



# **VARDHAMAN COLLEGE OF ENGINEERING**

**(AUTONOMOUS)**

Affiliated to **JNTUH**, Approved by **AICTE**, Accredited by **NAAC** with **A++** Grade, **ISO 9001:2015** Certified  
Kacharam, Shamshabad, Hyderabad - 501218, Telangana, India

[www.vardhaman.org](http://www.vardhaman.org)

## **CURRICULUM**

**For**

**Bachelor of Technology**

## **Mechanical Engineering**

**Under**

**Choice Based Credit System (CBCS)**

**B. Tech. - Regular Four-Year Degree Program**

(For batches admitted from the Academic Year 2022 - 2023)

**&**

**B. Tech. - Lateral Entry Scheme**

(For batches admitted from the Academic Year 2023 - 2024)

**October 2022**



## Vision of the Institution:

To be a pioneer institute and leader in engineering education to address societal needs through education and practice.

## Mission of the Institution:

- To adopt innovative student centric learning methods.
- To enhance professional and entrepreneurial skills through industry institute interaction.
- To train the students to meet dynamic needs of the society.
- To promote research and continuing education.

## Vision of the Department:

To be a premier center for producing competent mechanical engineers to cater the ever changing industrial demands and societal needs.

## Mission of the Department:

- To impart knowledge and skills in basic and applied areas of Mechanical Engineering through innovative learner-centric approach.
- To associate with industries and research organizations for gaining real-time practical knowledge.
- To facilitate continuous learning based on the dynamic needs of the society.

## Program Educational Objectives(PEOs):

**PEO1:** Graduates make their way to the society with proper scientific and technical knowledge to identify, formulate and solve Mechanical Engineering problems.

**PEO2:** Graduates adapt to a rapidly changing environment in the areas of Mechanical Engineering and explore a possible profession in industry, academic, research and self-employment opportunities.

**PEO3:** Graduates excel in a career by their team-working ability and communicate effectively to complete the task with minimal resources.

**PEO4:** Graduates commit to professional and ethical practices encouraging diversity, continuous improvement and lifelong learning.

## Program Outcomes(POs):

**PO1:Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.



**PO2:Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**PO3:Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**PO4:Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**PO5:Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**PO6:The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO7:Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**PO8:Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**PO9:Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO10:Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**PO11:Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

**PO12:Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

### **Program Specific Outcomes(PSOs):**

Graduates will be able to,

**PSO1:** Demonstrate knowledge in the area of design, analysis and fabrication of mechanical systems.

**PSO2:** Apply learned concepts and management skills to associate professionally in industry or as an entrepreneur.



**Programme Curriculum Structure**  
**B.Tech – Mechanical Engineering****Regulations: VCE-R22**

<b>I Year I Semester</b>										
Induction Program (Phase – I)										
#	Course Code	Title of the Course	Category	Hours per Week and Credit				Assessment Marks		
				L	T	P	C	CIE	SEE	Total
1	A8001	Matrices and Calculus	BS	3	1	0	4	40	60	100
2	A8006	Applied Physics	BS	3	0	0	3	40	60	100
3	A8501	Problem Solving through C	ES	3	0	0	3	40	60	100
4	A8304	Engineering Materials	ES	3	0	0	3	40	60	100
5	A8303	Engineering Drawing	ES	1	0	4	3	40	60	100
6	A8007	Applied Physics Laboratory	BS	0	0	2	1	40	60	100
7	A8502	Problem Solving through C Laboratory	ES	0	0	2	1	40	60	100
8	A8301	Engineering Workshop	ES	0	0	2	1	40	60	100
9	A8021	Social Innovation	ES	0	0	2	1	40	60	100
Total				13	01	12	20	360	540	900

<b>I Year II Semester</b>										
Induction Program (Phase – II)										
#	Course Code	Title of the Course	Category	Hours per Week and Credit				Assessment Marks		
				L	T	P	C	CIE	SEE	Total
1	A8002	Ordinary Differential Equations and Vector Calculus	BS	3	1	0	4	40	60	100
2	A8008	Engineering Chemistry	BS	3	0	0	3	40	60	100
3	A8010	English for Skill Enhancement	HS	2	0	0	2	40	60	100
4	A8505	Data Structures	ES	3	0	0	3	40	60	100
5	A8305	Engineering Mechanics	ES	3	0	0	3	40	60	100
6	A8009	Engineering Chemistry Laboratory	BS	0	0	2	1	40	60	100
7	A8011	English Language Communication Skills Laboratory	HS	0	0	2	1	40	60	100
8	A8507	Data Structures Laboratory	ES	0	0	2	1	40	60	100
9	A8302	Computer Aided Drawing	ES	0	0	2	1	40	60	100
10	A8022	Engineering Exploration	ES	0	0	2	1	40	60	100
Total				14	01	10	20	400	600	1000

**Programme Curriculum Structure**  
**B. Tech – Mechanical Engineering**

Regulations: VCE-R22

**II Year I Semester**

#	Course Code	Title of the Course	Category	Hours per Week and Credit				Assessment Marks		
				L	T	P	C	CIE	SEE	Total
1	A8003	Probability Distributions and Statistics	BS	3	1	0	4	40	60	100
2	A8306	Material Science and Metallurgy	PC	3	0	0	3	40	60	100
3	A8307	Mechanics of Solids	PC	3	0	0	3	40	60	100
4	A8212	Basic Electrical and Electronics Engineering	ES	3	0	0	3	40	60	100
5	A8308	Thermodynamics	PC	3	0	0	3	40	60	100
6	A8309	Material Science and Metallurgy Laboratory	PC	0	0	2	1	40	60	100
7	A8310	Mechanics of Solids Laboratory	PC	0	0	2	1	40	60	100
8	A8311	Computer Aided Machine Drawing	PC	0	0	2	1	40	60	100
9	A8023	Engineering Design Thinking	PW	0	0	2	1	40	60	100
Total				15	01	08	20	360	540	900
<b>Mandatory Courses (Non-Credit)</b>										
10	A8031	Gender Sensitization	MC	2	0	0	0	-	100	100
11	A8033	Universal Human Values 2: Understanding Harmony	MC	2	0	0	0	-	100	100

**II Year II Semester**

#	Course Code	Title of the Course	Category	Hours per Week and Credit				Assessment Marks		
				L	T	P	C	CIE	SEE	Total
1	A8013	Business Economics and Financial Analysis	HS	3	0	0	3	40	60	100
2	A8312	Kinematics of Machinery	PC	3	0	0	3	40	60	100
3	A8313	Thermal Engineering-I	PC	3	0	0	3	40	60	100
4	A8314	Fluid Mechanics and Hydraulic Machines	PC	3	1	0	4	40	60	100
5	A8315	Production Technology	PC	3	0	0	3	40	60	100
6	A8316	Fluid Mechanics and Hydraulic Machines Laboratory	PC	0	0	2	1	40	60	100
7	A8317	Thermal Engineering Laboratory	PC	0	0	2	1	40	60	100
8	A8318	Production Technology Laboratory	PC	0	0	2	1	40	60	100
9	A8024	Product Realization	PW	0	0	2	1	40	60	100
Total				15	01	08	20	360	540	900
<b>Mandatory Courses (Non-Credit)</b>										
10	A8032	Environmental Science and Technology	MC	2	0	0	0	-	100	100

**Programme Curriculum Structure**  
**B. Tech – Mechanical Engineering**

Regulations: VCE-R22

III Year I Semester										
#	Course Code	Title of the Course	Category	Hours per Week and Credit				Assessment Marks		
				L	T	P	C	CIE	SEE	Total
1	A8319	Dynamics of Machinery	PC	3	0	0	3	40	60	100
2	A8320	Metrology and Machine Tools	PC	3	0	0	3	40	60	100
3	A8321	Design of Machine Elements	PC	3	1	0	4	40	60	100
4	A8322	Thermal Engineering-II	PC	3	1	0	4	40	60	100
5		Professional Elective – I	PE	3	0	0	3	40	60	100
6	A8323	Metrology and Machine Tools Laboratory	PC	0	0	2	1	40	60	100
7	A8324	Dynamics of Machinery Laboratory	PC	0	0	2	1	40	60	100
8	A8325	Engineering Design Laboratory	PC	0	0	2	1	40	60	100
Total				15	02	06	20	320	480	800
<b>Mandatory Courses (Non-Credit)</b>										
9	A8034	Indian Constitution	MC	2	0	0	0	–	100	100

III Year II Semester										
#	Course Code	Title of the Course	Category	Hours per Week and Credit				Assessment Marks		
				L	T	P	C	CIE	SEE	Total
1	A8326	Heat Transfer	PC	3	0	0	3	40	60	100
2	A8327	Machine Design	PC	3	0	0	3	40	60	100
3	A8328	Finite Element Methods	PC	2	0	0	2	40	60	100
4		Professional Elective – II	PE	3	0	0	3	40	60	100
5		Professional Elective – III	PE	3	0	0	3	40	60	100
6	A8329	Heat Transfer Laboratory	PC	0	0	2	1	40	60	100
7	A8330	Numerical Simulation Laboratory	PC	0	0	2	1	40	60	100
8	A8012	Advanced English Communication Skills Laboratory	HS	0	0	2	1	40	60	100
9	A8331	Fundamentals of HVAC	PC	0	0	2	1	40	60	100
10	A8041	Mini-Project/Internship	PW	0	0	4	2	40	60	100
Total				14	00	12	20	400	600	1000
<b>Mandatory Courses (Non-Credit)</b>										
11	A8035	Research Methodology	MC	2	0	0	0	–	100	100

**Programme Curriculum Structure**  
**B. Tech – Mechanical Engineering**

Regulations: VCE-R22

IV Year I Semester										
#	Course Code	Title of the Course	Category	Hours per Week and Credit				Assessment Marks		
				L	T	P	C	CIE	SEE	Total
1	A8332	Instrumentation and Control Systems	PC	3	0	0	3	40	60	100
2	A8333	CIM and Robotics	PC	3	0	0	3	40	60	100
3		Professional Elective – IV	PE	3	0	0	3	40	60	100
4		Professional Elective – V	PE	3	0	0	3	40	60	100
5		Open Elective – I	OE	3	0	0	3	40	60	100
6	A8334	Instrumentation Laboratory	PC	0	0	2	1	40	60	100
7	A8335	CIM and Robotics Laboratory	PC	0	0	2	1	40	60	100
8	A8042	Project Work Phase – I	PW	0	0	6	3	100	-	100
Total				15	00	10	20	380	420	800

IV Year II Semester										
#	Course Code	Title of the Course	Category	Hours per Week and credit				Assessment Marks		
				L	T	P	C	CIE	SEE	Total
1		Professional Elective – VI	PE	3	0	0	3	40	60	100
2		Open Elective – II	OE	3	0	0	3	40	60	100
3		Open Elective – III	OE	3	0	0	3	40	60	100
4	A8043	Project Work Phase - II	PW	0	0	22	11	40	60	100
Total				09	00	22	20	160	240	400



## Programme Curriculum Structure B. Tech – Mechanical Engineering

Regulations: VCE-R22

### List of Professional Electives

<b>Professional Elective - I</b>	
<b>Course Code</b>	<b>Title of the Course</b>
A8351	Mechatronics
A8352	Operations Research
A8353	Automation in Manufacturing
A8354	Additive Manufacturing

<b>Professional Elective - II</b>	
<b>Course Code</b>	<b>Title of the Course</b>
A8355	Automobile Engineering
A8356	Turbomachinery
A8357	Refrigeration and Air Conditioning
A8358	Fluid Power Systems

<b>Professional Elective - III</b>	
<b>Course Code</b>	<b>Title of the Course</b>
A8359	Mechanical Vibrations
A8360	Composite Materials
A8361	Engineering Tribology
A8362	Advanced Mechanics of Solids

**Programme Curriculum Structure**  
**B. Tech – Mechanical Engineering****Regulations: VCE-R22****List of Professional Elective (Cont.)**

<b>Professional Elective - IV</b>	
<b>Course Code</b>	<b>Title of the Course</b>
A8363	Industry 4.0
A8364	Fuzzy Logic and Neural Networks
A8365	Renewable Energy Sources
A8366	Electric and Hybrid Vehicles

<b>Professional Elective - V</b>	
<b>Course Code</b>	<b>Title of the Course</b>
A8367	Solar Energy Technology
A8368	Computational Fluid Dynamics
A8369	Unconventional Machining Processes
A8370	Micro-Electro Mechanical Systems

<b>Professional Elective - VI</b>	
<b>Course Code</b>	<b>Title of the Course</b>
A8371	Artificial Intelligence in Mechanical Systems
A8372	Machine Learning in Mechanical Engineering
A8373	Production Planning and Control
A8374	Total Quality Management

**List of Open Electives**

#	Course Code	Title of the Course
1	A8181	Smart Cities
2	A8182	Disaster Management
3	A8183	Environmental Pollution Management
4	A8155	Green Building and Sustainability
5	A8224	Electric Vehicles
6	A8281	Solar Energy and Applications
7	A8282	Energy Storage Systems
8	A8283	Power Generation Systems
9	A8381	Hybrid Vehicles
10	A8382	Fundamentals of Robotics
11	A8383	3D Printing
12	A8402	Digital Electronics
13	A8481	Basic Electronics
14	A8482	Principles of Communication Engineering
15	A8483	Fundamentals of IoT
16	A8484	Introduction to Embedded Systems
17	A8510	Operating Systems
18	A8514	Database Management Systems
19	A8520	Software Engineering
20	A8607	Information Security
21	A8608	Java Programming
22	A8651	Ethical Hacking
23	A8652	Cyber Security
24	A8656	Blockchain Technology
25	A8658	Robotic Process Automation
26	A8681	E-Commerce
27	A8682	Full Stack Development
28	A8702	Artificial Intelligence
29	A8781	Computer Organization and Architecture
30	A8851	Data Science for Engineers
31	A8081	Mathematical Programming
32	A8082	Transform Calculus
33	A8083	Numerical Techniques
34	A8084	Entrepreneurship Development
35	A8085	Logistics and Supply Chain Management



## List of Open Electives (Cont.)

#	Course Code	Title of the Course
36	A8086	Management Science
37	A8087	Human Resource Management
38	A8088	Organizational Behaviour
39	A8089	Intellectual Property Rights
40	A8090	Professional Practice, Law & Ethics
41	A8091	National Cadet Corps (NCC)



**I YEAR I SEMESTER**



## Course Structure

### A8001 - Matrices and Calculus

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	1	0	45	15	0	4	40	60	100

## 1. Course Description

### Course Overview

This course provides mathematical knowledge required to analyze problems encountered in engineering. In this course, the students are acquainted with the solution of system of linear equations, eigen values and eigen vectors, functions of several variables, multiple integrals. In addition, this course can be applied in many areas of engineering such as computer graphics, cryptography, wireless communication and animation.

### Course Pre/co-requisites

This course has no specific prerequisite and co-requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8001.1. Solve system of linear equations using rank of a matrix.
- A8001.2. Examine the nature of quadratic form using eigen values and eigen vectors.
- A8001.3. Evaluate improper integrals using Beta and Gamma Functions.
- A8001.4. Examine the extremum of a function of several variables.
- A8001.5. Make use of multiple integrals to find the area and volume of a solid.

## 3. Course Syllabus

**Theory of Matrices:** Rank of a matrix by Echelon form and Normal form, Inverse of Non-singular matrices by Gauss- Jordan method, System of linear equations: Solving system of Homogeneous and Non-Homogeneous equations by Gauss elimination method, Gauss Seidel Iteration Method.

**Eigen Values and Eigen Vectors:** Linear Transformation and Orthogonal Transformation, Eigenvalues, Eigenvectors and their properties, Diagonalization of a matrix, Cayley-Hamilton Theorem (without proof), finding inverse and power of a matrix by Cayley-Hamilton Theorem. Rank, index, signature and nature of quadratic forms up to three



variables using eigen values.

**Calculus:** Mean value theorems: Rolle's theorem, Lagrange's Mean value theorem with their Geometrical Interpretation and applications, Cauchy's Mean value Theorem, Taylor's Series, Definition of Improper Integral: Beta and Gamma functions and their applications.

**Multivariable Calculus (Partial Differentiation and applications):** Definitions of Limit and Continuity, Partial Differentiation: Euler's Theorem, Total derivative, Jacobian, Functional dependence & independence. Applications: Maxima and minima of functions of two variables and three variables using method of Lagrange multipliers.

**Multivariable Calculus (Integration):** Evaluation of Double Integrals (Cartesian and polar coordinates), change of order of integration (only Cartesian form), Change of variables (Cartesian to polar), Evaluation of Triple Integrals. Applications: Areas (by double integrals) and volumes (by double integrals and triple integrals).

## 4. Books and Materials

### Text Books:

1. Grewal, B.S. Higher Engineering Mathematics, 43<sup>rd</sup> Edition, Khanna Publications, 2015.
2. Jain, R.K. and Iyengar, S.R.K. Advanced Engineering Mathematics, 3<sup>rd</sup> Edition, Narosa Publishing House, 2011.

### Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9<sup>th</sup> Edition, John Wiley & Sons, 2006.
2. Ramana, B.V. Higher Engineering Mathematics, 32<sup>nd</sup> Reprint, McGraw Hill Education (India) Pvt Ltd, 2018.

**Course Structure****A8006 - Applied Physics**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

Applied Physics course introduces the fundamental aspects of physics with applications to modern scientific world and focuses on recent trends in science and technology. This interdisciplinary knowledge which includes quantum computing, semiconductors, lasers, wave optics, optical fibers and nanomaterials encourage an understanding of technological applications of Physics. It's importance as a subject of social and industrial relevance enable the students to solve various engineering problems.

**Course Pre/co-requisites**

This course has no specific prerequisite and co-requisite.

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8006.1. Analyze the properties of quantum computers by quantum physics.
- A8006.2. Apply wave property of light to study different optical phenomenon.
- A8006.3. Interpret the charge carrier dynamics in semiconductors.
- A8006.4. Develop communication systems by means of lasers and optical fibers.
- A8006.5. Analyze the principles of nanoscience and technology for electronic applications.

**3. Course Syllabus**

**Quantum Mechanics and Quantum Computing:** Introduction to quantum physics, Blackbody radiation, Photoelectric effect, de-Broglie hypothesis, G.P. Thomson experiment, Concept of wave function, Heisenberg uncertainty principle, Time independent Schrödinger wave equation, One-dimensional potential box, Introduction to quantum computing, Bits and qubits, Classical and quantum logic gates, Interference and quantum entanglements, quantum teleportation and cryptography, IBM quantum, Application of quantum computers.



**Wave optics:** Waves and wavefronts, Huygens' principle, Superposition of waves, Constructive and destructive interference, Interference of light by Wavefront splitting – Young's double slit experiment, Amplitude splitting – Newton's rings, Diffraction: Fraunhofer and Fresnel diffraction, Diffraction of light at single slit, Diffraction grating – Intensity distribution of light.

**Semiconductors and Devices:** Intrinsic and extrinsic semiconductor, Density of states, Fermi-Dirac distribution function, Carrier concentration in intrinsic semiconductor, Direct and indirect bandgap semiconductor, Structure, Working principle and Characteristics of P-N junction diode, Hall effect, Light Emitting Diode (LED) and Solar cell.

**Lasers and Optical fibers:** Introduction to lasers, Einstein's coefficients, three and four level laser systems, Ruby laser, He-Ne laser, Semiconductor laser, Applications of lasers, Introduction to optical fibers, Structure of optical fiber, Total internal reflection, Step index and Graded index optical fibers, Acceptance angle - Numerical aperture, Optical fibers in communication System, Applications of optical fibers.

**Nanoscience:** Introduction of nanomaterials, Surface area to Volume ratio, Quantum confinement, Top-down fabrication: Ball milling and Chemical Vapor Deposition (CVD) methods, Bottom-up fabrication: Sol-Gel and Combustion methods, Characterization techniques: X-Ray Diffraction (XRD), Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Applications of nanomaterials.

## 4. Books and Materials

### Text Books:

1. Pandey, B. K. and Chaturvedi, S., Engineering Physics, 1<sup>st</sup> Edition, New Delhi: Cengage Learning India Pvt. Ltd, 2013
2. Bernhardt, Chris., Quantum computing for everyone, MIT Press, 2019.

