc.,) more effectively.
2. Knowledge of formulating mathematical models for quantitative analysis of managerial problems in industry

**UNIT—I****INTRODUCTION TO LINEAR PROGRAMMING:**

Introduction-Linear programming problem formulation – General formulation of Linear programming problem- formulation of LP problems - Graphical solution – simplex method (simple problems) - artificial variable techniques – twophase method, Big-M-method – general rules for converting any primal into its dual.

**UNIT – II****ASSIGNMENT MODELS:**

Formulation –mathematical formulation of assignment problem – Hungarian method for assignment problem- Unbalanced assignment Problems-variations in the assignment problem-Travelling Salesman problem.

**UNIT – III****THEORY OF GAMES:**

Introduction – minimax (maxmin) criterion and optimal strategy –solution of games with saddle points – rectangular games without saddle points –reduce game by dominance –graphicmethod for  $m \times 2$  &  $2 \times n$  games-arithmetic method for finding optimum strategies and game value.

**UNIT – IV****DECISION THEORY:**

Introduction –decision making environments - decision making under conditions of certainty- decision making under conditions of uncertainty-Maximax criterion-maximin criterion-minimax regret criterion-Hurwitz criterion-Laplace criterion-decision making under conditions of risk-expected value criterion-expected opportunity loss criterion-expected value of perfect information.

**UNIT-V****PROJECT MANAGEMENT:**

Phases of project management-network logic-numbering the events(Fulkerson's rule)- – identifying critical path – probability of completing the project within given time- Project Evaluation and Review Technique.

**COURSE OUTCOMES:** Students are able to

**CO1: Apply** linear programming techniques to solve industrial optimization problems. [K3]

**CO2: Solve** assignment problems using operation research techniques. [K3]

**CO3: Analyze** game theory and apply them for optimization. [K4]

**CO4: Solve** the decision theory problem through the applications of game theory. [K4]

**CO5: Scheduling** the production and manage the project [K4]

**TEXT BOOKS:**

1. Operations Research / S.D.Sharma, Ramnath co, Meerut
2. Operations Research / R.Pannerselvam, PHI Publications

**REFERENCE BOOKS:**

1. Operations Research / A.M.Natarajan, P.Balasubramani, A.Tamilarasi/Pearson Education.
2. Operations Research, P.K.Gupta, D.S.Hira, S.Chand

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**19BSXO01 : QUANTUM COMPUTING**

**Pre-requisite:** Basics of Quantum Mechanics and Computer Science

**Objective of the course:** The objective of this course is to provide the students an introduction to quantum computation. Much of the background material related to the algebra of complex vector spaces and quantum mechanics is covered within the course.

#### Unit – I

**Background Mathematics, Physics and Introduction to Quantum Computation:** Hilber space, Probabilities and measurements, entanglement, density operators and correlation, basics of quantum mechanics, Measurements in bases other than computational basis, Quantum bits, Bloch sphere representation of a qubit, multiple qubits. **(8 Hours)**

#### Unit – II

**Quantum Circuits:** Single Qubit gates, multiple qubit gates, design of quantum circuits. **(8Hours)**

#### Unit – III

**Quantum Information and Cryptography:** Comparison between classical and quantum information theory. Bell states. Quantum teleportation. Quantum Cryptography, no cloning theorem. **(8 Hours)**

#### Unit – IV

**Quantum Algorithms:** Classical computation on quantum computers. Relationship between quantum and classical complexity classes. Data base Search, FFT and prime factorization, Deutsch's Algorithm. **(8 Hours)**

#### Unit – V

**Noise and error correction:** Graph states and codes, Quantum error correction, fault-tolerant computation, Physical implementation of quantum computers. **(8 Hours)**

#### Text Books:

1. Nielsen M. A., Quantum Computation and Quantum Information, Cambridge University Press (2002).
2. Benenti G., Casati G. and Strini G., Principles of Quantum Computation and Information, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific (2004).
3. Pittenger A. O., An Introduction to Quantum Computing Algorithms (2000).



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**19BSXO02 : OPTOELECTRONICS**

**COURSE OBJECTIVES:**

A deep understanding of the fundamentals of optoelectronics including Optical emission from semiconductors, quantum efficiency, heterojunction, quantum well, Optoelectronic modulators. Be familiar with recent trends in optoelectronics.

**COURSE OUTCOME:**

Students who successfully complete this course will have an

- ability to understand the fundamental concepts of Optoelectronics;
- ability to understand the concept of optoelectronic modulators
- ability to design single-mode junction lasers at different wavelengths to meet specs;
- ability to incorporate heterostructures and quantum wells to improve device performance;
- ability to design junction & avalanche photodiodes to meet specs

**UNIT – I****Electronic properties of Semiconductors:**

Effect of temperature on band gap, density of carriers in intrinsic and extrinsic semiconductors, conduction processes in semiconductors, electron-hole pair formation and recombination, PN junction, carrier recombination and diffusion, Injection efficiency, heterojunction, internal quantum efficiency, double heterojunction, quantum well and super lattices.

**UNIT – II**

**Opto Electronic Modulators:** Basic principles, Polarization, birefringence. Electro-optic Modulators- electro optic effect, integrated optical modulator, EO materials. Kerr modulators, scanning and switching.

**Magneto Optic Modulators:** Faraday effect, Acousto-optic Modulators, Magneto-optic modulators.

**UNIT – III**

**Opto-electronic devices:** Injection luminescence and LED, LED structures, LED-Materials, Power and efficiency, heterostructure LED. Laser: Basic concepts, Optical emission from semiconductors- Hetero junction lasers. Semiconductor Injection Lasers, Injection laser structures- gain guided lasers, index guided lasers, Distributed Feedback Lasers.

**UNIT – IV**

**Opto-electronic Display devices:** Photo luminescence, cathode luminescence, Electro luminescence, CRT, Plasma panel display, LCD and LED displays- liquid crystals, properties, Numeric displays

**UNIT – V**

**Optoelectronic detectors:** Thermal detectors, Photon devices- Photo emissive detectors, Photo conductive detectors, Photomultipliers (PMT), Image intensifiers, Photo diodes- PIN & APD, photo transistors.

**Design of detector arrays:** CCD, Solar cells.

**Text Books:**

1. Opto electronics - An introduction - J Wilson and J F B Hawkes. (PHI)
2. Optical fiber communication - J M Senior (Pearson, 2nd Ed )
3. Fiber Optics and Optoelectronics – R P Khare, (Oxford University Press, 4th Ed)

**References:**

1. Solid State Electronic Devices - Ben G Streetman, Sanjaykumar Banerjee, PHI, 6th Ed, 2006)
2. Fundamentals of Photonics- B E A Saleh and M C Teich, (John Wiley, 2007)