### Reference Books:

1. Palanisamy, P.K, Engineering Physics, 1<sup>st</sup> Edition, Scitech Publications, 2013
2. David Halliday, Jearl Walker, Robert Resnick, David G. Rethwisch, William D. Callister, Engineering Physics, 6<sup>th</sup> Edition, Wiley India Pvt Ltd, 2006
3. Brij Lal and Subrahmaniyam, A textbook of Optics, 23<sup>rd</sup> Edition, S Chand, 2006.

**Course Structure****A8501 - Problem Solving through C**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

As an introductory course common to all branches, the student will be able to learn problem solving skills using 'C' programming language, which is a pre-requisite to learn many other programming Languages. The purpose of this course is to provide the basic programming methodology in C. This course will enable the students to learn programming skills necessary to implement all the basic mathematical, scientific and real world applications. C is a structured high-level programming language. The student can write programs using structures, functions and pointers. The course enables to perform file operations to store data permanently. This course will give the foundation for a beginner to develop computer programmes effectively.

**Course Pre/co-requisites**

This course has no specific prerequisite and co-requisite.

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8501.1. Identify various building blocks to write a C program.
- A8501.2. Use control statements for solving a given problem.
- A8501.3. Write programs using arrays and strings to store and manipulate sequential data.
- A8501.4. Build programs with functions and structures for solving a complex problem.
- A8501.5. Make use of Pointers and Files to store and retrieve data efficiently.

**3. Course Syllabus**

**Algorithms, Flowcharts and Introduction to C :** Algorithms- Definition, characteristics and examples. Flowcharts- Definition, Symbols and examples. Structure of a C Program, Identifiers, Variables, Constants and Data Types. Operators-Arithmetic, Relational, Logical, Assignment, increment and decrement, Conditional, Bitwise and Special Operators. Evaluation of Expressions, Precedence of Arithmetic operators, Type conversions, Operator precedence and Associativity. Formatted input and output.



**Control Statements:** Conditional Statements- if, if else, nested if, else if ladder and switch statements. Iterative or Loop statements- while, do while and for statements. Jump statements- break, continue and goto statements.

**Arrays and Strings :** Arrays: Introduction, One Dimensional Arrays - Declaration and initialization, Reading and Writing. Two Dimensional Arrays - Declaration and initialization, Reading and Writing. Strings: Introduction, Declaration and initialization, Reading and writing, string handling functions, handling two dimensional strings, Command line arguments.

**Functions, Structures and Unions:** Functions- Introduction, Function definition and Function call, Categories of functions, Recursion, Limitations of recursive functions, Passing Arrays to functions, Common Preprocessor Directives. Structures- Definition, Declaration and Initialization, accessing structure members, Array of Structures, Arrays with in structures, Structures and functions , size of structures , Unions- Definition, Declaration and Initialization, accessing Union members.

**Pointers and Files :** Pointers-Declaration, Initialization, Pointer to Pointer, Pointer Arithmetic, Parameter Passing Techniques, Pointer to Arrays, Pointers to Structures. Files- Introduction, defining, opening and closing a File, Input - Output operations on Files, Random Access in files.

## 4. Books and Materials

### Text Books:

1. Byron Gottfried., Programming with C, 4<sup>th</sup> Edition (Schaum's Outlines), New Delhi, McGRAW HILL Edition, 2018.
2. E Balagurusamy., Programming in ANSI C, 8<sup>th</sup> Edition, Tata McGRAW HILL, New Delhi, 2019.

### Reference Books:

1. Yeshvanth Kanethkar., Let Us C, 5<sup>th</sup> Edition, BPB Publications, New Delhi, India, 2017.
2. B.A. Forouzan and R.F. Gilberg., Computer Science: A Structured Programming Approach Using C, 3<sup>rd</sup> Edition, Thompson Learning, 2007.
3. P. Padmanabham., C & Data structures, 3<sup>rd</sup> Edition, B.S. Publications, 2016.
4. Jeri R. Hanly and Elliot B.Koffman., Problem solving and Program Design in C, 7<sup>th</sup> Edition, Pearson Publication, 2016.

**Course Structure****A8304 - Engineering Materials**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

This course covers the various materials used in mechanical engineering like metals, ceramics, polymers, composite materials and other new materials. And also discuss the material structure, classification and usage. Introduce the testing methods for various material properties and ASTM standards used in testing.

**Course Pre/co-requisites**

This course has no specific prerequisite and co-requisite.

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8304.1. Classify the various materials that will be essential for the mechanical engineering applications.
- A8304.2. Express the mechanical properties of metals and their testing procedures.
- A8304.3. Illustrate the application of materials and their processing .
- A8304.4. Identify the requirement and need for the development of the new materials.
- A8304.5. Differentiate between Ferrous and Non ferrous materials and their alloys.

**3. Course Syllabus**

**Introduction:** Classification of Engineering Materials, Ashby chart, Mechanical Properties of Metals and their testing equipment/procedures, ASTM standards for testing, Stress–Strain Behavior of various materials, Sources of Material Data .

**Metals and Metal Alloys:** Classification of Metal Alloys, Classification, composition, properties and usage of Ferrous alloys, steel, HSS, grey cast iron, white cast iron; Classification, composition, properties and usage of Non-ferrous materials, Aluminum, Titanium, Zinc, Copper, Nickel, Cobalt and their alloys .

**Composites:** Definitions, Reinforcements and matrices, Types of reinforcements, Types of matrices, Classification of composites, Properties of composites in comparison with standard materials Manufacturing methods: Hand and spray lay - up, injection molding, resin



injection, filament winding, pultrusion, centrifugal casting and prepregs. .

**Ceramics and Polymers:** Classification of ceramic materials, Crystal Structure, Applications and Properties of Ceramics, Ceramic fabrication techniques, Carbon: Diamond and Graphite. Polymer Structures, Chemistry of Polymer Molecules, Classification scheme of polymer molecules, Thermoplastic and Thermosetting Polymers, Characteristics, Applications, and Processing of Polymers, Elastomers. .

**Nano Materials:** Materials in nano technology: Semiconductor Nanomaterials (Zinc oxide nano materials, titanium dioxide nanoparticles, Metal nanoparticles, ceramic nano materials metal nano particles (Silver, gold, iron and copper), applications, bio materials and other recent materials.

## 4. Books and Materials

### Text Books:

1. George Murray, Charles V. White, Wolfgang Weise, "Introduction to Engineering Materials", 2<sup>nd</sup> Edition, CRC Press, 2007.
2. William D. Callister, David G. Rethwisch, "Materials Science and Engineering", 10<sup>th</sup> Edition, Wiley Edition, India, 2018.

### Reference Books:

1. E. Paul De Garmo, J.T. Black, R.A. Kohler, "Materials and Processes in Manufacturing", 11<sup>th</sup> Edition, John Wiley and Sons, Inc., NY, 2012.
2. M.A. Shah, K.A. Shah, Nano technology, 2<sup>nd</sup> Edition, WILEY, 2019
3. K. K. Chawala, Ceramic Matrix composite Materials, 2<sup>nd</sup> Edition, Kluwer Academic Publishers, 2003



## Course Structure

### A8303 - Engineering Drawing

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
1	0	4	15	0	60	3	40	60	100

## 1. Course Description

### Course Overview

Engineering drawing is said to be the language of engineers. It is the graphical representation of objects and their relationships based on certain basic principles and standard conventions. It can be regarded as a powerful tool to convey ideas. This course is included in all engineering curricula with the aim of training the students and making them graphically literate. This course covers orthographic projections for points, lines, planes and solids in different positions, the development of lateral surfaces and the isometric projections. The students are able to create simple solid models of various domain applications.

### Course Pre/co-requisites

This course has no specific prerequisite and co-requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8303.1. Construct various types of scales and curves used in engineering practice..
- A8303.2. Describe the location of objects referring to the principal planes of projection.
- A8303.3. Create orthographic views of points, lines, planes and solids appropriate to the projection system in use.
- A8303.4. Develop the lateral surface areas of regular solids by construction methods.
- A8303.5. Generate 3-dimensional views of simple objects using isometric coordinates.

## 3. Course Syllabus

**Introduction to Engineering Drawing::** Principles of engineering drawing and their significance. Construction of scales – Plane, Diagonal and Vernier scales. Construction of engineering curves, Ellipse, Parabola, Hyperbola (General method only) cycloid, Epicycloid, Hypocycloid and Involutés.

**Orthographic Projections-I:** Principles of orthographic projections. Projections of point, line, and plane - inclined to one plane and inclined to both principal planes.



**Orthographic Projections-II:** Orthographic projections of Prism, Cylinder, Pyramid and Cone - inclined to one plane and inclined to both principal planes.

**Development of Lateral Surfaces:** Development of Regular Solids – Prism, Cylinder, Pyramid and Cone.

**Isometric Projections:** Concept of isometric projection – Isometric scale – Isometric view of Line, regular Plane and Solid. Conversion of isometric view to orthographic views and vice-versa.

## 4. Books and Materials

### Text Books:

1. Bhatt N.D., Panchal V.M., Ingle P.R., "Engineering Drawing", 53<sup>rd</sup> Edition, Charotar Publishing House, 2019
2. Basant Agrawal, C. M. Agrawal, "Engineering Graphics", 3<sup>rd</sup> Edition, TMH Publication, 2010.

### Reference Books:

1. Narayana, K.L., P Kannaiyah, "Text book on Engineering Drawing", 3<sup>rd</sup> Edition, Sci-Tech Publishers, 2020.
2. K. Balaveera Reddy et al, Computer Aided Engineering Drawing, 2<sup>nd</sup> Edition, Scitech Publications, 2013
3. Shah, M.B., Rana B.C., Engineering Drawing and Computer Graphics, 2<sup>nd</sup> Edition, Pearson Education, 2009

**Course Structure****A8007 - Applied Physics Laboratory**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

**1. Course Description****Course Overview**

Applied Physics Laboratory covers the concepts of semiconductors, communication systems and wave optics. These experiments have number of applications and are valuable tool in the arsenal of engineers across multiple domains. This course also makes students familiar with the instrumental methods and various electrical properties of semiconducting devices. This basic knowledge will enable the scientific fervor to solve various engineering problems.

**Course Pre/co-requisites**

This course has no specific prerequisite and co-requisite.

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8007.1. Evaluation of properties of light radiation by wave optics.
- A8007.2. Interpret the principles of semiconductors.
- A8007.3. Determine the properties of laser light and estimate losses in optical fibre.
- A8007.4. Analyze the VI characteristics of LED and solar cell.
- A8007.5. Apply resonance principle to calculate frequency of AC supply.

**3. List of Experiments**

- 1. Determination of the wavelength of Sodium light by Newton's rings method.
- 2. Determination of wavelengths of spectral lines of Mercury (Hg) source using diffraction grating.
- 3. Determination of threshold voltage and study the V-I characteristics of LED.
- 4. To Study the V-I characteristics of PN junction diode under Forward and Reverse bias conditions.
- 5. Verification of the type of semiconductor material by estimating the density of majority carriers using Hall Effect.
- 6. Determination of the energy bandgap of a given semiconductor.
- 7. Determination of quality factor of solar cells and it's V-I Characteristics.



8. Determination of the wavelength of a given source of Laser light using plane transmission grating.
9. Evaluation of the numerical aperture (NA) and transmission losses of a given optical fiber.
10. Evaluation of frequency ( $n$ ) of an AC supply, using Sonometer.

#### 4. Laboratory Equipment/Software/Tools Required

1. Newton's Ring kit
2. Spectrometer
3. Regulated power supply (DC and AC)
4. Hall Effect Setup
5. Light Emitting Diode Kit
6. Solar cell Kit
7. Sonometer Setup
8. Semiconductor Laser Source
9. Plane diffraction grating
10. Optical fiber trainer kit
11. Meters - Ammeter, Voltmeter, Digital Multimeter
12. Diodes, Resistors, Capacitors, Bread Board

#### 5. Books and Materials

##### Text Books:

1. Sushil Kumar Jain, Majeet Singh, Applied Physics Experiments, JBC Press, 2013

##### Reference Books:

1. S B Mal, Er. Ashish Jesuja Practical Physics for Engineering Students of B.Tech, JBC Press, 2015
2. Applied Physics Laboratory Manual, Department of Physics, VCE 2022



## Course Structure

### A8502 - Problem Solving through C Laboratory

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

## 1. Course Description

### Course Overview

As an introductory course common to all branches, the student will be able to learn problem solving skills using 'C' programming language, which is a pre-requisite to learn many other programming Languages. The purpose of this course is to provide the basic programming methodology in C. This course will enable the students to learn programming skills necessary to implement all the basic mathematical, scientific and real world applications. C is a structured high-level programming language. The student can write programs using structures, functions and pointers. The course enables to perform file operations to store data permanently.

### Course Pre/co-requisites

This course has no specific prerequisite and co-requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8502.1. Use various programming constructs of C to solve a given problem.
- A8502.2. Make use of arrays, pointers and structures to organize data.
- A8502.3. Develop applications using functions for code reuse.
- A8502.4. Write programs using files for storing and accessing data.

## 3. List of Experiments

1. Variables and Expressions
  - a. Write a C program for Swapping of two numbers using a third variable
  - b. Write a C program for the simple and compound interest.
  - c. Write a C program to evaluate the expressions. (Finding  $y=m*x+c$ , displacement).
2. Operators
  - a. Write a C program to implement increment, decrement and Bitwise operators
  - b. Write a C program to find the greatest of 3 numbers using conditional operator.
3. Conditional Statements-I
  - a. Write a C program for finding the max and min from the three numbers.



- b. Write a C program to Check the given year is leap year or not.
- c. Write a C program to find the roots of a quadratic equation. .
4. Conditional Statements-II
  - a. Write a C program to check the given number is power of 2 or not using bit wise operators.
  - b. Write a C program to read 3 subject Marks. Calculate and display the grade of a student based on the percentages.
  - c. Write a C Program to perform Arithmetic Operations using switch statement.
5. Iterative Statements-I
  - a. Write a C program to find sum of n natural numbers  $(1+2+3 \dots +n)$ .
  - b. Write a C program to find factorial of a given number.
  - c. Write a C program to print Fibonacci numbers.
  - d. Write a C program to find reverse of the given number.
  - e. Write a C program to Check if the binary representation of a positive number is palindrome or not. For example, 101, 11, 11011, 1001001 are palindromes. 100, 110, 1011, etc., are not palindromes.
6. Iterative Statements-II
  - a. Write a C program to read a password until it is correct. For wrong password print "Incorrect password" and for correct password print "Correct password" and quit the program. The correct password is 1234.
  - b. Write a C program to check the given number is prime or not.
  - c. Write a C program to find the GCD of given two numbers.
  - d. Write a C program to print the output in various triangle patterns using Nested for loop.
  - e. Write a C Program to find the sum of the series Geometric Progression.
7. Arrays
  - a. Write a C program to find the largest and smallest number among a list of integers.
  - b. Write a C Program to read an array of n elements and find the mean, variance and standard deviation.
  - c. Given an integer array of election votes having candidate IDs, write a program to find the winner of the election.
8. Multi Dimensional Arrays
  - a. Write a C program to find Addition of two Matrices.
  - b. Write a C program to find Multiplication of two Matrices.
9. Strings
  - a. Write a C program to demonstrate the string handling functions.
  - b. Write a C program to Check whether a given string is palindrome or not.



- c. Write a C program to concatenate three strings.
  - d. Write a C program to count the lines, words and characters in a given text.
10. Functions
- a. Write a C program to find the factorial of a given number using non-recursive and recursive function
  - b. Write a C program to find the nth term of a Fibonacci series using recursive function.
  - c. Write a c program to compute x power y.
11. Structures
- a. Write a C program to create a Student structure containing name, rollNo and grade as structure members. Display the name, rollNo and grade of a student.
  - b. Write a C program to create a Book structure containing name, author and pages as structure members. Display the name, author and pages of a Book.
  - c. Write a C Program to Create a Student structure containing name, rollNo and grade as structure members. Display the name, rollNo and grade of n students by using array of structures concept.
12. Structures
- a. Write a C Program to Add Two Complex Numbers by Passing Structure to a Function
  - b. Write a C Program to Add Two Distances (in inch-feet system) using Structures
13. Pointers
- a. Write a C program to swap two integers using following methods.
    - i) Call by Value ii) Call by Reference
  - b. Write a C program to demonstrate pointer arithmetic.
  - c. Write a C Program to Check the given string is palindrome or not using pointer.
  - d. Write a C program to print n cities names using pointers and strings.
14. Files
- a. Write a C program to merge two files into a third file.
  - b. Write a C program to reverse the contents of a file.
  - c. Write a C Program to use random access functions in files.

## 4. Laboratory Equipment/Software/Tools Required

- 1. Computer Systems (PCs) installed with Ubuntu OS (Open Source/ Freeware)
- 2. GCC Compiler (Open source / Freeware).

**Course Structure****A8301 - Engineering Workshop**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

**1. Course Description****Course Overview**

Engineering Workshop is an establishment of space and facility where the students acquire the knowledge on different materials, equipment, tools and workshop practices that are the core methods of engineering industry. This course is of prime importance which makes the learner competent in handling practical work in all types and trades of engineering. It also develops the skills with dignity of labour, precision, safety at work place, team working innovative ideas in making and development of right attitude.

**Course Pre/co-requisites**

This course has no specific prerequisite and co-requisite.

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8301.1. Identify the trade based materials and tools to prepare the models.
- A8301.2. Illustrate each trade and tool by hands on training in making the models.
- A8301.3. Apply different workshop practice methods towards workshop models.
- A8301.4. Analyze the trade based operations in the process of product development.
- A8301.5. Develop a progressive product towards a societal need.

**3. Course Syllabus****PART – A (Demonstration)**

1. CNC Machining.
2. Additive Manufacturing with one Model.
3. Power Tools, Plastic Moulding, Metal Casting.
4. Welding (TIG/MIG, Gas Welding), Brazing.

**PART - B (Practical)**

1. Fitting : L - Fit / V - Fit / Square – Fit / Semi Circular - Fit.
2. Carpentry : Cross Lap Joint / Dovetail Joint / T – Lap Joint / Corner Lap Joint.
3. House wiring : Series / Parallel / One Bulb One Switch / Tube Light / Two-way switch.



4. Welding : Butt Joint / Lap Joint / T Joint .
5. Foundry : Single Piece / Multi Piece.
6. Tin Smithy : Open Scoop / Funnel / Rectangular Tray / Cylindrical
7. Plumbing : Pipe Threading / Pipe Joints.

**Note: Minimum one experiment from each Trade with total of 12 Experiments**

#### 4. Laboratory Equipment/Software/Tools Required

1. Fitting : Bench vise, Hacksaw frame, Calipers, Files, Try Square
2. Carpentry : Carpentry vise, Chisels, Saws, Wooden Hammer, Try Square
3. House wiring : Wiring Bundles, Socket Pins, Tester, Poker, and Cutting Plier
4. Welding : Welding M/c, Safeguards, Chipping Hammer, Electrode Holder
5. Foundry : Wooden patterns, Riddle, Riser, Runner, Gate cutter, Rammers
6. Tin Smithy : Wire Gauge, Snips, Pliers, Steel rule, Soldering kit, Nylon Hammers.
7. Plumbing : Pipe Wrench, Pipe Cutter, Pliers, Pipe Die Set
8. Additional : Model Joints and Electric Boards

**Course Structure****A8021 - Social Innovation**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

**1. Course Description****Course Overview**

Social Innovation is an open-ended course to develop social connectedness in engineering students through social awareness and social consciousness. This can be done through live field exposure along with faculty led conceptual presentations, real case reviews, self-study assignments, literature and field survey. Through this course, the students are expected to use their engineering knowledge to provide innovative solutions to existing social problems. This course also develops critical thinking ability among the students to develop sustainable solutions.

**Course Pre/co-requisites**

This course has no specific prerequisite and co-requisite.

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8021.1. Develop awareness on social issues faced by local regions.
- A8021.2. Identify the mind set of human Race and interpret the societal issues as simple, complicated, and complex problems.
- A8021.3. Identify the need statement along with its main causes and effects.
- A8021.4. Develop an innovative and sustainable solution for social issues by thinking critically and creatively.

**3. Course Syllabus**

**Introduction to Social Innovation:** Core definitions, core elements and common features of social innovation, a typology of social innovation, Awakening social consciousness.

**Create Mindsets and Wicked Problems:** Seven mindsets – Empathy, Optimism, Iteration, Creative confidence, making it, embracing ambiguity, Learning from failures. Distinguish between simple, complicated, and complex problems; describe the characteristics of wicked problems, breakdown a given problem by unpacking its complexity.



**Critical and Creative Thinking for Social Innovation:** Definition, engineering thinking and learning, distinguish between creativity and innovation. Models of Creative thinking. [Appreciative Inquiry (AI), Asset Based Community Development (ABCD) and Concept of Bricolage.

**Process of Social Innovation:** Community study, develop questionnaire, identifying the causes of a particular problem, identify needs, record your learning's, generate ideas, select promising ideas, prototyping, and testing.

**Social Innovation across Four Sectors:** The non-profit sector, public sector, the private sector, the informal sector, links between and cross sectors. Stages of Innovation: Social organizations and enterprises, social movements, social software and open source methods, common patterns of success and failure.

## 4. Books and Materials

### Text Books:

1. Robin Murray, Julie Caulier-Grice, Geoff Mulgan, "The open book of social innovation: Ways to Design, Develop and Grow Social Innovation", The Young Foundation, 2010.
2. Julie Caulier-Grice, Anna Davies, Robert Patrick & Will Norman, The Young Foundation (2012) Social Innovation Overview: A deliverable of the project: "The theoretical, empirical and policy foundations for building social innovation in Europe" (TEPSIE), European Commission – 7th Framework Programme, Brussels: European Commission, DG Research.

### Reference Books:

1. Geoff Mulgan, "Social Innovation: What it is, Why it matters and How it can be accelerated", The Young Foundation, 2007.
2. Asset Based Community Development (ABCD) Model – <http://www.nurtureddevelopment.org/asset-based-community-development/>
3. Diana Whitney & Amanda Trosten-Bloom, "The Power of Appreciative inquiry – A Practical Guide to Positive Change", 2<sup>nd</sup> Edition, Berrett-Koehler Publishers, Inc, 2010.

**I YEAR II SEMESTER**



## Course Structure

### A8002 - Ordinary Differential Equations and Vector Calculus

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	1	0	45	15	0	4	40	60	100

## 1. Course Description

### Course Overview

This course provides mathematical knowledge required to analyze problems encountered in engineering. In this course, the students are acquainted with ordinary differential equations of first and higher order and Laplace transforms, vector calculus. In addition, this course can be applied in many areas of engineering such as wireless communication, signal processing, robotics and animation.

### Course Pre/co-requisites

This course has no specific prerequisite and co-requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8002.1. Solve ordinary differential equations of first and higher order.
- A8002.2. Make use of ordinary differential equations to solve engineering problems.
- A8002.3. Apply Laplace transforms to solve ordinary differential equations.
- A8002.4. Determine divergence and curl of a vector point function.
- A8002.5. Make use of vector integral theorems to evaluate area, surface area and volumes

## 3. Course Syllabus

**First Order Ordinary Differential Equations:** Exact differential equations, Equations reducible to exact differential equations, linear and Bernoulli's equations, Orthogonal Trajectories (only in Cartesian Coordinates). Applications: Newton's law of cooling, Law of natural growth and decay.

**Ordinary Differential Equations of Higher Order:** Second order linear differential equations with constant coefficients: Non-Homogeneous terms of the type  $e^{ax}$ ,  $\sin ax$ ,  $\cos ax$ , polynomials in  $x$ ,  $e^{ax} V(x)$  and  $xV(x)$ , method of variation of parameters, Equations reducible to linear ODE with constant coefficients: Cauchy-Euler equation. Applications:



L-C-R Circuits.

**Laplace Transforms:** Laplace Transform of standard functions, First shifting theorem, Second shifting theorem, Unit step function, Dirac delta function, Laplace transforms of functions when they are multiplied and divided by 't', Laplace transforms of derivatives and integrals of function, Evaluation of integrals by Laplace transforms, Laplace transform of periodic functions, Inverse Laplace transform, convolution theorem (without proof). Applications: solving Initial value problems by Laplace Transform method.

**Vector Differentiation:** Vector point functions and scalar point functions, Gradient, Directional derivatives, Divergence and Curl, Vector Identities, Scalar potential functions, Solenoidal and Irrotational vectors.

**Vector Integral Calculus:** Line integral, work done, Surface integrals, Volume integrals. Vector integral theorems: Green's theorem in a plane, Stoke's theorem and Gauss divergence theorem (without proof) and their applications.

## 4. Books and Materials

### Text Books:

1. Grewal, B.S. Higher Engineering Mathematics, 43<sup>rd</sup> Edition, Khanna Publications, 2015.
2. Jain, R.K. and Iyengar, S.R.K. Advanced Engineering Mathematics, 3<sup>rd</sup> Edition, Narosa Publishing House, 2011.

### Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9<sup>th</sup> Edition, John Wiley & Sons, 2006.
2. Ramana, B.V. Higher Engineering Mathematics, 32<sup>nd</sup> Reprint, McGraw Hill Education (India) Pvt Ltd, 2018.

**Course Structure****A8008 - Engineering Chemistry**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

This course emphasizes a strong background of Chemistry, infused with an orientation towards the applied chemistry and materials technology. A course that focuses on the general applications of chemical principles to the analysis and evaluation of engineering problems as water and its treatment for various purposes, engineering materials as plastics, fibres, elastomers, composites, non-conventional energy sources, batteries and fuel cells.

**Course Pre/co-requisites**

This course has no specific prerequisite and co-requisite.

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8008.1. Apply the knowledge of electrochemical series to protect different metals from corrosion.
- A8008.2. Analyze the hardness and other impurities present in the water for industrial and domestic applications.
- A8008.3. Evaluate the behaviour of different engineering materials.
- A8008.4. Analyze the different types of fossil fuels, characteristics and their applications.
- A8008.5. Compare the materials to study various physical and chemical properties.

**3. Course Syllabus****Battery Chemistry & Corrosion:**

**Batteries:** Classification – Primary battery (dry cell and lithium cell) and Secondary battery (Lithium-ion cell and lead acid battery). Fuel cells – Hydrogen-Oxygen fuel cell– Engineering applications, Solar cells - Introduction and applications of Solar cells. **Corrosion and Its Control:** Causes and effects of corrosion – Theories of Corrosion – Chemical corrosion – oxidation corrosion, Electrochemical theory of corrosion - mechanism. Types of corrosion – Galvanic corrosion – Concentration cell corrosion (Pitting corrosion and Waterline corrosion). Factors affecting the rate of corrosion, Pilling-Bedworth rule, corrosion



control methods – cathodic protection – sacrificial anodic – impressed current cathodic protection.

**Water and its treatment:** Introduction – hardness of water – causes of hardness – types of hardness: temporary and permanent – expression and units of hardness, Numerical problems. Boiler troubles: sludges, scales and caustic embrittlement. Internal treatment of boiler feed water – Calgon conditioning – Phosphate conditioning – Colloidal conditioning – Softening of water by ion exchange processes. Potable water – its characteristics. Desalination of water – Reverse osmosis. Sewage – Steps involved in treatment of sewage.

**Polymeric Materials:** Terminology, Types of Polymerization – Addition and Condensation polymerization with examples. Characteristics of Plastics, fibres and elastomers. Plastics: Thermo- plastic resins & Thermosetting resins. Preparation, properties and engineering applications of Polyvinyl chloride and Teflon. Fibers: Preparation, properties and engineering applications of Nylon-6,6 and Dacron. Elastomers: Natural rubber and its vulcanization, Artificial rubbers - Buna-S and Butyl rubber. Conducting Polymers: Classification, mechanism of conduction in trans - polyacetylene – applications.

**Energy Sources:** Introduction, Calorific value of fuel – HCV, LCV- Dulong's formula – Numerical Problems. Classification- solid fuels – coal – analysis of coal – proximate and ultimate analysis and their significance. Liquid fuels – petroleum and its refining, Cracking and its types – moving bed catalytic cracking. Knocking – octane and cetane rating, synthetic petrol - Fischer-Tropsch's process; Gaseous fuels – composition, characteristics and applications of LPG and CNG, Biodiesel – Transesterification, advantages

**Engineering Materials:**

**Nanomaterials:** Introduction, Chemical synthesis by sol-gel, precipitation, solvo-thermolysis and thermolysis methods. Applications of nanomaterials in Industry and Engineering.

**Graphene:** Isolation, Structure and strength, applications in Computer, Electrical and Electronic Devices.

**Alloys:** Definition – Purpose of alloying, Types of alloys – Ferrous Alloys (Stainless steel, Nichrome, Alnico), Non-ferrous alloys (solder, brass and bronze).

**Portland cement:** Chemical constituents, Setting and Hardening and applications of cement.

## 4. Books and Materials

**Text Books:**

1. Rama Devi. B, Aparna. P, Prasanta Rath, Engineering Chemistry, 2<sup>nd</sup> Edition, Cengage



Publications, 2022.

2. Jain and Jain, Engineering Chemistry, 16<sup>th</sup> Edition, Dhanpat Rai Publication Company, 2015.

**Reference Books:**

1. Shikha Agarwal, Engineering Chemistry, Cambridge University Press, Delhi, 2015.
2. Shashi Chawla, Engineering Chemistry, Dhanpatrai and Company (P) Ltd. Delhi, 2011.
3. Thirumala Chary. M, Laxminarayana. E and Shashikala. K, A text book of Engineering Chemistry, Pearson Publications, 2021.

**Course Structure****A8010 - English for Skill Enhancement**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
2	0	0	30	0	0	2	40	60	100

**1. Course Description****Course Overview**

This course has been designed to develop linguistic and communicative competencies among engineering students. The Reading and Writing skills of the students are honed during the sessions using the prescribed textbook. Additional focus is laid on grammar and vocabulary. In addition, the students are encouraged to read texts which are aimed at developing their comprehension skills.

**Course Pre/co-requisites**

This course has no specific prerequisite and co-requisite.

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8010.1. Build competence in grammar for effective communication.
- A8010.2. Acquire suitable vocabulary required for achieving communicative competence.
- A8010.3. Utilize academic reading skills to comprehend different texts effectively.
- A8010.4. Develop effective writing skills for academic purposes.
- A8010.5. Demonstrate basic proficiency in professional correspondence.

**3. Course Syllabus****‘Toasted English’ by R.K.Narayan**

**Vocabulary** : Word Formation - Prefixes and Suffixes; Synonyms and Antonyms; Conjunctions

**Grammar** : Identifying Common Errors in Writing with Reference to Articles and Prepositions

**Reading** : Techniques for Effective Reading

**Writing** : Sentence Structures -Use of Phrases and Clauses in Sentences- Types of sentences; Punctuation; Techniques for Writing precisely – Paragraph Writing – Types, Structures and Features of a Paragraph - Creating Coherence-Organizing Principles of Paragraphs in Documents.



## ‘Appro JRD’ by Sudha Murthy

- Vocabulary** : Homophones, Homonyms and Homographs  
**Grammar** : Identifying Common Errors in Writing with reference to Tenses, Noun-pronoun Agreement and Subject-verb Agreement  
**Reading** : Sub-Skills of Reading – Skimming and Scanning  
**Writing** : Essay writing; Precis writing

## Lessons from Online Learning’ by F.Haider Alvi, Deborah Hurst et al

- Vocabulary** : Words Often Confused; Idioms  
**Grammar** : Misplaced Modifiers  
**Reading** : Sub-Skills of Reading – Intensive Reading and Extensive Reading – Exercises for Practice  
**Writing** : Letter Writing: Letter of Request, Letter of Inquiry, Letter of Apology, Letter of Complaint.

## ‘Art and Literature’ by Abdul Kalam

- Vocabulary** : Standard Abbreviations in English  
**Grammar** : Redundancies and Clichés in Oral and Written Communication  
**Reading** : Survey, Question, Read, Recite and Review (SQ3R Method)  
**Writing** : Information Transfer; Letter of Application and Resume/CV writing; Email writing- format, style and etiquette.

## Chapter entitled ‘Go, Kiss the World’ by Subroto Bagchi

- Vocabulary** : Technical Vocabulary and their Usage  
**Grammar** : Identify the errors with reference to Active and Passive Voice; Reported speech  
**Reading** : Reading Comprehension: Exercises for Practice.  
**Writing** : Technical Reports- Introduction – Characteristics of a Report – Categories of Reports Formats- Structure of Reports (Manuscript Format) -Types of Reports - Writing a Report.

## 4. Books and Materials

### Text Books:

1. English: Language, Context and Culture by Orient BlackSwan Pvt. Ltd, Hyderabad. 2022. Print.

### Reference Books:



1. Raman, Meenakshi and Sharma, Sangeeta, Technical Communication- Principles and Practice, 3<sup>rd</sup> Edition, Oxford University Press, New Delhi. Print, 2015.
2. Muralikrishna C. and Sunita Mishra, Communication Skills for Engineers, 2<sup>nd</sup> Edition, Pearson, 2011
3. Ashraf Rizvi M, Effective Technical Communication, 2<sup>nd</sup> Edition, McGraw Hill Education, 2017
4. Swan, Michael, Practical English Usage, Oxford University Press. Fourth Edition, 2016.
5. Chaudhuri, Santanu Sinha. (2018). Learn English: A Fun Book of Functional Language, Grammar and Vocabulary, 2<sup>nd</sup> Edition, Sage Publications India Pvt. Ltd.

**Course Structure****A8505 - Data Structures**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

Data Structures is a course for an engineering graduate to improve the programming skills using C Language. It is a logical model of organizing data, used in designing and implementing efficient algorithms. Data structures are important as they are implemented in every software application. This course covers various operations on Singly Doubly Linked Lists. The linear data structures stacks and queues are implemented using both arrays and linked lists. The course also includes fundamental terminology of non-linear data structures like Trees and Graphs which are especially used to handle large amount of data. The course will also enable the use of appropriate searching and sorting method in handling collection of elements.

**Course Pre/co-requisites**

A8501 - Problem Solving through C

A8502 - Problem Solving through C Laboratory

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8505.1. Select appropriate sorting and searching technique for a given application.
- A8505.2. Use various forms of linked lists to perform operations on data efficiently.
- A8505.3. Build applications using stack data structure for real time applications.
- A8505.4. Construct various forms of Queues to solve a real time problem.
- A8505.5. Make use of nonlinear data structures for organizing data.

**3. Course Syllabus**

**Searching and Sorting:** Asymptotic Notations, Time Complexity and Space Complexity of algorithms, Introduction to Searching, Linear search and Binary search. Introduction to Sorting, Bubble sort, Selection sort, Insertion sort, Merge Sort and Quick sort.

**Dynamic Memory Allocation and Linked Lists:** Introduction, Dynamic Memory Allocation Functions: malloc, calloc, free and realloc. Self-Referential Structures. Linked List-



Introduction, Basic Terminologies, Linked Lists versus Arrays, Operations on Singly Linked Lists and Doubly Linked Lists. (Create, insert, delete, reverse, display and count).

**Stacks:** Introduction, Array and Linked List representation of Stacks, Operations on Stack using Array and Linked List. Applications of Stacks: Infix to Postfix conversion, Evaluation of Postfix Expression.

**Queues:** Introduction, Array and Linked List representation of Queues, Operations on Queue using Array and Linked List. Circular Queue and Deque implementation using arrays.

**Trees and Graphs:** Introduction to Trees, Basic Terminologies, Representation of Binary Tree and Tree Traversal Techniques- Pre order, In order and Post order. Introduction to Graphs, Graph Terminology, Directed Graphs, Non Directed Graphs, Representation of Graphs.

## 4. Books and Materials

### Text Books:

1. Reema Thareja., Data Structures Using C, 2<sup>nd</sup> Edition, Oxford University Press, New Delhi India, 2014.

### Reference Books:

1. Samanta Debasis., Classic Data Structures, 2<sup>nd</sup> Edition, Prentice Hall of India, New Delhi, India, 2012.
2. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed., Fundamentals of Data Structure in C, 2<sup>nd</sup> Edition, University Press, India, 2008.

**Course Structure****A8305 - Engineering Mechanics**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

Engineering Mechanics is a branch of Physical Science which uses the Laws of Mechanics to predict forces and torques and its effects on the motion of rigid bodies. The course covers a basic introduction to both statics and dynamics. This course is the key prerequisite course to sequences of courses dealing with mechanics of solids, Kinematics and Dynamics of Machinery and Design of Machine Members.

**Course Pre/co-requisites**

A8002 - Ordinary Differential Equations and Vector Calculus.

A8006 - Applied Physics

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8305.1. Illustrate the types of forces and moments acting on a rigid body.
- A8305.2. Apply the laws of mechanics to evaluate different types of forces acting on a rigid body.
- A8305.3. Identify the centroid and moment of inertia of composite bodies.
- A8305.4. Apply the basic concepts of kinematics and kinetics to solve numerical problems.
- A8305.5. Calculate the forces and moments by using equilibrium conditions of a force system.

**3. Course Syllabus**

**Introduction to Engineering mechanics :** Basic Concepts, Resultants of Force System, Parallelogram law, Forces and components, Resultant of coplanar Concurrent Forces, Components of forces in Space, Moment of Force, principle of moments, Coplanar Applications, Couples, Resultant of any Force System. Equilibrium of Force Systems, Free Body Diagrams, Equations of Equilibrium, Equilibrium of planar Systems.

**Friction:** Friction covering, Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, Ladder friction, wedge friction.



**Centroid and centre of gravity:** Centroid of simple figures from first principle, centroid of composite sections, Pappus theorems. Centre of Gravity and its implications, centre of gravity of composite sections.

**Moment of inertia:** Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections. Mass moment inertia of circular plate, Cylinder, Cone, Sphere, mass moment of inertia of composite bodies.

**Dynamics of particles:** Work Energy Equation, Conservation of energy, Impulse and Momentum principle, direct central collisions, coefficient of restitution.

## 4. Books and Materials

### Text Books:

1. Ferdinand. Singer, "Engineering Mechanics", 5<sup>th</sup> Edition, Harper and Bros,2013.
2. R.C Hibbler, "Engineering Mechanics",12<sup>th</sup> Edition,Prentice Hall,2009

### Reference Books:

1. Ferdinand P. Beer, "Vector Mechanics for Engineers Statics",12<sup>th</sup> Edition, Mc-Graw Hill,2019.
2. J.L Meriam and L.G.Kraige,"Engineering Mechanics-Statics", 2<sup>nd</sup> Edition, Wiley,2020.
3. S.S. Bhavikati & K.G. Rajasekharappa, "Engineering Mechanics", 1<sup>st</sup> Edition, Newage publications, 1994.



### Course Structure

#### A8009 - Engineering Chemistry Laboratory

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

## 1. Course Description

### Course Overview

The Chemistry Laboratory conducts fundamental studies of highway materials to understand mechanisms. It provides students with a practical approach towards the various techniques used in engineering application. Practical awareness is inculcated and students are trained both quantitatively and qualitatively during the lab sessions to enhance their understanding and problem solving abilities.

### Course Pre/co-requisites

This course has no specific prerequisite and co-requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8009.1. Apply the instrumental techniques to find out the concentrations or equivalence points of solutions.
- A8009.2. Analyze the impurities present in the water using volumetric analysis.
- A8009.3. Make use of different titrations to measure various properties of chemical species.
- A8009.4. Analyze the importance of temperature and pressure on physical properties like viscosity and surface tension of liquids.
- A8009.5. Calculate the yield of synthetic drugs by maintaining specific reaction conditions.

## 3. List of Experiments

1. Estimation of amount of ferrous ion in a given solution by permanganometry.
2. Estimation of amount of ferrous ion in given solution by dichrometry.
3. Estimation of hardness of water by complexometry using EDTA.
4. Determination of chloride content in water by argentometry.
5. Estimation of amount of hydrochloric acid in a given sample by conductometry.
6. Estimation of amount of acetic acid in a given sample by conductometry.



7. Estimation of amount of hydrochloric acid in a given sample by potentiometry.
8. Estimation of amount of  $\text{Fe}^{+2}$  in a given sample by potentiometry.
9. Estimation of  $\text{Mn}^{+2}$  in a given sample by colorimetry.
10. Estimation of  $\text{Cu}^{+2}$  in a given sample by colorimetry.
11. Determination of viscosity of a given fluid by Ostwald's viscometer.
12. Determination of surface tension of a given liquid by using stalagmometer.
13. Preparation of Aspirin.
14. Preparation of Nylon 6

#### 4. Laboratory Equipment/Software/Tools Required

1. Digital Conductometer
2. Digital Potentiometer
3. Digital Colorimeter
4. Electrical Water Heater
5. Wall Mount Distillation Plant
6. Analytical/Digital Weighing Balance
7. Ostwald's Viscometer
8. Stalagmometer
9. Stopwatch
10. Thermometer
11. RB Flask condenser
12. Magnetic Stirrer
13. Pipette
14. Burette
15. Beaker

#### 5. Books and Materials

##### Text Books:

1. Ramadevi. B and Aparna. P, Lab manual for Engineering chemistry, S Chand Publications, New Delhi, 2022.

##### Reference Books:

1. Inorganic Quantitative analysis by A.I. Vogel, ELBS Publications.
2. Ahluwalia. V.K, College Practical Chemistry, Narosa Publications Ltd. New Delhi, 2007.



### Course Structure

#### A8011 - English Language and Communication Skills Laboratory

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

## 1. Course Description

### Course Overview

This course is designed to cater to the needs of students in developing their oral communication skills. It begins with an introduction to Phonetics to make them understand the received pronunciation and to help them speak with neutral accent and appropriate intonation. This course incorporates listening skills and draws exercises of listening comprehension from various general and business contexts. The speaking exercises in this course will help the students to present their ideas in different situations, besides helping them to develop team spirit by participating in pair/ group activities.

### Course Pre/co-requisites

This course has no specific prerequisite and co-requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8011.1. Acquire the received pronunciation and speak in a neutral accent.
- A8011.2. Use contextual vocabulary for lucid spoken communication.
- A8011.3. Comprehend accent of different varieties of English.
- A8011.4. Develop skills for professional presentations.
- A8011.5. Demonstrate the ability to communicate by enhancing listening skills

## 3. Course Syllabus

**CALL Lab:** Listening Skill- Its importance – Purpose- Process- Types- Barriers- Effective Listening; Introduction to Phonetics – Speech Sounds – Vowels and Consonants

**ICS Lab:** Spoken vs. Written language- Formal and Informal English; Ice-Breaking Activity and JAM Session- Self Introduction, Importance of Non Verbal Communication; Situational Dialogues: Introducing Others – Greetings – Taking Leave.

**CALL Lab:** Past Tense and Plural Marker Rules, Structure of Syllables; Listening to Monologues and Dialogues



**ICS Lab:** Pair Activity: Asking and giving directions; Exchanging information, Making Requests and Seeking Permissions and Justifying Opinions.

**CALL Lab:** Stress pattern in sentences; Weak and Strong Forms; Neutralization of Mother Tongue Interference; Listening to Group Conversation

**ICS Lab:** Describing Place, Person and Event

**CALL Lab:** Intonation; Listening for Specific Information

**ICS Lab:** Group activity: Agreeing and/or disagreeing, Suggesting, Speculating, Comparing and contrasting; Telephone Etiquette; Introduction to Group Discussion

**CALL Lab:** Differences between British and American Pronunciation; Listening for General Comprehension of the Content

**ICS Lab:** Introduction to Interview Skills; Mock Interviews; Structured Presentations; Ex-tempore Presentations

## 4. Books and Materials

### Reference Books:

1. Brook-Hart, Guy, Cambridge English Business Benchmark- Upper Intermediate Business Vantage (with CD), 2nd Edition, South Asian Edition, Cambridge University Press, 2019.
2. Hancock, M., English Pronunciation in Use Intermediate, Cambridge University Press. Print, Cambridge, 2009.
3. Mohanraj, J., Let Us Hear Them Speak, 1st Edition, Sage Texts Print, New Delhi, 2015
4. Exercises in Spoken English, Parts I-III CIEFL, Oxford University Press, 1997.



## Course Structure

### A8507 - Data Structures Laboratory

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

## 1. Course Description

### Course Overview

Data Structures laboratory course provides implementation of linear and nonlinear data structures to organize data efficiently. Data structures are important as they are implemented in every software application. This course covers various operations on Singly Linked Lists and Doubly Linked Lists. The linear and nonlinear data structures are implemented using both arrays and linked lists. The course will also enable the use of appropriate searching and sorting method in handling collection of elements. The course is basis for data structures implementation in various programming languages.

### Course Pre/co-requisites

A8501 – Problem Solving through C

A8502 – Problem Solving through C Laboratory

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8507.1. Implement various searching and sorting techniques on a given data.
- A8507.2. Organize data efficiently using linked lists.
- A8507.3. Perform various operations on data structures using arrays and linked lists.
- A8507.4. Write programs to traverse tree using linked list.

## 3. List of Experiments

1. Write a C Program to Implement Linear Search and Binary Search.
2. Write a C Program to Implement Bubble Sort and Selection Sort.
3. Write a C Program to Implement Insertion Sort and Quick Sort.
4. Write a C Program to Implement Merge Sort.
5. a) Write a C program to Read an array of integers whose size will be specified interactively at run time and print those elements.  
b) Write a C program to Illustrate Self Referential Structures.
6. Write a C program to implement Singly Linked List Operations: Creation, Insertion, Deletion, Reverse, Count and Traversal.



7. Write a C program to implement Doubly Linked List Operations: Creation, Insertion, Deletion, Count and Traversal.
8. Write a C program to implement Stack operations using Arrays.
9. Write a C program to implement Stack operations using Linked List
10. a) Write a C Program to implement to convert an expression from Infix to Postfix.  
b) Write a C Program to Evaluate arithmetic expression.
11. a) Write a C program to implement Queue operations using Arrays.  
b) Write a C program to implement Queue operations using Linked List.
12. Write a C program to implement Circular Queue operations using Arrays.
  
13. Write a C program to implement Deque operations using Arrays.
14. Write a C Program to Implement Traversals on Binary Tree using linked list.

#### 4. Laboratory Equipment/Software/Tools Required

1. Computer Systems (PCs) installed with Ubuntu OS (Open Source/ Freeware)
2. GCC Compiler (Open source / Freeware).



## Course Structure

### A8302 - Computer Aided Drawing

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

## 1. Course Description

### Course Overview

This course covers the essential core topics for working with the AutoCAD software, orthographic projections for points, lines, planes and solids in different positions, the development of lateral surfaces and the isometric projections. The students are able to create simple solid models of various domain applications.

### Course Pre/co-requisites

This course has no specific prerequisite and co-requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8302.1. Illustrate various menu bars and tool bars on AutoCAD interface.
- A8302.2. Differentiate first angle and Third angle projection system based on representation of orthographic views.
- A8302.3. Create orthographic views of points, lines, planes and solids using appropriate tools.
- A8302.4. Develop the lateral surface areas of regular solids by construction methods.
- A8302.5. Model 3-dimensional views of simple objects using isometric coordinates.

## 3. Course Syllabus

**Introduction to AutoCAD:** File menu of AutoCAD with New, Open, Save, Save as and Close, Basic 2D commands like Line, Circle, Ellipse, Multi Line, Construction Line, Polyline, Point, Donut, Ellipse, Polygon, Rectangle, Arc, Erase, Snap, Redraw, Regenerate, Zoom, Pan.

**Editing of AutoCAD Drawing:** Modify Properties of Drawing Entity, Copy, Move, Rotate, Mirror, Offset, Array, Scale, Stretch, Lengthen, Trim, Extend, Break, Chamfer, Fillet.

**Orthographic Projections-I:** Orthographic projections of Points, Lines and planes inclined to one plane and inclined to both the principal planes.



**Orthographic Projections-II:** Orthographic projections of regular solids-prism, cylinder, pyramid and cone inclined to one of the reference plane.

**Isometric Projections:** Isometric coordinates, Isometric Scale, Isometric Views of Lines, Planes and solids. Conversion of Isometric View to Orthographic Views and Vice-versa.

#### 4. Laboratory Equipment/Software/Tools Required

1. PC installed with operating system (Windows)
2. Auto CAD software

#### 5. Books and Materials

**Text Books:**

1. Bhatt N.D., Panchal V.M. & Ingle P.R., "Engineering Drawing", 53<sup>rd</sup> Edition, Charotar Publishing House, 2019.
2. K. Balaveera Reddy et al, "Computer Aided Engineering Drawing", 2<sup>nd</sup> Edition, CBS Publications, 2015.

**Reference Books:**

1. Narayana, K.L. & P Kanniah, "Text book on Engineering Drawing" , 3<sup>rd</sup> Edition, Sci-Tech Publishers, 2020.
2. Basant Agrawal B. and Agrawal C. M., "Engineering Graphics", 3<sup>rd</sup> Edition, TMH Publication, 2020.
3. Shah, M.B., Rana B.C., "Engineering Drawing and Computer Graphics", 2<sup>nd</sup> Edition, Pearson Education, 2009.

**Course Structure****A8022 - Engineering Exploration**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

**1. Course Description****Course Overview**

This Course provides an opportunity for freshman students to learn in new ecosystem and is one of the unique outcomes of innovative education ecosystem in digital era of our nation. The focus of this course is on Engineering Design Process, Problem Solving, Multi-disciplinary skills, Ethics and Data Acquisition and Analysis. This course is co-designed and co-taught by faculty members drawn from multiple engineering disciplines; it follows Project Based Learning (PBL) pedagogy with need statements covering broad themes of environmental, educational, smart appliances, smart agriculture, industrial needs etc. are used by students to carve out problem definitions by linking Sustainable Development Goals defined by United Nation. Students work in teams to solve identified problems and serves as a platform for peer learning and push students in Multi-disciplinary design thinking in first year itself.

**Course Pre/co-requisites**

A8021 - Social Innovation

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8022.1 Compare and contrast the contributions of different types of engineers in the development of a product, process, or system.
- A8022.2 Apply the common engineering design process to solve complex problems and arrive at viable solution.
- A8022.3 Explore various contemporary software and hardware tools to provide solutions for the problems.
- A8022.4 Apply skills needed for successful teamwork including the basics of project management and written and oral communication.
- A8022.5 Identify the key elements of professional codes of ethics as well as the ethical and societal issues related to the disciplines and their impact on society and the world.



## 3. Course Syllabus

**Introduction to Engineering and Engineering Study:** Difference between science and engineering, scientist and engineer needs and wants, various disciplines of engineering, some misconceptions of engineering, Expectation for the 21st century engineer and Graduate Attributes.

**Engineering Design Process:** Design Cycle, Multidisciplinary facet of design, Importance of analysis in engineering design, general analysis procedure, generation of multiple solution, decision matrix, Concepts of reverse engineering and general mechatronics system.

**Introduction to Open-source Platforms:** Open-source hardware & software tools, Development (Arduino) of Programming (Tinker CAD Tools) and its Essentials, Introduction to Sensors, Transducers and Actuators and its Interfacing with Open-Source H/W & S/W tools.

**Engineering Ethics:** Identifying Engineering as a Profession, Significance of Professional Ethics, Code of Conduct for Engineers. Sustainability: Introduction to sustainability, Sustainability leadership, Life cycle assessment.

**Project Management & Tools:** Introduction, Significance of teamwork, Importance of communication in engineering profession, Checklist, Timeline, Gantt Chart, Significance of documentation.

## 4. Laboratory Equipment/Software/Tools Required

1. Open-source Hardware: Microchip ATmega328P (UNO/NANO/MEGA).
2. I/O Peripherals: LCD, Keypad, DC/Servo Motor, Switch, 7-Segment LED modules, GSM, GPS etc.
3. Sensor Tool Kit: Digital RED/WHITE/GREEN/BLUE Light Module, IR, Analog Sound, Soil Moisture, LM35 Analog Linear Temperature, MQ7 Analog Carbon Monoxide etc.
4. Open-source Software: Arduino IDE Version 1.8.5.

## 5. Books and Materials

### Text Books:

1. Philip Kosky, Robert T. Balmer, William D. Keat, George Wise, Exploring Engineering: An Introduction to Engineering and Design, Academic Press, 3<sup>rd</sup> Edition, 2012.
2. Byron Francis, Arduino: The Complete Beginner's Guide, Create space Independent Publishers, 2016.



3. M. Govindarajan, S. Natarajan & V. S. Senthil Kumar, Engineering Ethics, 1<sup>st</sup> Edition, Phi Learning, 2009.

**Reference Books:**

1. Neerparaj Rai, Arduino Projects for Engineers, 1<sup>st</sup> Edition, BPB Publications, 2016.
2. Simon Monk, Programming Arduino: Getting Started with Sketches, 2<sup>nd</sup> Edition, McGraw-Hill Education, 2016.
3. W. Richard Bowen, Engineering Ethics – Outline of an aspirational approach, Springer London.

**II YEAR I SEMESTER**



### Course Structure

#### A8003 - Probability Distributions and Statistics

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	1	0	45	15	0	4	40	60	100

## 1. Course Description

### Course Overview

This course provides a solid undergraduate foundation in both probability distributions and mathematical statistics and at the same time provides an indication of the relevance and importance of the theory in solving practical problems in the field of multidisciplinary engineering applications. The mathematical skills sustained from this course form a suitable base to analytical and theoretical concepts encountered in engineering profession.

### Course Pre/co-requisites

This course has no specific prerequisite and co-requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8003.1. Identify an appropriate probability distribution for a given discrete or continuous random variable and compute probabilities .
- A8003.2. Make use of probability distributions to analyze and solve a given problem.
- A8003.3. Interpret correlation coefficient in context and study regression analysis and apply the least square errors method numerically and algebraically to find the curve of best fit.
- A8003.4. Inspect scientific hypothesis and estimate confidence intervals at different levels.
- A8003.5. Compute P-value of a test statistics using component of hypothesis test.

## 3. Course Syllabus

**Random Variables:** Discrete and Continuous random variables, Discrete Probability, Distributions, Continuous Probability Distributions, Mean and Variance of Random Variables.

**Probability Distributions:** Discrete distributions: Binomial distribution, Poisson distribution. Continuous distribution: Uniform distribution, Normal distribution, areas under



the Normal Curve, applications of the Normal Distribution.

**Correlation and Regression:** Scatter diagram, Positive and Negative correlation, limits for coefficient of Correlation, Karl Pearson's coefficient of correlation, Spearman's Rank correlation, Regression Analysis:- Concept, two lines of regression, Properties of regression coefficients.

**Curve Fitting:** Method of least squares - Fitting a straight line, second degree parabola and non-linear curves of the form by the method of least squares.

**Estimation and Testing of Hypothesis for Large samples:** Point estimation, Maximum error estimate, Interval Estimation, Introduction to Hypothesis, Level of significance, one tailed and two tailed test, Test concerning one mean and one proportion, Two means and two Proportions.

**Testing of Hypothesis for Small samples:** Test for single mean, difference of means and paired t-test, Test for ratio of variances (F-test), Chi-square test for goodness of fit and independence of attributes.

## 4. Books and Materials

### Text Books:

1. Gupta, S.C. and Kapoor, V. K. Fundamentals of Mathematical statistics, 10<sup>th</sup> Revised Edition, S Chand & Sons, New Delhi, 2000.
2. Grewal, B.S. Higher Engineering Mathematics, 43<sup>rd</sup> Edition, Khanna Publications, 2015.

### Reference Books:

1. T.T. Soong, Fundamentals of Probability and Statistics For Engineers, John Wiley & Sons, Ltd, 2004.
2. Miller and Freund's, Probability and Statistics for Engineers, 8<sup>th</sup> Edition, Pearson Education
3. Iyengar, T.K.V. Probability and Statistics, S Chand Publications, 2015.



### Course Structure

#### A8306 - Material Science and Metallurgy

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

The course provides an overview of material science in which different material properties and their interrelationship with various metallurgical parameters will be studied. This is an integrated course having theory and practical components that integrates hands on experience with different experiments to study structure of materials using metallurgical microscopes. This course forms the basis for the study of advanced courses like Production Technology I and II, Composite materials, Nanotechnology and High Temperature Materials. It is imperative that these concepts are well understood.

### Course Pre/co-requisites

A8006 - Applied Physics

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8306.1. Illustrate the basic principles of materials through crystal structure.
- A8306.2. Identify the phases and interrelationship between structure and properties of materials.
- A8306.3. Construct phase diagram of alloy systems at different temperatures and composition.
- A8306.4. Apply basic principles of ferrous and non-ferrous physical metallurgy for selection of materials.
- A8306.5. Analyze effect of heat treatment on material properties.

## 3. Course Syllabus

**Structure of Materials:** Lattices, basic idea of symmetry. Bravais lattices, unit cells, crystal structures, crystal planes and directions, co-ordination number. Imperfections in solids: point defects, line defects, surface defects. Grain and grain boundaries, effect of grain boundaries on the properties of metal / alloys, determination of grain size. Constitution Of Alloys: Necessity of alloying, types of solid solutions, Hume Rotherys rules, intermediate alloy phases, and electron compounds, different strengthening mechanism of



alloys

**Equilibrium Diagram:** Experimental methods of construction of equilibrium diagrams, Isomorphous alloy systems, equilibrium cooling and heating of alloys, Lever rule, miscibility gaps, eutectic systems, congruent melting intermediate phases, peritectic reaction. Transformations in the solid state allotropy, eutectoid, peritectoid reactions, phase rule, relationship between equilibrium diagrams and properties of alloys. Study of Fe-Fe<sub>3</sub>C, equilibrium phase diagram.

**Heat treatment of alloys:** Effect of alloying elements on Fe-Fe<sub>3</sub>C system, Annealing, normalizing, Hardening, TTT diagrams, tempering, Hardenability, surface hardening methods, Age hardening treatment, Cryogenic treatment of alloys. Special metals and alloys- Super alloys, maraging steels.

**Cast iron and steels:** Structure and properties of White Cast iron, Malleable Cast iron, grey cast iron, Spheroidal graphite cast iron, Alloy cast irons. Classification of steels, structure and properties of plain carbon steels, Low alloy steels, tool and die steels.

**Non-Ferrous metals and alloys:** Structure and properties of copper and its alloys, Aluminium and its alloys, Titanium and its alloys. Ceramic materials: Crystalline ceramics, glasses, cermets, abrasive materials, nanomaterials - definition, properties and applications of the above. Composite materials: Classification of composites, particle - reinforced materials, fibre reinforced materials, metal ceramic mixtures, metal matrix composites and C - C composites. Methods of manufacturing of composites.

#### 4. Books and Materials

**Text Books:**

1. Raghavan V, "Physical Metallurgy: Principles and Practice" 2<sup>nd</sup> Edition, PHI Learning Pvt Limited, Delhi, India,2012.
2. George Dieter, "Mechanical Metallurgy",3<sup>rd</sup> Edition, McGraw-Hill, New Delhi, India,2017.

**Reference Books:**

1. William D. Callister, Jr,"Materials Science and Engineering", 8<sup>th</sup> Edition,Wiley Edition, India,2007.
2. Sidney H. Avner, "Introduction to physical metallurgy", 2<sup>nd</sup> Edition, Tata McGraw-Hill,India,2009.
3. Vijendra Singh, "Physical Metallurgy", 1<sup>st</sup> Edition, Standard Publishers, India,2000.

**Course Structure****A8307 - Mechanics of Solids**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

This course will provide the fundamental background needed to understand the material behavior under various types of loads. This deals stress and strain concepts, axially loaded members, thermal, shear and bending stresses, deflections in beams, stresses in thin and thick cylinders under internal and external pressure. This course forms the basis for the study of advanced courses like Design of Machine Members, Finite Element Methods and Advanced Mechanics of Solids.

**Course Pre/co-requisites**

A8305 - Engineering Mechanics

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8307.1. Demonstrate the concepts of stress and strain in structural members.
- A8307.2. Construct Shear force, Bending Moment diagrams for beams and Mohr's circle for plane stress.
- A8307.3. Determine the deflections and deformations of structural members.
- A8307.4. Analyze stresses in structural members
- A8307.5. Evaluate the mechanical properties of solid bodies subjected to various types of loading.

**3. Course Syllabus**

**Simple stresses and strains:** Elasticity and plasticity, Types of stresses and strains, Hooke's law, stress strain diagram for mild steel, Working stress, Factor of safety, Lateral strain, Poisson's ratio and volumetric strain, Elastic module and the relationship between them, Bars of varying section, composite bars, Temperature stresses.

**Compound stresses, Thin and Thick Cylinders:** Introduction, plane stress, stresses on inclined sections, principal stresses and maximum shear stresses, Mohr's circle for plane stress. Thin and Thick cylinders: Derivation of formula for longitudinal and circumferential stresses hoop, longitudinal and volumetric strains, changes in diameter, and volume of thin



cylinders, Thin spherical shells. A thick cylinder lame's equation, cylinders subjected to inside and outside pressures.

**Shear force and Bending moment:** Definition of beam, Types of beams, Concept of shear force and bending moment, Relation between Shear Force and Bending Moment, and rate of loading at a section of a beam. Shear Force and Bending Moment diagrams for cantilever simply supported and overhanging beams subjected to point loads, U.D.L., uniformly varying loads and combination of these loads.

**Flexural and Shear stresses:** Theory of simple bending, Assumptions, Derivation of bending equation, Neutral axis, Determination bending stresses, section modulus of rectangular and circular sections (Solid and Hollow), I, T, Angle and Channel sections, Design of simple beam sections. Shear stresses: Derivation of formula, Shear stress distribution across various beams sections like rectangular, circular, I, T, angle and channel sections.

**Deflection of Beams:** Bending into a circular arc slope, deflection and radius of curvature, Differential equation for the elastic line of a beam, Double integration and Macaulay's methods, Determination of slope and deflection for cantilever and simply supported beams subjected to various loads.

## 4. Books and Materials

### Text Books:

1. Ramamrutham. S, "Strength of Materials" 17<sup>th</sup> Edition, Dhanpat Rai Publications, New Delhi, India,2012.
2. Timoshenko S. P, "Strength of Materials",3<sup>rd</sup> Edition, Vol. I Paperback,2002.

### Reference Books:

1. S. S Rattan,"Strength of Material", 3<sup>rd</sup> Edition,Tata McGraw-Hill,2017.
2. Bhavikatti S. S, "Strength of materials", 3<sup>rd</sup> Edition, Vikas Publishing House, New Delhi, India,2008.
3. Bansal R. K, "Strength of materials", 10<sup>th</sup> Edition, Laxmi Publications, Hyderabad, India,2007.



### Course Structure

#### A8212 – Basic Electrical and Electronics Engineering

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

This course is intended to introduce the basic concepts of Electric Circuits, Machines, Diodes and Rectifiers to Mechanical Engineering students. This course makes the student to understand the basics of Network theorems and its applications. The operation and performance of D.C. Machines (Motors and Generators) will be exposed to the students theoretically. Also, the students are made to have awareness about the AC fundamentals, electronic devices and digital systems. .

### Course Pre/co-requisites

This course has no specific prerequisite and co-requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8212.1. Solve electrical circuits using fundamental laws, network theorems and AC circuit concepts.
- A8212.2. Analyze the operation, construction and E.M.F. equation of DC generators, and evaluate the magnetization and load characteristics of DC shunt generators.
- A8212.3. Analyze the principles, types, characteristics, speed control methods, tests and efficiency of DC shunt motors.
- A8212.4. Analyze the operation and characteristics of electronic devices.
- A8212.5. Apply theorems of Boolean algebra to simplify a digital circuit.

## 3. Course Syllabus

**DC Circuits:** Electrical circuit elements (R, L and C), voltage and current sources, Ohms Law, KVL and KCL, Mesh and Nodal Analysis, Super position, Thevenin's, Norton's and Maximum Power Transfer Theorems- Numerical Problems. **AC Circuits:** Representation of sinusoidal waveforms, Average and RMS values, form factor and peak factor- conceptual description only.



**D. C. Generators:** Principle of operation, constructional features, armature windings, E.M.F. Equation, Types of DC Generators, Magnetization Characteristics and Load Characteristics of DC Shunt Generator- Numerical Problems.

**D. C. Motors:** Principle of operation - Types-Back E.M.F., Torque equation, Characteristics of DC Shunt Motor, Speed control of D.C. Motors (Armature and field control), Losses and Efficiency, Brake Test, Swinburne's Test-conceptual description only.

**Electronic Devices:** Diodes - symbols, operation, V-I characteristics, rectifiers – half wave, full wave and bridge rectifiers. Transistors - Construction and operation, CB, CE and CC configurations and characteristics-conceptual description only.

**Digital Systems:** Representation of Numerical Data in Binary Form, Basic and universal logic gates, Boolean algebra, De Morgan's laws, Simplification by Boolean theorems, Implementation using logic gates- Numerical Problems.

## 4. Books and Materials

### Text Books:

1. T. K. Nagasarkar, M. S. Sukhija (2007), Basic Electrical Engineering, 2nd Edition, Oxford University Press, New Delhi

### Reference Books:

1. A. E. Fitzgerald, C. Kingsley, S. Umans (2002), Electric Machinery, 5th Edition, Tata Mc Graw Hill Companies, New Delhi
2. B. L. Theraja, A. K. Theraja (2002), A Text book of Electrical Technology, 2nd Edition, S. Chand Publishers, New Delhi
3. S. Salivahanan, N Suresh Kumar, A. Vallavaraaj (2007), Electronic Devices and Circuits, Tata Mc Graw Hill, India.
4. J. Millman, C. Halkias, and SatyabrathaJit (2011), Electronic Devices and Circuits, 3rd Edition, Tata Mc Graw Hill, New Delhi

**Course Structure****A8308 - Thermodynamics**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

Thermodynamics is the field of physics that deals with the relationship between heat and work in a substance undergoing thermodynamic process. Key topics include thermodynamic properties of fluids, first law of thermodynamics applied to common engineering situations, second law of thermodynamics applied to heat engines and refrigeration systems. The course is extended to the study of properties of pure substance and the analysis of power cycles.

**Course Pre/co-requisites**

This course has no specific prerequisite and Co-Requisite

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8308.1. Develop an insight of the basic concepts of classical thermodynamics.
- A8308.2. Apply the laws of thermodynamics to solve engineering problems.
- A8308.3. Evaluate change in entropy for ideal and real gases.
- A8308.4. Solve problems using relationships of thermodynamic fluids.
- A8308.5. Analyze the performance of basic thermodynamic cycles.

**3. Course Syllabus**

**Basic concepts:** Macroscopic and microscopic approaches, thermodynamic systems, boundary, surroundings, thermodynamic property, intensive and extensive properties, concept of continuum, gas laws, thermodynamic equilibrium, state, path, process and cycle, quasi static, reversible and irreversible processes, Energy and its forms, concepts of heat and work, equality of temperature and Zeroth Law of thermodynamics, thermodynamic temperature scales.

**First law of thermodynamics:** First law of thermodynamics, internal energy, enthalpy, PMM -I, Steady flow energy equation, Application of First law to non-flow and steady flow processes, Throttling and free expansion processes, Limitations of first law of thermodynamics.



**Second law of thermodynamics:** Kelvin-Planck and Clausius statements, heat engine, heat pump, refrigerator, PMM-II, Carnot cycle, Carnot heat engine, Carnot theorem and its corollaries, Entropy, Clausius inequality, principle of entropy increase, Availability, unavailable energy.

**Pure substance:** Properties of pure substance, phase transformation, saturated and superheated steam, solid-liquid-vapour equilibrium, dryness fraction, properties of dry, wet and superheated steam, Mollier diagram and steam calorimetry. Thermodynamic relations: Maxwell's equations, Tds equations, Difference in heat capacities, ratio of heat capacities, energy equation, Joule-Thomson effect. Clausius- Clapeyron equation, Evaluation of thermodynamic properties from an equation of state (Vander Wall's Equation).

**Power cycles:** Air standard cycles - Otto, Diesel and Dual combustion cycles, description and representation on PV and TS diagrams, Thermal efficiency, mean effective pressures on air standard basis, comparison of cycles, Brayton cycle and Rankine Cycle.

#### 4. Books and Materials

**Text Books:**

1. P. K. Nag, "Engineering Thermodynamics" 3<sup>rd</sup> Edition, Tata McGraw-Hill, New Delhi, India,2008.
2. G.J.Vanwylen and R. E. Sonntag "Fundamentals of Classical Thermodynamics",4<sup>th</sup> Edition, Wiley Eastern, New Delhi, 1994.

**Reference Books:**

1. Yunus Cengel, Boles,"Thermodynamics - An Engineering Approach", 3<sup>rd</sup> Edition,Tata McGraw-Hill,2017.
2. J.B. Jones, R. E. Dugan, "Engineering Thermodynamics", 1<sup>st</sup> Edition, Prentice Hall of India Learning, New Delhi, India,2009.



### Course Structure

#### A8309 - Material Science and Metallurgy Laboratory

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

## 1. Course Description

### Course Overview

The course provides an overview of material science in which different material properties and their interrelationship with various metallurgical parameters will be studied. Study the structure of materials using metallurgical microscopes.

### Course Pre/co-requisites

This course has no specific prerequisite and co-requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8309.1. Illustrate the basic principles of materials through crystal structure.
- A8309.2. Identify the phases and interrelationship between structure and properties of materials.
- A8309.3. Understanding metals and their use in industries
- A8309.4. Apply basic principles of ferrous and non-ferrous physical metallurgy for selection of materials..
- A8309.5. Analyze effect of heat treatment on material properties.

## 3. List of Experiments

1. Preparation and study of crystal models for simple cubic and body centered cubic structures.
2. Preparation and study of crystal model for face centered cubic structure.
3. Preparation and study of the microstructure of mild steels.
4. Preparation and study of the microstructure of medium carbon steels.
5. Preparation and study of the microstructure of high carbon steels.
6. Preparation and study of the microstructure of gray cast iron.
7. Preparation and study of the microstructure of malleable cast iron.
8. Preparation and study of the microstructure of pure aluminium.
9. Preparation and study of the microstructure of brass and bronze.
10. Preparation and study of the microstructure of titanium and super alloy.
11. Harden ability of steels by Jominy End Quench Test.



12. Study of change in microstructure of steel after annealing, normalizing, hardening and tempering.

#### **4. Laboratory Equipment/Software/Tools Required**

1. Trinocular Metallurgical Microscope
2. Disc Polishing Machine
3. Metallurgical Sample specimen set
4. Belt grinder
5. Emery papers
6. Chemicals
7. Muffle Furnace
8. Jominy End Quench Test



## Course Structure

### A8310 - Mechanics of Solids Laboratory

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

## 1. Course Description

### Course Overview

This course will provide the fundamental background needed to understand the material behavior under various types of loadings. Test the material properties like strength, hardness, toughness, Ductility, Modulus rigidity. shear and bending stresses, deflections in beams.

### Course Pre/co-requisites

A8304 - Engineering Materials

A8305 - Engineering Mechanics

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8310.1. Test the mechanical properties of solid bodies subjected to various types of loading.
- A8310.2. Analyze the mechanical properties of solid bodies subjected to various types of loading.
- A8310.3. Determine the deflections and deformations of structural members.
- A8310.4. Calculate the strength of various structural members.
- A8310.5. Select the material for Industrial applications.

## 3. List of Experiments

- 1. To determine tensile strength of mild steel specimen using Universal Testing Machine.
- 2. To determine modulus of rigidity given specimen using Torsion Testing Machine.
- 3. To determine Young's modulus and stiffness of simply supported beam.
- 4. To determine Young's modulus and stiffness of Cantilever beam.
- 5. To determine Hardness of given specimen using Brinell Hardness Testing Machine.
- 6. To determine Hardness of given specimen using Rockwell Hardness Testing Machine.
- 7. To determine Hardness of given specimen using Vicker's Hardness Testing Machine.
- 8. To determine impact strength of given specimen by Charpy Testing Machine.
- 9. To determine impact strength of given specimen by Izod Testing Machine.
- 10. To determine stiffness and modulus of rigidity of given spring using Spring Testing Machine.



11. To determine compressive strength of given specimen using Compression Testing Machine.

#### 4. Laboratory Equipment/Software/Tools Required

1. Universal Testing Machine
2. Torsion Testing Machine
3. Simply supported beam apparatus
4. Cantilever beam apparatus
5. Brinell Hardness testing Machine
6. Rockwell Hardness testing Machine
7. Vicker's Hardness testing Machine
8. Impact testing Machine
9. Spring Testing Machine
10. Compression Testing Machine



## Course Structure

### A8311 - Computer Aided Machine Drawing

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

## 1. Course Description

### Course Overview

Machine drawing is used to communicate the necessary technical information required for manufacture and assembly of machine components. These drawings follow rules laid down in national and International Organizations for Standards (ISO). Hence the knowledge of the different standards is very essential. Students have to be familiar with industrial drafting practices and thorough understanding of production drawings to make them fit in industries. The following topics have been covered to fulfil the above objectives. Classification of Machine Drawings, Principles of Drawings, Sectioning, Dimensioning, Limits, Fits and Tolerance, Symbols and Conventional Representation, Screw Fasteners, Key Joints, Coupling and its Types, Riveted Joints, Structural Applications, Assembly Drawings, Introduction of Computer Aided Drafting, Introduction of Solid 3D Modeling

### Course Pre/co-requisites

A8303 - Engineering Drawing

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8311.1. Identify product symbols, weld symbols, pipe joints by conventional representation.
- A8311.2. Illustrate various machine components through drawings as per ISO standards.
- A8311.3. Draw machine components by applying the principles of engineering drawing.
- A8311.4. Prepare the part or assembly drawings as per the conventions.
- A8311.5. Analyze part models and assembly drawings for developing 3D model.

## 3. Course Syllabus

### Contents

#### Machine drawing conventions:

1. Need for drawing conventions – Introduction to IS conventions
2. Conventional representation of materials, common machine elements and parts such as screws, nuts, bolts, keys, gears.



3. Methods of dimensioning, general rules for sizes and placement of dimensions for holes, centers, curved and tapered features.
4. Title boxes, their size, location and details - common abbreviations & their liberal usage.
5. Types of Drawings – working drawings for machine parts.

### **Wing of machine components:**

Selection of Views, additional views for the following machine elements and parts with every drawing proportion.

1. Popular forms of Screw threads, bolts, nuts, stud bolts, tap bolts, set screws.
2. Keys, Cotter and knuckle joints.
3. Riveted joints for plates
4. Shaft coupling, spigot and socket pipe joint.
5. Journal, pivot and collar and foot step bearings.

### **Assembly Drawing:**

Drawings of assembled views for the part drawings of the following using conventions and easy drawing proportions.

1. Engine parts – stuffing box, cross head, eccentric, connecting rod, piston assembly.
2. Other machine parts - Screws jack, Machine Vice, Plummer block, Lathe-Tailstock, Tool post and revolving centre.
3. Valves: Steam stop valve, spring loaded safety valve, Feed check valve and Air cock.

### **NOTE:**

1. First angle projection to be adopted.
2. All the drawing components/Assembly to be drawn using any Computer aided drafting package

## **4. Laboratory Equipment/Software/Tools Required**

1. Software Used: Autodesk FUSION 360

## **5. Books and Materials**

### **Text Books:**

1. N. Sidheshwar, P.Kannaiah, "Machine Drawing", 3<sup>rd</sup> Edition, Tata Mc Graw hill education (P) Ltd, New Delhi, India, 2009.
2. K.L. Narayana, P. Kannaiah, K. Venkata Reddy, "Machine Drawing", 3<sup>rd</sup> Edition, New Age Publishers, New Delhi, India, 2006.

### **Reference Books:**

1. Dhawan, " Machine Drawing-A Text book of Machine Drawing", 4<sup>th</sup> Edition, S. Chand Publications, New Delhi, India, 2008.
2. N. Sidheshwar, P.Kannaiah, V.V.S. Sastry, "Machine Drawing", 21<sup>st</sup> Edition, Tata Mc Graw hill education (P) Ltd, New Delhi, India, 1999.



## Course Structure

### A8023 - Engineering Design Thinking

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

## 1. Course Description

### Course Overview

This course links the primary fields of engineering, explores the engineering design process from conceptual design and optimal choice evaluation to prototyping for project construction. It also provides insights into particular design challenges within their specific fields of engineering and enables the learners to apply the knowledge in real time - designing, constructing and testing a prototype (actual physical build) to solve a real-world engineering problems. In extent, this course is an excellent roadmap for the design engineers seeking to broaden their engineering knowledge to design concepts to their current work.

### Course Pre/co-requisites

A8021 - Social Innovation

A8022 - Engineering Exploration

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8023.1. Interpret the problem-solving skills and product design skills.
- A8023.2. Apply foundational knowledge of the primary fields of engineering and scientific concepts to find sustainable solution.
- A8023.3. Customize the HCD model to the traditional engineering design process.
- A8023.4. Inspect the design and assess a prototype that solves real engineering problem.
- A8023.5. Expound the solutions for identified problems and document the findings/reflections for further design.

## 3. Course Syllabus

**Introduction & Case Studies:** Definition of design, design process, different problem types, characteristics of novice and informed designers, enhance negotiation and iteration in design, Recognized organizations for design and innovation, shopping cart case study, benefits of failure in design.

**Human Centered Design:** Introduction to HCD (Human Centered Design), HCD as a Mindset, personas and scenarios, best practice working with communities.



**Development of Specification and prototyping:** Definition of specification, three examples of ways to generate specifications, how to manage specifications, functional decomposition, three kinds of prototypes, how prototypes can be used in the design process, how to use prototypes can be used to elicit input from users.

**Ideation, Innovation & Creativity in Design:** Concept Selection, Interpretation of Creativity and Innovation, Brain storming and expanding the design Space, case study using decision matrix.

**Design for Robustness:** Review the design, Brainstorm potential failure models, List the potential effects of failure & causes for each failure.

#### 4. Laboratory Equipment/Software/Tools Required

1. Computers installed with operating system

#### 5. Books and Materials

##### Text Books:

1. William C. Oakes, Les L. Leone, and Craig J. Gunn, Engineering Your Future, Okemos, MI: Great Lakes Press, 2004.
2. Crismond, D., Contrasting strategies of beginning and informed designers: One representation of learning progressions in engineering design, 2007.
3. Ryan Jacoby and Diego Rodrigue, Innovation, Growth, and Getting to Where You Want to Go, Design Management Review, Vol. 18 No. 1, Winter, 2007.
4. G.Pahl and W.Beitz, Engineering design: A systematic approach, Springer 2<sup>nd</sup> Edition.
5. Dean Nieuwsma, Seeing Social Power: Technology Design for User Empowerment, Great Lakes Press, 2012
6. Avery, C. M., Teamwork is an Individual Skill: Getting Your Work Done When Sharing Responsibility. San Francisco, CA: Berrett-Koehler Publishers, Inc., 2001.
7. Astin, A. W., & Astin, H. S., Leadership reconsidered: Engaging higher education in social change - Battle Creek, MI: W. K. Kellogg Foundation, 2000.

##### Reference Books:

1. Ali K.Kamrani, Emad Abouel Nasr, Engineering design and Rapid Prototyping, 2<sup>nd</sup> Edition, Springer, 2010
2. Ken Hurst, Engineering design principles, Elsevier Science, 2<sup>nd</sup> Edition, 2005.



## Course Structure

### A8031 - Gender Sensitization

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
2	0	0	30	0	0	0	-	100	100

## 1. Course Description

### Course Overview

Gender Sensitization is a course that introduces students to different dimensions of gender issues. It is one of the basic requirements for the normal development of an individual and primarily highlights the contribution of both the genders in creation and development of a well balanced society. A curriculum-based approach to bring a change is desired to inculcate sensitivity towards issues concerning the relationship between men and women, caste, declining sex ratio, struggles with discrimination, sexual harassment, new forums for justice, eve-teasing, etc., The need for this sensitivity has been felt and realized through times immemorial and in almost all kinds of human existence, across the globe.

### Course Pre/co-requisites

This course has no specific prerequisite and co-requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8031.1. Interpret gender sensitization and problems of other genders.
- A8031.2. Identify the reasons for the female feticide.
- A8031.3. Attain a finer grasp of how gender discrimination works in our society and how to counter it.
- A8031.4. Develop sensitivity towards sexual and domestic violence.
- A8031.5. Recognize gender sensitivity issues through literature and media.

## 3. Course Syllabus

**Understanding Gender:** Introduction: Definition of Gender-Basic Gender Concepts and Terminology-Exploring Attitudes towards Gender-Construction of Gender-Socialization: Making Women, Making Men Preparing for Womanhood. Growing up Male. First lessons in Caste.



**Gender Roles and Relations:** Two or Many? -Struggles with Discrimination-Gender Roles and Relations-Types of Gender Roles- Gender Roles and Relationships Matrix-Missing Women-Sex Selection and Its Consequences- Declining Sex Ratio. Demographic Consequences Gender Spectrum: Beyond the Binary.

**Gender and Labour:** Division and Valuation of Labour-Housework: The Invisible Labor-“My Mother doesn’t Work.” “Share the Load.”-Work: Its Politics and Economics -Fact and Fiction. Unrecognized and Unaccounted work. -Gender Development Issues-Gender, Governance and Sustainable Development Gender and Human Rights-Gender and Mainstreaming.

**Gender - Based Violence:** The Concept of Violence- Types of Gender-based Violence-Gender-based Violence from a Human Rights Perspective-Sexual Harassment: Say No!- Sexual Harassment, not Eve-teasing- Coping with Everyday Harassment- Further Reading: “Chupulu”. Domestic Violence: Speaking Out: Is Home a Safe Place? -When Women Unite [Film]. Rebuilding Lives. Thinking about Sexual Violence Blaming the Victim-“I Fought for my Life. . . .”

**Gender and Culture:** Gender and Film-Gender and Electronic Media Gender and Advertisement Gender and Popular Literature- Gender Development Issues-Gender Issues-Gender Sensitive Language-Gender and Popular Literature - Just Relationships: Being Together as Equals Mary Kom and Onler. Love and Acid just do not Mix. Love Letters. Mothers and Fathers. Rosa Parks- The Brave Heart.

## 4. Books and Materials

### Text Books:

1. Towards a World of Equals: A Bilingual Textbook on Gender”. Telugu Akademi, Hyderabad, 2015

### Additional Resources:

1. [www.worldofequals.org.in](http://www.worldofequals.org.in)

**Course Structure****A8033 - Universal Human Values 2: Understanding Harmony**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
2	0	0	30	0	0	0	-	100	100

**1. Course Description****Course Overview**

Values are individual beliefs that motivate people to act in one way or the other, it has an inherent worth, and it prepares an individual to adapt in the family, community and society. The basic five Human Values: Love, Peace, Truth, Right Conduct and Non-violence are hidden in every human being; they are our candid attributes. These fundamental human values contain mankind's deepest moral aspirations and form the basis of our lives as individuals and as societies. A didactic system based on human values helps in holistic development of students and it aids to their understanding of true happiness which can only be found within, not in the transient outside world. All objects in the world are subjected to change, however, the ideals, virtues and values established in human hearts remain as a perpetual source of inspiration to the humankind. The course is an overview of human values that are universally accepted and it highlights the need to incorporate these values in students so that they can contribute their service to human race fruitfully. It briefly discusses their role in their family, society and nature and sensitises them towards harmonious living.

**Course Pre/co-requisites**

This course has no specific prerequisite and co-requisite.

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8033.1. Analyze the process of self-exploration, right understanding, relationships, natural acceptance for achieving ultimate happiness .
- A8033.2. Examine human being as a co-existence of self 'I' and the material 'Body'.
- A8033.3. Correlate the universal harmonious order in society, undivided society and from family to world family.
- A8033.4. Interpret the harmony in nature, holistic perception at all levels of existence.
- A8033.5. Analyze professional competence for augmenting universal human order, ethical human conduct for acceptance of human values.



### 3. Course Syllabus

**Course Introduction - Need, Basic Guidelines, Content and Process for Value Education:** Purpose and motivation for the course, recapitulation from Universal Human Values-1; Self-Exploration what is it? –its content and process; ‘Natural Acceptance’ and Experiential Validation – as the process for self-exploration; Continuous Happiness and Prosperity- A look at basic human aspiration; Right Understanding, Relationship and Physical facility; Understanding Happiness and Prosperity correctly; Method to fulfill the above Human Aspirations; Understanding and living in harmony at different levels.

**Understanding harmony in the Human Being- Harmony in Myself!:** Understanding human being as a co-existence of the sentient ‘I’ and the material ‘Body’; Understanding the needs of Self (‘I’) and ‘Body’-happiness and physical facility; Understanding the body as an instrument of ‘I’; Understanding the characteristics and activities of ‘I’ and harmony ‘I’; Understanding the harmony of ‘I’ with the body: Sanyam and health; Correct appraisal of physical needs, meaning of prosperity in detail; Programs to ensure Sanyam and Health.

**Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship:** Understanding values in human-human relationship; meaning of justice (nine universal values in relationships) and program for its fulfillment to ensure mutual happiness: Trust and Respect as the foundational values of relationship; Understanding the meaning of Trust; difference between intention and competence; Understanding the meaning of respect, Difference between respect and differentiation; the other salient values in relationship; Understanding harmony in the society; Visualizing a universal harmonious order in society.

**Understanding Harmony in the Nature and Existence - Whole existence as Co-existence:** Understanding the harmony in the Nature; Interconnectedness and mutual fulfillment among the four orders of nature-recyclability and self-regulation in nature; Understanding Existence as Co-existence of mutually interacting units in all-pervasive space; Holistic perception of harmony at all levels of existence.

**Implications of the above Holistic Understanding of Harmony on Professional Ethics:** Natural Acceptance of Human Values; Definitiveness of Ethical Human Conduct; Basics for Humanistic Education, Humanistic Constitution and Humanistic Universal Order; Competence in professional ethics; Case studies of typical holistic technologies, management models and productive systems; Strategy for transition from the present state to Universal Human Order.



## 4. Books and Materials

### Text Books:

1. Human values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, 1<sup>st</sup> Edition, Excel Books, New Delhi, 2010.

### Reference Books:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A. N. Tripathi, 3<sup>rd</sup> Edition New age Intl. Publishers, New Delhi, 2019.
3. The Story of My Experiments with Truth- by Mohandas Karamchand Gandhi, 1<sup>st</sup> Edition, Fingerprint Publishing, 2009.

**II YEAR II SEMESTER**



## Course Structure

### A8013 - Business Economics and Financial Analysis

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

This course addresses the concepts, principles and techniques of Business Economics and Financial Analysis. It covers the fundamentals of Business Economics and its various aspects. Financial analysis gives clear idea about concepts and conventions of accounting, accounting procedures like journal, ledger, trial balance, final accounts and interpretation of financial statements through ratios.

### Course Pre/co-requisites

This course has no specific prerequisite and co-requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8013.1. Examine the types of business and impact of macroeconomic variables on business.
- A8013.2. Analyze interrelationship among various economic variables and its impact.
- A8013.3. Classify the market structure to decide the fixation of suitable price.
- A8013.4. Apply accounting principles & rules for preparing financial statements.
- A8013.5. Analyze financial statements to assess financial health of business.

## 3. Course Syllabus

**Introduction to Business and Economics: Business:** Structure of Business Firm, Theory of Firm, Types of Business Entities, Limited Liability Companies, Sources of Capital for a Company, Non-Conventional Sources of Finance. **Economics:** Significance of Economics, Micro and Macro Economic Concepts, Concepts and Importance of National Income, Inflation, Money Supply and Inflation, Business Cycle, Features and Phases of Business Cycle. Nature and Scope of Business Economics, Role of Business Economist.

**Demand and Supply Analysis: Elasticity of Demand:** Elasticity, Types of Elasticity, Measurement and Significance of Elasticity of Demand, Factors affecting Elasticity of



Demand, Law of Demand. Demand Forecasting: Methods of Demand Forecasting.

**Supply Analysis:** Determinants of Supply, Supply Function and Law of Supply. .

**Production, Cost, Market Structures & Pricing: Production Analysis** Factors of Production, Production Function, Production Function with one variable input, two variable inputs, Returns to Scale, Different Types of Production Functions.

**Cost analysis:** Types of Costs, Short run and Long run Cost Functions.

**Market Structure:** Nature of Competition, Features of Perfect competition, Monopoly, Oligopoly, Monopolistic Competition. Pricing: Types of Pricing, Product Life Cycle based Pricing, Break Even Analysis (simple problems).

**Financial Accounting:** Accounting concepts and Conventions, Accounting Equation, Double-Entry system of Accounting, Rules for maintaining Books of Accounts, Journal, Posting to Ledger, Preparation of Trial Balance, Elements of Financial Statements, Preparation of Final Accounts (Simple Problems).

**Financial Ratios Analysis:** Concept of Ratio Analysis, Importance and Types of Ratios- Liquidity Ratios, Turnover Ratios, Profitability Ratios, Proprietary Ratios, Solvency, Leverage Ratios – Analysis and Interpretation (simple problems).

#### 4. Books and Materials

**Text Books:**

1. D. D. Chaturvedi, S. L. Gupta, Business Economics - Theory and Applications, International Book House Pvt. Ltd. 2013.
2. Dhanesh K Khatri, Financial Accounting, Tata Mc –Graw Hill, 2011.
3. Geethika Ghosh, Piyali Gosh, Purba Roy Choudhury, Managerial Economics, 2e, Tata Mc Graw Hill Education Pvt. Ltd. 2012.

**Reference Books:**

1. A.R. Aryasri (2011), Managerial Economics and Financial Analysis, TMH, India.
2. S. N. Maheshwari, Sunil K Maheshwari, Sharad K Maheshwari, Financial Accounting, 5e, Vikas Publications, 2013.

**Course Structure****A8312 - Kinematics of Machinery**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

This course deals with the fundamental concepts and principles applied by engineers in the design of structures and to provide in-depth knowledge in basic mechanisms. It builds upon the mathematics and physics courses, extending to learn the systematic way of solving problems and kinematics to understand what happens to a body when force(s) is/are applied to it. It aims also to engage students to understand the different methods of obtaining a mechanism and utilize analytical, mathematical and graphical aspects of kinematics for effective design.

**Course Pre/co-requisites**

A8305 - Engineering Mechanics

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8312.1. Identify the various fundamental principles of kinematic pairs, chains and inversions.
- A8312.2. Summarize the functions of straight-line motion and steering mechanisms.
- A8312.3. Examine the velocity and acceleration diagram for different links of a given mechanisms.
- A8312.4. Construct the cam profile for a given specified motions.
- A8312.5. Estimation of transmission of power by various power transmitting elements in real time practice.

**3. Course Syllabus**

**Mechanisms and Machines:** Mechanisms: Elements or Links, Classification, Rigid Link, flexible and fluid link, Degrees of Freedom, Types of kinematic pairs, sliding, turning, rolling, screw and spherical pairs, lower and higher pairs, closed and open pairs, constrained motion completely, partially or successfully constrained and incompletely constrained. Machines: Mechanism and machine, kinematic chain, inversion of mechanism, inversions of four bar chain, Beam Engine, Coupling rod of a locomotive, Watt's indicator mechanism inversions



of single slider crank chain - Pendulum pump, Oscillating cylinder engine, Rotary I.C. Engine, Crank and slotted lever quick return motion mechanism, Whit worth quick return motion mechanism and inversions of double slider crank chain- Elliptical trammel, Scotch yoke mechanism, Oldham's coupling.

**Velocity and Acceleration diagrams:** Kinematics: Velocity and acceleration, Motion of link in machine, Determination of Velocity and acceleration diagrams, Graphical method, Application of relative velocity method four bar chain. Plane motion of body: Instantaneous center of rotation, centroids and axodes, relative motion between two bodies, three centre's in line theorem, Graphical determination of instantaneous centre, diagrams for simple mechanisms and determination of angular velocity of points and links. Analysis of mechanisms: Analysis of slider crank chain for displacement, velocity and acceleration of slider, Acceleration diagram for a given mechanism, Klein's construction, Coriolis acceleration.

**Straight line motion mechanisms:** Straight line motion - Exact and approximate straight line mechanisms and its types, Peaucellier, Hart and Scott Russel, Grasshopper, Watts, Tchebicheff and Robert Mechanisms and Pantograph. Steering mechanisms: Conditions for correct steering, Davis Steering gear, Ackerman's steering gear, velocity ratio. Hooke's joint: Single and double Hooke's joint, Universal coupling, application, problems.

**Cams:** Definitions of cam and followers, their uses, Types of followers and cams, Terminology, Types of follower motion, Uniform velocity, Simple harmonic motion and uniform acceleration and retardation Displacement, Velocity and acceleration diagrams. Construction of Cam profiles- Cam with knife edge follower, roller follower and flat faced follower. Maximum velocity and maximum acceleration during outward and return strokes in the above 3 cases.

**Higher pairs:** : friction wheels and toothed gears, types, law of gearing, condition for constant velocity ratio for transmission of motion, Form of teeth: cycloidal and involute profiles. Velocity of sliding, phenomena of interferences, Methods of interference. Introduction to Helical, Bevel and worm gearing. Gear trains: Introduction, Train value, Types, Simple and reverted wheel train, Epicyclic gear Train. Methods of finding train value or velocity ratio, Epicyclic gear trains.

## 4. Books and Materials

### Text Books:

1. S. S. Rattan, "Theory of Machines and Mechanisms" 3<sup>rd</sup> Edition, Tata McGraw-Hill



education,2009.

2. Thomas Bevan, "Theory of machines", 3<sup>rd</sup> Edition, CBS Publishers, New Delhi, India, 2012.

### **Reference Books:**

1. Ghosh. A and Mallick, A.K., "Theory of Mechanisms and Machines", 3<sup>rd</sup> Edition, East-West Press Pvt. Ltd., New Delhi, 1998.
2. R. K. Bansal, "Theory of machines", 5<sup>th</sup> Edition, Lakshmi Publications, Hyderabad, India, 2013.
3. R. S. Khurmi, J. K. Gupta, "Theory of machines", 14<sup>th</sup> Edition, S. Chand Publishers, New Delhi, India, 2010.

**Course Structure****A8313 - Thermal Engineering - I**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

This course is intended to introduce basic principles of Internal Combustion (IC) engines. It is further extended to cover the application of IC engines, air compressors and gas turbines by their inclusion in the content. In day-to-day life IC engines, air compressors and gas turbines are playing vital role and have wide applications in many situations directly or indirectly. Thus, there is a great relevance of this course for mechanical engineers.

**Course Pre/co-requisites**

A8308 - Thermodynamics

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8313.1. Compare air standard cycles with actual and fuel air cycles.
- A8313.2. Analyze combustion phenomenon in SI and CI engines
- A8313.3. Analyze the performance parameters of internal combustion engines, compressors and gas turbines..
- A8313.4. Solve the problems related to internal combustion engines, compressors and gas turbines.
- A8313.5. Evaluate the performance of internal combustion engines and compressors.

**3. Course Syllabus**

**IC engines:** Classification, Working principles, Valve and Port Timing Diagrams. 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.

**Combustion in IC engines:** Combustion in SI Engines Normal Combustion and abnormal combustion, Importance of flame speed and effect of engine variables, Type of Abnormal combustion, pre-ignition and knocking, Fuel requirements and fuel rating, anti-knock additives, combustion chamber – requirements, types. Combustion in C.I. Engines: Stages of combustion, Delay period and its importance, Effect of engine variables, Diesel Knock, need



for air movement, open and divided combustion chambers and nozzles used – fuel requirements and fuel rating.

**Testing And Performance of IC Engines:** Parameters of performance, measurement of cylinder pressure, fuel consumption, air intake, exhaust gas composition, Brake power, Determination of frictional losses and indicated power, Performance test, Heat balance sheet.

**Compressors:** Classification of compressors, Reciprocating compressors: Principle of operation, work required, Isothermal efficiency volumetric efficiency and effect of clearance, multi-stage compression, under cooling, saving of work, minimum work condition for multi-stage compression. Centrifugal compressors: Mechanical details, principle of operation, velocity and pressure variation, impeller blade shape-losses, slip factor, Air power input factor, pressure coefficient and adiabatic coefficient, velocity diagrams, power required.

**Gas turbines:** : Simple gas turbine plant, Ideal cycle, essential components, parameters of performance, actual cycle, regeneration, inter cooling and reheating, optimum pressure ratio.

## 4. Books and Materials

### Text Books:

1. V. Ganesan, "I.C. Engines", 3<sup>rd</sup> Edition, Tata McGraw-Hill, New Delhi, India, 2011
2. M. Mahesh Rathore, "Thermal Engineering", 1<sup>st</sup> Edition, Tata McGraw-Hill, New Delhi, India, 2010.

### Reference Books:

1. John Heywood, "Internal combustion engine fundamentals", 2<sup>nd</sup> Edition, Tata McGraw-Hill, New Delhi, 2011.
2. Mathur, Sharma, "IC Engines", 3<sup>rd</sup> Edition, Dhanpat Rai and Sons, New Delhi, India, 2008.
3. R. K. Rajput, Thermal Engineering, 18<sup>th</sup> Edition, Lakshmi Publications, New Delhi, India, 2011



### Course Structure

#### A8314 - Fluid Mechanics and Hydraulic Machines

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	1	0	45	14	0	4	40	60	100

## 1. Course Description

### Course Overview

This course mainly deals with the behaviour of fluids and hydraulic machines. The concepts include fluid properties, fluid statics and dynamics. This course also covers working principles of Hydraulic Machines and its characteristics. This course is an integrated course having theory and practical components that integrates hands on experience on various fluid flow parameters including hydraulic machines such as turbines and pumps. This course is fundamental to study some of the advanced courses like Heat Transfer and Computational Fluid Dynamics.

### Course Pre/co-requisites

A8304 - Engineering Mechanics

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8314.1. Determine various fluid properties and fluid flow types by using property functions.
- A8314.2. Solve fluid flow problems by applying continuity equation and Bernoulli's equation
- A8314.3. Estimate energy losses and boundary layer parameters for laminar and turbulent flows.
- A8314.4. Analyze the hydrodynamic force of jets on stationary and moving vanes.
- A8314.5. Evaluate the performance parameters of hydraulic turbines and pumps.

## 3. Course Syllabus

**Fluid statics:** Dimensions and units: physical properties of fluids- specific gravity, viscosity, and surface tension - Vapour pressure and their influence on fluid motion- atmospheric, gauge and vacuum pressures – measurement of pressure- Piezometer, U-tube and differential manometers.

**Fluid dynamics:** Fluid kinematics: Stream line, path line and streak lines and stream tube, classification of flows-steady & unsteady, uniform & non uniform, laminar & turbu-



lent, rotational and irrotational flows-equation of continuity for one dimensional flow and three dimensional flows. Fluid dynamics: Surface and body forces –Euler’s and Bernoulli’s equations for flow along a stream line, momentum equation and its application on force on pipe bend.

**Impact of jets:** Closed conduit flow: Reynold’s experiment, Hagen-Poiseuille equation, Darcy-Weisbach equation, Minor losses in pipes, pipes in series and pipes in parallel, total energy line and hydraulic gradient line. Measurement of flow: Pitot tube, venturi meter and orifice meter. Impact of jets: Hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow over radial vanes.

**Hydraulic turbines:** Classification of turbines, Heads and efficiencies, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies, Performance of turbines.

**Hydraulic pumps:** Classification, Centrifugal pumps: working, work done – manometric head - losses and efficiencies specific speed - performance characteristic curves. Reciprocating pumps: Working, Classification, Discharge, slip.

## 4. Books and Materials

### Text Books:

1. Modi & S. M. Seth, "Hydraulics and Fluid Mechanics including hydraulic machines", 21<sup>st</sup> Edition, RajSons Publications Pvt. Ltd, New Delhi, India,2017.
2. S. K. Som & G. Biswas, "Introduction to Fluid Mechanics and Fluid Machines", 3<sup>rd</sup> Edition, Tata McGraw hill education (P) Ltd, New Delhi, India,2012.

### Reference Books:

1. M. Fank White, "Fluid Mechanics", 7<sup>th</sup> Edition, Tata McGraw hill education (P) Ltd, New Delhi, India,2017.
2. Bruce R. Munson, "Fluid Mechanics", 7<sup>th</sup> Edition, Wiley India Pvt. Ltd,2019.
3. D.S. Kumar, "Fluid Mechanics and Fluid Power Engineering",9<sup>th</sup> Edition, S.K.Kotaria and Sons,2015.

**Course Structure****A8315 - Production Technology**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

Production technology deals with various manufacturing processes of materials like melting, casting joining, hot and cold working, forming and plastic components making. A combination of basic theory and industrial manufacturing processes will be discussed.

**Course Pre/co-requisites**

A8306 - Material Science and Metallurgy

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8315.1. Explain the process of making patterns, preparation of sand mould, various special casting processes and casting defects.
- A8315.2. Select appropriate Joining methods to join Work pieces by using different welding techniques.
- A8315.3. Identify various metal forming processes for the various applications.
- A8315.4. Describe the properties and bonding techniques of plastics by using plastic molding techniques.
- A8315.5. Illustrate the various non-destructive testing methods for a specific application.

**3. Course Syllabus**

**Casting:** Steps involved in sand casting process, gating system, sprue and riser design, casting defects. Special casting processes: Centrifugal, Die-casting, Investment casting.

**Welding:** Gas welding, ARC welding, TIG and MIG welding, Plasma arc welding, resistance welding, Thermit welding. Advanced welding processes & joining processes: Solid state joining methods, Laser welding, Electron beam welding, Soldering and Brazing. Heat affected zones in welding, welding defects, causes and remedies.

**Hot working and cold working:** Strain hardening, recovery, recrystallisation and grain growth, Comparison of hot working and cold working. Rolling: Theory of rolling, types of Rolling mills, rolling defects, Drawing: wire drawing and Tube drawing, Forging: Types



of forging, forging defects. Sheet metal operations. Forces and power requirements in the above processes

**Extrusion:** Forward extrusion and backward extrusion, impact extrusion and hydrostatic extrusion. Additive manufacturing: Introduction, methods of AM, types of plastics and plastic processing methods.

**Non-destructive testing:** Various non-destructive testing methods like visual inspection, liquid dye penetrant, Magnetic particle testing, ultrasonic testing, radiography, computer aided tomography. Interpretation of defects in cast, welded and hot /cold worked and AM products.

## 4. Books and Materials

### Text Books:

1. P. N. Rao, "Manufacturing Technology", Vol -1, 3<sup>rd</sup> Edition, Tata McGraw- Hill education (P) Ltd, New Delhi, 2011.
2. Ghosh and Malik, "Manufacturing Science", 2<sup>nd</sup> Edition, Tata McGraw- Hill education(P) Ltd, New Delhi, 2014..

### Reference Books:

1. R. K. Jain, "Production Technology", 16<sup>th</sup> Edition, Khanna publishers, New Delhi, India,2010.
2. S. Raghuwanshi, "A course in workshop Technology", Vol - II, 3<sup>rd</sup> Edition, Dhanpat Rai & Co, New Delhi, India,2011.
3. Richard W. Heine, Carl R. Loper, Philip C. Rosenthal, "Principles of Metal Casting" , 1<sup>st</sup> Edition, Tata McGraw-Hill Education,2001.



### Course Structure

#### A8316 - Fluid Mechanics and Hydraulic Machines Laboratory

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

## 1. Course Description

### Course Overview

This course mainly deals with the behaviour of fluids and hydraulic machines. The objective of this course is to enable the student to understand laws of fluid mechanics and evaluate pressure, velocity and acceleration fields for various fluid flows and performance parameters for hydraulic machinery.

### Course Pre/co-requisites

A8304 - Engineering Mechanics

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8316.1. Demonstrate the classical experiments in fluid mechanics and hydraulic machinery.
- A8316.2. Correlate various flow measuring devices such as Venturimeter and orifice meter.
- A8316.3. Discuss the performance characteristics of turbines and pumps.
- A8316.4. Analyze the hydrodynamic force of jets on stationary and moving vanes
- A8316.5. Estimate energy losses and boundary layer parameters for laminar and turbulent flows.

## 3. List of Experiments

1. Calibration of Venturi meter
2. Calibration of Orifice meter.
3. Determination of friction factor in a given pipe line.
4. Determination of loss co-efficient due to sudden contraction
5. Verification of Bernoulli's theorem
6. Determination of the nature of flow through a pipe. (Reynold's experiment)
7. Determination of the efficiency of vane using Impact of jet on Vane Setup.
8. Determination of the operating characteristics of Pelton wheel turbine
9. Determination of the operating characteristics of Francis Turbine
10. Determination of the operating characteristics of Kaplan Turbine



11. Determination of the efficiency of Single Stage Centrifugal Pump.
12. Determination of the efficiency of Multi Stage Centrifugal Pump.
13. Determination of the efficiency of Reciprocating Pump

#### **4. Laboratory Equipment/Software/Tools Required**

1. Venturimeter and Orifice meter setup
2. Major and Minor Losses in pipes setup
3. Bernoulli's theorem verification setup
4. Reynolds Apparatus
5. Impact of jet on vane setup
6. Pelton turbine test rig
7. Francis turbine test rig
8. Kaplan Turbine test rig
9. Single Stage Centrifugal Pump test rig
10. Multi Stage Centrifugal Pump test rig
11. Reciprocating Pump test rig



## Course Structure

### A8317 -Thermal Engineering Laboratory

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

## 1. Course Description

### Course Overview

In this laboratory, students will have the opportunity to study the working principle of IC engines (both SI and CI engines), performance and characteristics in terms of heat balancing, economical speed variations, air fuel ratio influence on the engine.

### Course Pre/co-requisites

A8308 - Thermodynamics

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8317.1. Determine the valve timing diagram of SI engine and CI engine.
- A8317.2. Apply the concept of Morse test on SI engine.(multi cylinder).
- A8317.3. Experiment on IC engine load variations with Air fuel ratio.
- A8317.4. Calculate the performance characteristics of an Engine.
- A8317.5. Evaluate the performance of internal combustion engines and compressors.

## 3. List of Experiments

1. To conduct the Performance Test on Single Cylinder 4 Stroke Diesel Engine.
2. To conduct the Motoring Test on Single Cylinder 4-Stroke Diesel Engine.
3. To conduct the Heat Balance test on 4-Stroke Diesel Engine.
4. To conduct the Performance Test on Single Cylinder 2-stroke Petrol Engine
5. To conduct the Performance Test on Single Cylinder 4-stroke Petrol Engine.
6. To conduct the Performance Test on Four Stroke Single Cylinder Variable Compressor Ratio (VCR) Petrol Engine.
7. To conduct the Morse Test on Multi Cylinder 4 Stroke Petrol Engine.
8. To conduct the Performance Test on twin Cylinder Reciprocating Air Compressor.
9. To draw Valve Timing Diagram for 4-stroke diesel engine.
10. To draw Port Timing diagram for 2-stroke petrol engine.
11. Disassembly/assembly of an engine (old engine)



12. To calculate viscosity of given oil using given viscometer.

#### **4. Laboratory Equipment/Software/Tools Required**

1. Single Cylinder 4-stroke Diesel Engine test rig
2. Single Cylinder 2-stroke Petrol Engine test rig
3. Single Cylinder 4-stroke Petrol Engine test rig
4. Single Cylinder 4-stroke VCR Petrol Engine test rig
5. Multi Cylinder 4-stroke Petrol Engine test rig
6. 4-Stroke VCR Petrol Engine test rig
7. Twin Cylinder Reciprocating Air Compressor test rig
8. Single cylinder 4-stroke diesel engine cut model
9. Single cylinder 2-stroke petrol engine cut model
10. Model of 2-Stroke Diesel Engine
11. Single Cylinder 4-stroke diesel engine for assembly and disassembly
12. Redwood viscometer



## Course Structure

### A8318- Production Technology Laboratory

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

## 1. Course Description

### Course Overview

The aim of this course is to conduct experiments chiefly encompasses Metal casting, Welding, Press working and processing of Plastics. It inculcates knowledge and skill to the students starting from preparing a wooden pattern to completion of a casting which also comprises different Sand testing techniques. Also, students can understand broadly Welding and press working skills employed in Industries. One of the most outstanding features of plastics is the ease with which they can be processed. Production Technology lab also throws light on processing of plastics by Blow and Injection molding machines.

### Course Pre/co-requisites

A8303 - Engineering Workshop

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8318.1. Demonstrate practical understanding of Moulding, melting and casting.
- A8318.2. Understand the Pattern design and making, casting drawing.
- A8318.3. Demonstrate practical understanding of Spot welding, TIG welding.
- A8318.4. Explain practical understanding of Hydraulic press, deep drawing and extrusion operation.
- A8318.5. Illustrate practical understanding of ARC welding lap and butt joint.

## 3. List of Experiments

1. To prepare a wooden pattern of given model.
2. To determine the Compressive Strength of the Moulding Sand.
3. To test the permeability of given Moulding sand.
4. To Prepare a Casting for the given Solid Pattern using Sand Moulding Process.
5. To join the given two work pieces as a Lap Joint and Butt Joint using Arc welding process.
6. To join GI (Galvanized iron) sheets using Resistance spot welding.
7. To join a given work pieces by using Gas welding Process.



8. To prepare Butt Joint Using Tungsten Inert Gas Welding process.
9. To conduct punching and blanking operations on sheet metal by using hydraulic press.
10. To prepare a V-shape bend on G.I sheet metal by using fly press.
11. To produce a component by using Injection Moulding machine.
12. To produce a Hollow component using Blow Moulding machine.

#### 4. Laboratory Equipment/Software/Tools Required

1. Wood turning lathe machine
2. Universal sand strength testing machine
3. Permeability test setup
4. Furnace and Foundary tools
5. Arc welding machine
6. Resistance spot welding.
7. Oxy acetylene gas welding setup
8. Tig Welding Set Up
9. Hydraulic Press
10. Mechanical fly press
11. Injection moulding set up
12. Blow moulding machine



## Course Structure

### A8024 - Product Realization

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

## 1. Course Description

### Course Overview

Making the students socially responsible is the main motto. In this process introducing technological concepts and creating innovating product is carried out for the community. The Product Realization introduces communication with community, planning of product realization, design and development of the product added with skill sets of leadership. This course given an exposure on converting an innovative idea to physical product to meet the need of the community. It improves skill of research paper writing, patent drafting and also developing the skill of preparation of business models.

### Course Pre/co-requisites

A8021 - Social Innovation

A8022 - Engineering Exploration

A8023 - Engineering Design Thinking

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

A8024.1. Interpret the specifications of product and solve for practical realization.

A8024.2. Analyse the customers mind set and design the product.

A8024.3. Develop Gantt chart to define timeline for product realization.

A8024.4. Conceptualize the terms called product, purchase, production and monitoring of products.

A8024.5. Communicate the process of converting an idea to physical product to the community.

## 3. Course Syllabus

### Theory

**Introduction and Planning of Product Realization:** Introduction to Product Realization, Need for Product Realization, Product realization process, Case Study of Product Realization for Global Opportunities. Plan and develop the processes needed for product realization, Defining Quality objectives and requirements, establish processes documents.



Needs - verification, validation, monitoring inspection and test activities (inspection nodes) and criteria for product acceptance and record needed. Case study on timeline of Product realization planning (Gantt Chart).

**Customer-Related Processes:** Product information Enquiries, contracts or order handling Customer feedback including customer complaints, A field survey.

**Design and Development:** Review verification and validation of each design and development stages, Functional and performance requirements, Information for purchasing, production and service provisions, review and validation, Develop a Design model of the product.

**Purchasing, Production and Service Provision:** Purchasing information, Vendors evaluation and approval process, Verification of purchased product. Control of production, service provision, validation of processes for production and service provision, Identification and tractability, Customer property and Preservation of product.

**Scope of Product Perseverance:** Writing proficiency for papers, Patent drafting and development of business model.

## Practice

1. Introducing oneself to the steps of Product realization.
2. Case Study to define the necessity.
3. Brainstorming Session on Product Realization in teams.
4. Watching videos on Planning of product realization in real time scenario from R Labs.
5. Verification of the Product specifications which satisfies all the needs.
6. Discussion with Customers about the product and the specifications.
7. Discussion about the finished product and taking feedback.
8. Feedback Analysis and redesign if required.
9. Verification of redesigned product and market study.
10. Discussion on different Purchasing and Services for the product development.
11. Data from the customer for market and feedback of market is acquired.
12. Activity on Observation skills to know how to use one's observation skills in understanding the parameters
13. Brainstorming deliberations on the initial observations and measuring of the product.
14. Familiarization of the respective templates with the help of sample case study.



## 4. Books and Materials

### Text Books:

1. Mileta M Tomovic, Sowping Wang, Product Realization – A Comprehensive Approach, 1<sup>st</sup> Edition, Spinger, 2009.
2. Stark, John, Product Life Cycle Management, 21<sup>st</sup> century Paradigm for Product Realisation 2011, Springer.

### Reference Books:

1. Verna J. Bowen, Lucy V. Fusco, The Competitive Edge Research Priorities for U.S. Manufacturing, National Academy of Sciences.
2. Renuka Thota, Suren Dwivedi, Implementation of product realization concepts in design and manufacturing courses, University of Louisiana-Lafayette.

**Course Structure****A8032 - Environmental Science and Technology**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
2	0	0	30	0	0	0	-	100	100

**1. Course Description****Course Overview**

This course enables the students to engage with the scientific principles, concepts, and methodologies required to understand the interrelationships of the natural world. This course requires that the students should identify and analyze the natural and human-made environmental problems and evaluate the relative risks associated with these problems. It provides the scope to examine alternative solutions for resolving or preventing them. It is essentially a multidisciplinary approach that brings out an appreciation of our natural world and human impact on its existence and irrigational control measures. Its components include Biology, Geology, Chemistry, Physics, Engineering, Sociology, Health, Anthropology, Economics, Statistics, Computers and Philosophy, engineering technology, Integrating sustainable development into their engineering practice.

**Course Pre/co-requisites**

This course has no specific prerequisite and co-requisite.

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8032.1. Illustrate the important components of environment.
- A8032.2. Identify global environmental problems to come out with best possible solutions.
- A8032.3. Make use of environmental laws & environmental ethics for the protection of forest and wildlife..
- A8032.4. Apply to maintain harmonious relation between nature and human being and integrating sustainable development goals into their engineering practice.
- A8032.5. Analyse the major environmental effects of exploiting natural resources.

**3. Course Syllabus**

**Fundamentals of Environment and Ecology:** The multidisciplinary nature of environmental studies, environmental ethics, Global environmental issues, Planetary boundaries, Fundamentals of ecology - ecosystem definition, structure and functions of ecosystem, food



chain and food web, feedback loops, Ecosystem services.

**Natural Resources and Management:** Classification of resources: Renewable and Non-renewable re- sources. Forest resources: Uses and over exploitation of forests. Dams and their environmental impacts. Water resources: Use and over utilization of surface and ground water, conflicts over water. Energy resources: Renewable energy resources: solar energy, wind energy and geothermal energy. Food resources: Problems with Chemical fertilizers and pesticides. Biofertilizers (organic farming) and their importance. Bio-geo chemical cycles, Socio-ecological systems

**Biodiversity and Its Conservation:** Introduction and definition. Genetic diversity, species diversity and ecosystem diversity. Values of biodiversity: Consumptive use, Productive use, Social, Ethical, Aesthetic and Option values. Man-wildlife conflicts. In-situ and Ex-situ conservation of biodiversity, Biodiversity Law.

**Environmental Pollution and Control:** Definition, causes, effects and control measures of Environmental pollution, Air pollution, water pollution, Soil pollution, solid and hazardous waste management, Noise pollution, E-waste, bio-medical waste, Wastewater treatment and emerging pollutants, Standards for Air and Water.

**Concept of sustainable development:** Sustainable development goals, Carbon footprints, Net-Zero-Emissions, Montreal protocol a success story, Conference of parties (CoP), IPCC, Kyoto protocol, Environmental Acts, Life cycle analysis, Circular Economy, Sustainable Living, Ecological Engineering- ecological restoration, natural and constructed wetlands, nature-based solutions. Case Studies: Mission Kakatiya, Chipko Movement, Water Man of India (Dr. Rajendra Singh), Watershed management.

## 4. Books and Materials

### Text Books:

1. Anubha Kaushik, C.P. Kaushik. Perspectives in Environmental Studies. 6th Edition, New age international publishers, 2018.
2. M. Anji Reddy. Textbook of Environmental Science and Technology, Revised Edition, BS Publications, 2014.

### Reference Books:

1. Erach Bharucha. Textbook of Environmental Studies for Undergraduate Courses, 2nd Edition, Orient BlackSwan Publishers, 2013.
2. Benny Joseph, Environmental studies, 3rd Edition, McGraw Hill Education (India) Private Limited, 2018.

**III YEAR I SEMESTER**

**Course Structure****A8319 - Dynamics of Machinery**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

Dynamics of machinery is an applied field of mechanical engineering that is concerned with understanding the relationship between the forces and the effect of forces on the parts of a machine. This course helps to learn how to analyze the motions of mechanisms, and analyze forces in machines.

**Course Pre/co-requisites**

A8305 - Engineering Mechanics

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8319.1 Compute frictional losses, torque transmission of mechanical systems
- A8319.2 Illustrate the effect of forces on different Machine members
- A8319.3 Analyze balancing problems in rotating and reciprocating machinery
- A8319.4 Analyze stabilization of sea vehicles, aircrafts and automobile vehicles
- A8319.5 Determine the natural frequencies of continuous systems starting from the general equation of displacement.

**3. Course Syllabus**

**Friction:** Friction and lubrication, Pivot And Collar, Mechanical Clutches - Single Disc or Plate Clutch, Multiple Disc Clutch, Cone Clutch, Centrifugal Clutch, Brakes- Band Brake, Block and Band Brake, Internal Expanding Shoe Brake.

**Turning Moment Diagram and Fly Wheels :** Turning Moment, Inertia Torque of Connecting Rod Angular Velocity And Acceleration, Crank Effort And Torque Diagrams Governors: Watt, Porter and Proell Governors. Spring Loaded Governors – Hartnell And Hartung With Auxiliary Springs. Sensitiveness, Isochronisms And Hunting.

**Balancing of Rotating and Reciprocating Masses:** Balancing of Rotating Masses Single and Multiple, Single and Different Planes. Balancing of Reciprocating Masses: Primary,



Secondary, and Higher Balancing of Reciprocating Masses. Analytical and Graphical Methods. Locomotive Balancing - Hammer Blow, Swaying Couple, Variation of Tractive Efforts.

**Gyroscopic Couple and Precessional Motion :** Effect of gyroscopic couple on an aero plane and on a naval ship, stability of a four wheel vehicle moving in a curved path, stability of a two-wheel vehicle taking a turn.

**Basic Features of Vibratory Systems :** Degrees Of Freedom, Single Degree of Freedom, Free Vibration– Equations of Motion, Natural Frequency, Types of Damping, Damped Vibration, Torsional Vibration of Shaft, Critical Speeds of Shafts, Torsional Vibration, Two and Three Rotor Torsional Systems.

## 4. Books and Materials

### Text Books:

1. S. S. Ratan, Theory of Machines, 3<sup>rd</sup> Edition, Tata McGraw- Hill education (P) Ltd, New Delhi, India.
2. Thomas Bevan, Theory of machines, 3<sup>rd</sup> Edition, CBS Publishers, New Delhi, India.

### Reference Books:

1. J. S. Rao, R. V. Dukupati, Mechanism and Machine Theory, 2<sup>nd</sup> Edition, New Age Publishers, New Delhi, India.
2. Shigley, Theory of Machines, 3<sup>rd</sup> Edition, Tata McGraw hill education (P) Ltd, New Delhi, India.
3. RS Khurmi and JK Gupta, Theory of Machines, 14<sup>th</sup> Edition, S. Chand Publishing , New Delhi, India.

**Course Structure****A8320 - Metrology and Machine Tools**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

The purpose of this course is to learn about the machines like lathe, shaper, slotter, planer, milling machine, drilling machine, grinding machine etc. This course helps the students to operate the machines and to do machining for different applications. Students will come to know about metal cutting theory, different cutting tools and tool angles also. In metrology student will learn basics of linear and angular measurement instruments, Surface roughness, limits and tolerances etc.

**Course Pre/co-requisites**

A8315 - Production Technology

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8320.1 Identify the important elements of metal cutting including advanced machinery
- A8320.2 Apply the machining process on work piece under automatic and semiautomatic machines
- A8320.3 Estimate the machining time of various machines and tools
- A8320.4 Solves problems limits and fits
- A8320.5 Analyze the performance of machine tools.

**3. Course Syllabus**

**Theory of Metal Cutting:** Basic definitions: cutting speed, feed and depth of cut, orthogonal and oblique cutting, classification of cutting tools. Mechanics of Metal Cutting, Merchant's circle diagram, forces acting on a single point cutting tool in turning, stress, strain and work done in cutting process. Problems related to cutting speed, feed and depth of cut

**Machine Tools:** Different operations on lathe machine, Single spindle and multi-spindle automatic lathes, Shaping, Slotting and Planing Machines- Different operations on Shaping, Slotting and Planing machines. Milling Machines-Types of milling machines, different oper-



ations on milling machine.

**Drilling and Boring Machines:** Types of Drilling and Boring machines, Different Operations performed using Drilling machines. Grinding Machines, Types of Grinding machines, Operations on Grinding machines, Tool and Cutter Grinding machine and selection of a grinding wheel.

**Systems of Limits and Fits:** Normal size, tolerance limits, deviations, allowance, fits and their types, unilateral and bilateral tolerance system, hole and shaft basis systems, Design of go and No go gauges. Screw Thread Measurement, Errors in Screw threads, measurement of effective diameter, angle of thread and pitch.

**Surface Roughness Measurement:** Methods of measurement of Surface finish using Talysurf instrument. Machine Tool Alignment Tests, Alignment tests on Lathe, Milling, and Drilling Machines. coordinate measuring machines, Types of CMM and Applications of CMM.

## 4. Books and Materials

### Text Books:

1. Anand K Bewoor, Vinay A Kulkarni, Metrology and Measurement, 1<sup>st</sup> Edition, Tata McGraw Hill, Education, New Delhi, India.
2. P N Rao, Manufacturing Technology (Volume II), Metal cutting and Machine Tools, 2<sup>nd</sup> Edition, Tata McGraw Hill, New Delhi, India.

### Reference Books:

1. R. K. Jain, Production Technology, 16<sup>th</sup> Edition, Khanna publishers, New Delhi, India.
2. R. K. Jain, Engineering Metrology, 20<sup>th</sup> Edition, Khanna Publishers, New Delhi, India.
3. Geoffrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools" 3<sup>rd</sup> Edition, McGraw Hill.



### Course Structure

#### A8321 - Design of Machine Elements

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	1	0	45	0	0	4	40	60	100

## 1. Course Description

### Course Overview

This course covers up the methodical approaches for Machine Design-1 such as: Application of theories of failure, analysis of different types of joints (rivet, weld, cotter and knuckle), analysis of power transmission in shafts and spring design.

### Course Pre/co-requisites

A8305 - Engineering Mechanics

A8307 - Mechanics of Solids

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8321.1 Apply the mechanism of the theories of failure to structural members at various loading conditions.
- A8321.2 Design different kinds of mechanical joints (rivet and weld) based on strength.
- A8321.3 Analyze the components and working principle of cotter and knuckle joint.
- A8321.4 Develop the knowledge of power transmission in shafts.
- A8321.5 Determine the stress and deflection of springs at various operating condition.

## 3. Course Syllabus

**Introduction:** Design procedure, manufacturing considerations in Design, Materials Selection. Design Against Static Load: Theories of failure, Stresses due to bending and torsional moment, Design of simple machine parts. Design Against Fluctuating Load: Stress Concentration, Reduction of Stress Concentration, Endurance Limit, S-N Curves, Gerber, Soderberg, Goodman and modified Goodman criterion, Fatigue and Failure, Design against combined loads.

**Design of Joints:** Welded Joints: Types of Welded Joints, Stress Relieving of Welded Joints, Strength of Butt Weld and Fillet Weld (Parallel and Transverse), axially loaded eccentric and unsymmetrical welded joints.

Riveted Joints: Types of Riveted Joints, Strength Equations, Joint Efficiency, Boiler Shell, Caulking and Fullering, Longitudinal and lap joint for boiler shell, Eccentrically Loaded



Riveted Joint.

**Design of Cotter and Knuckle joints:** Cotter Joint: Types of Cotter Joint, Design Procedure for Cotter Joint: Socket and Spigot, Sleeve and Cotter Joint. Knuckle Joint: Failure of knuckle joint, Design Procedure for Knuckle Joint.

### **Design of keys, Coupling and Shafts:**

Keys: Types of Keys: Saddle Keys, Sunk Keys, Feather Keys, Woodruff Key, Square and Flat Keys, Design of Square and Flat Keys.

Couplings: Types of Couplings, Design of Rigid Flange Coupling and Bushed-pin Flexible Coupling.

Design of shafts: Transmission Shafts, Design of Solid and Hollow Shafts Based on Strength and Rigidity, ASME Codes for Shaft Design, Shaft subjected to twisting moment, Shaft subjected to bending moment and combined bending and twisting moment.

**Design of Springs :** Springs: Types of spring, Stress and Deflection Equations, Design of Helical Springs, Design against Fluctuating Load, Surge in spring, leaf spring.

## **4. Books and Materials**

### **Text Books:**

1. V.B. Bhandari, Design of Machine elements, 4<sup>th</sup> Edition, McGraw Hill Education (India) Private Limited, New Delhi.
2. Shigley, Mechanical Engineering Design, 10<sup>th</sup> Edition, McGraw Hill Education (India) Private Limited, New Delhi.

### **Reference Books:**

1. Robert L. Norton, Machine Design: An Integrated Approach, 5<sup>th</sup> Edition, Pearson India Education Services Pvt. Ltd.
2. N C Pandya and C S Shah, Machine Design, 20<sup>th</sup> Edition, Charotar Publishing House Pvt. Ltd., New Delhi, India.
3. R S Khurmi and J K Gupta, A text book of Machine Design, 25<sup>th</sup> Edition, Eurasia Publishing House, New Delhi.

### **Data Book Permitted:**

1. Machine Design Data Book by V B Bhandari, McGraw Hill Edition (India).
2. S. M. D. Jalaludin (2014) Design Data Hand Book-2<sup>nd</sup> Edition- Anuradha Publishers- Kumbakonam- Chennai-India.

**Course Structure****A8322- Thermal Engineering II**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	1	0	45	0	0	4	40	60	100

**1. Course Description****Course Overview**

This course is based on the fundamental concepts and analysis techniques of thermodynamics course learnt in previous semester. This course presents the thermodynamic analysis of the Rankine cycle and the methods to improve its performance. It develops theoretical knowledge related to steam nozzles and steam turbines. It also gives an understanding of vapour compression refrigeration system and thus it's an important course for mechanical engineers.

**Course Pre/co-requisites**

A8308-Thermodynamics

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8322.1 Analyze steam power cycle performance using thermodynamic properties
- A8322.2 Compare the flow through nozzles to decide nozzle shape
- A8322.3 Evaluate the operating parameters of steam turbines
- A8322.4 Solve steam turbine problems through velocity triangle concepts
- A8322.5 Estimate the refrigeration capacity by applying thermodynamic principles.

**3. Course Syllabus**

**Steam Power Cycle:** Rankine cycle - Schematic layout, Comparison between Rankine Cycle and Carnot cycle. Thermodynamic Analysis, Concept of Mean Temperature of Heat addition, Methods to improve cycle performance, Regeneration and reheating.

**Steam Nozzles:** Function of nozzle, applications, types, Flow through nozzles, velocity of nozzle at Exit-Ideal and actual expansion in nozzle, velocity coefficient, and condition for maximum discharge, criteria to decide nozzle shape.

**Impulse Turbine:** Classification, Impulse turbine; Mechanical details, Velocity diagram, effect of friction, power developed, axial thrust, blade or diagram efficiency, condition for maximum efficiency. De-Laval Turbine - its features. Methods to reduce rotor Speed-



Velocity compounding and pressure compounding, Velocity and Pressure variation along the flow, combined velocity diagram for a velocity compounded impulse turbine.

### **Reaction Turbines:**

Mechanical details, principle of operation, thermodynamic analysis of a stage, degree of reaction, velocity diagram, Parson's reaction turbine, condition for maximum efficiency.

**Refrigeration:** Units of refrigeration, Types of Refrigeration, Vapour compression refrigeration system; description, analysis, refrigerating effect. Capacity, power requirement, COP, Refrigerants and their desirable properties, alternative Refrigerants.

## **4. Books and Materials**

### **Text Books:**

1. R. K. Rajput , Thermal Engineering, 10<sup>th</sup> Edition, Lakshmi Publications, New Delhi, India.
2. S Domkundwar,C P Kothandaraman, Domkundwar, A course in Thermal Engineering, 6<sup>th</sup> Edition, DhanpatRai Publication, New Delhi India.

### **Reference Books:**

1. Ballaney P L, Thermal Engineering,25<sup>th</sup> Edition, Khanna Publishers, Delhi.
2. R. Yadav, Thermodynamics and Heat Engines, 6<sup>th</sup> Edition, Central Publishing House, Allahabad.

**Course Structure****A8323 - Metrology and Machine Tools Laboratory**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

**1. Course Description****Course Overview**

To create awareness on various mechanical measuring instruments. To make students familiar with various operations on machine tools.

**Course Pre/co-requisites**

A8303 - Engineering Workshop

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8323.1. Impart practical exposure to the metrology equipment & Machine Tools
- A8323.2. Conduct experiments and understand the working of the same
- A8323.3. Hands on experience on lathe machine to perform turning, facing, threading operations.
- A8323.4. Practical exposure on flat surface machining, milling and grinding operations
- A8323.5. Skill development in drilling and threading operations, Linear and angular measurements exposure

**3. List of Experiments**

1. Applications of vernier calipers, micrometer, Bore gauge and height gauge.
2. Machine tool alignment test on the lathe and milling machine.
3. Tool maker's microscope and its application.
4. Measurement of effective diameter of screw thread by using two wire and three wire method.
5. Surface roughness measurement by using Taly Surf surface roughness tester.
6. Determine the angle of work piece by using Sine Bar.
7. To perform step turning, taper turning, Thread cutting and knurling operations using lathe machine.
8. To perform drilling and tapping operations using drilling machine.
9. To perform different types of milling operations using milling machine.
10. To perform grinding operations using cylindrical and surface grinding machines.



11. To perform planing operation using planing machine.
12. To perform shaping and key way machining by using Shaper and slotting machine.

#### 4. Laboratory Equipment/Software/Tools Required

1. Vernier calipers, micrometer, Bore gauge and height gauge
2. Dial indicator, mandrel, spirit level, straight edge
3. Tool makers Microscope.
4. Micrometer with two wire and three wire setup.
5. Taly Surf surface roughness tester.
6. Sine bar, slip gauges and dial indicator
7. Lathe machine
8. Drilling machine.
9. Milling machine.
10. Cylindrical grinding machine and surface grinding machine.
11. Planing machine.
12. Shaping machine



## Course Structure

### A8324 - Dynamics of Machinery Laboratory

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

## 1. Course Description

### Course Overview

The Theory of Machines Laboratory is a facility dedicated to practical experimentation and analysis of mechanical systems. It focuses on principles related to the dynamics and kinematics of machines. Students perform hands-on experiments to study mechanisms, gears, cams, and linkages, gaining insights into the behavior and performance of various mechanical systems. The laboratory enhances understanding of theoretical concepts through real-world applications in machine design and operation.

### Course Pre/co-requisites

A8303 - Engineering Workshop

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8324.1. Define the basics of mechanism and their inversions and able to show the displacement, velocity and acceleration in different mechanisms
- A8324.2. Apply different principles and methods for kinematic and dynamic analysis of mechanisms
- A8324.3. Classify cams and followers & analyze the cam design
- A8324.4. Elaborate different modes of power transmission and use of friction in power transmission
- A8324.5. Classify different types of gears and evaluate their working in various gear trains. Also make use of balancing and vibration in mechanical systems

## 3. List of Experiments

1. To determine the active and reactive gyroscopic couples and compare them.
2. To determine stiffness of the given helical spring, period and frequency of undamped free vibration of spring mass system.
3. To balance the given reciprocating mass system.
4. To balance the given rotating mass system with the aid of the force polygon and the couple polygon.
5. To determine the whirling speed of shaft.



6. To determine the characteristic curves of the spring-loaded governor.
7. To determine the period and frequency of torsional vibration of the single rotor system.
8. To determine the period and frequency of torsional vibration of the two-rotor system.
9. To study the transverse vibrations of a simply supported beam.
10. To determine the radius of gyration and the moment of Inertia of a given circular plate.
11. To determine the mass moment of inertia of the given connecting rod by using oscillating method.

Note: Minimum ten experiments needs to be conducted.

#### 4. Laboratory Equipment/Software/Tools Required

1. Motorized Gyroscope
2. Longitudinal Vibrations of Spring Mass system
3. Balancing of Reciprocating Masses
4. Balancing of Rotating Masses
5. Whirling speed of shaft
6. Governor Experimental Setup
7. Torsional Vibrations for Single and Multi Rotor System
8. Transverse Vibrations of Free Beam Setup
9. Trifilar Suspension System
10. Flywheel and Connecting rod setup

**Course Structure****A8325 - Engineering Design Laboratory**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

**1. Course Description****Course Overview**

Engineering Design Laboratory course is one of the important courses in mechanical engineering. This course introduces Advanced Spectrum Analysis, 3D Printing and Components and Vibration Equipment's.

**Course Pre/co-requisites**

A8307 - Mechanics of Solids

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8325.1. Determine the deflection, whirling speed and stress of different structures
- A8325.2. Analyze the transverse vibration of different beam set up
- A8325.3. Evaluate the compressive, tensile and buckling of 3-D printed structures
- A8325.4. Estimate the natural frequency of dynamic system
- A8325.5. Calculate the natural frequencies and amplitudes of mechanical components.

**3. List of Experiments**

1. Advanced Spectrum Analysis.
2. Compressive/Tensile strength of 3D printed components Using different layer height.
3. Compressive/Tensile strength of 3D printed components Using different infill.
4. Buckling analysis of 3D printed components
5. Estimation of damping using logarithmic decrement curve.
6. Transverse vibration of beam Apparatus.
7. To determine the deflection of a structural member using Pin jointed setup.
8. Calculation of shear center of different cross sections using Shear center setup.
9. Buckling Analysis of column using column buckling setup.
10. To determine the deflection of a frame using Portal frame set up.
11. Analyze the stress distribution of structural member using curved beam apparatus.

Note: Minimum ten experiments needs to be conducted.



#### **4. Laboratory Equipment/Software/Tools Required**

1. 3D Printer
2. Mini Tensile and Compressive Equipment.
3. Column Buckling Setup.
4. Whirling of shafts Apparatus
5. Transverse vibrations of Beam Apparatus.
6. Pin Jointed Truss Setup.
7. Shear Center Setup.
8. Portal Frame Setup.
9. Curved Beam Apparatus.

**Course Structure****A8034 - Indian Constitution**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
2	0	0	30	0	0	0	-	100	100

**1. Course Description****Course Overview**

This course enables the students to understand the constitution of India as the Supreme law of India. The student will also gain knowledge about the parliament of India and how it functions. This course will survey the basic structure and operative dimensions of the Indian constitution. It will explore various aspects of the Indian political and legal system from a historical perspective highlighting the various events that led to the making of the Indian constitution.

**Course Pre/co-requisites**

This course has no specific prerequisite and co-requisite.

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8034.1. Identify the important components of Indian Constitution.
- A8034.2. Apply the fundamental rights in right way and become a more responsible citizen.
- A8034.3. Illustrate the evolution of Indian Constitution.
- A8034.4. Identify the basic structure of Indian Constitution.
- A8034.5. Relate the basic concepts of democracy, liberty, equality, secular and justice.

**3. Course Syllabus**

**Evolution of Indian constitution:** Indian independence act 1947, formation of constituent assembly of India, committees of the constituent assembly, constitution of India drafting committee, brief study about Indian Constitution drafting committee Chairman, time line of formation of the constitution of India.

**Structure of the constitution of India:** Parts, schedules, appendices, constitution and government, constitution and judiciary.

**Preamble to the constitution of India:** Brief study about sovereignty, socialist, secularism, democracy, republic, justice (political justice, social justice, economic justice), liberty, equality, fraternity, unity & integrity.

**Acts:** Salient Features, Provisions of the acts: Right to education act, right to information act, anti-defection law, Jan Lokpal bill.



**Fundamental rights:** Right to equality, right to freedom (freedom of speech and expression, right to practice any profession etc.), right against exploitation, right to freedom of religion, cultural & education rights, right to property, right to constitutional remedies

## 4. Books and Materials

### Text Books:

1. Dr. Durga das basu. Introduction to the constitution of India, 21<sup>st</sup> Edition, Lexis Nexis books publication Ltd, 2013.

### Reference Books:

1. Subhash C. Kashyap, Our Constitution, National Book Trust, New Delhi, 2011.
2. Arun K Thiruvengadam, The Constitution of India, 1<sup>st</sup> Edition, Hart publishing India, 2017.

**III YEAR II SEMESTER**

**Course Structure****A8326 - Heat Transfer**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

This course is an introduction to the principal concepts, methods of heat transfer. The objectives of this course is to develop the fundamental principles and laws of heat transfer, mass transfer and to explore the implications of these principles for system behaviour, to formulate the models necessary to study, analyze and design heat transfer systems through the application of these principles, to develop the problem solving skills essential to good engineering practice of heat transfer in real world applications.

**Course Pre/co-requisites**

A8002 - Ordinary Differential Equations and Vector Calculus

A8314 - Fluid Mechanics and Hydraulic Machines

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8326.1 Solve heat and mass transfer problems by applying basic laws and principles
- A8326.2 Analyze steady and transient state heat conduction problems using correlations
- A8326.3 Evaluate heat transfer coefficient by applying convective heat transfer concepts
- A8326.4 Compare heat exchanger performance for various types of fluid flows
- A8326.5 Estimate radiation heat transfer by using emission characteristics of objects.

**3. Course Syllabus**

**Introduction :** Modes and mechanisms of heat transfer, Basic laws of heat transfer –Applications of heat transfer. Conduction Heat Transfer: General heat conduction equation in Cartesian, cylindrical and spherical coordinates. 1D steady state heat conduction through Homogeneous slabs, hollow cylinder and sphere, Overall heat transfer coefficient, Electrical analogy, Critical radius of insulation.

**Heat Transfer From Extended Surfaces:** Types of fins. Heat flow through rectangular and circular fins, Long, Short and insulated tips, fins losing heat at the tip, efficiency and effectiveness of fins. One Dimensional Transient Heat Conduction: Systems with negligi-



ble internal resistance, Significance of Biot and Fourier Numbers. Heisler charts. Convective Heat Transfer: Dimensional analysis-Buckingham Pi Theorem - Application for developing non-dimensional correlation for convective heat transfer, Lumped parameter systems.

**Convection :** Forced Convection: External Flows – Concepts of hydrodynamic and thermal boundary layer and use of empirical correlations for Flat plates and Cylinders, Internal Flows – Concepts about Hydrodynamic and Thermal Entry Lengths, use of empirical correlations for Horizontal Pipe Flow and annulus flow. Free Convection: Development of Hydrodynamic and thermal boundary layer along a vertical plate – Use of empirical relations for Vertical plates and pipes.

**Heat Exchangers:** Classification of heat exchangers – overall heat transfer Coefficient and fouling factor – Concepts of LMTD and NTU methods - Problems using LMTD and NTU methods. Boiling And Condensation: Regimes of Pool boiling, Flow boiling and Nucleate Boiling. Film wise and drop wise condensation, Nusselt's theory of condensation on a vertical plate.

**Radiation Heat Transfer:** Emission characteristics – Laws of black-body radiation – Irradiation – Total and monochromatic quantities – Laws of Planck, Wien, Kirchoff, Lambert, Stefan and Boltzmann – Heat exchange between two black bodies – concepts of shape factor – Emissivity – heat exchange between grey bodies – radiation shields – electrical analogy for radiation networks. Basic Concepts – Diffusion Mass Transfer , Fick's Law of Diffusion ,Steady state Molecular Diffusion ,Convective Mass Transfer.

#### 4. Books and Materials

**Text Books:**

1. R.C. Sachdeva, Fundamentals of Engineering, Heat and Mass Transfer, 3<sup>rd</sup> Edition, New Age, New Delhi.
2. HOLMAN, Heat Transfer, 9<sup>th</sup> Edition, TMH, New York.

**Reference Books:**

1. D.S. Kumar, Heat and Man Transfer, 8<sup>th</sup> Edition, S.K. Kataria, New Delhi.
2. M. Thirumaleshwar, Fundamentals of Heat and Mass Transfer, 2<sup>nd</sup> Edition, Pearson, India.
3. YUNUS A CENGEL, Heat Transfer a Practical Approach, 2<sup>nd</sup> Edition, TMH, New York.

**Course Structure****A8327 - Machine Design**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

This course covers the systematic approach for the design of mechanical components in engineering design eras such as different types of bearing, application of various types of gears, power transmission through friction drives and IC engine components.

**Course Pre/co-requisites**

A8307 - Mechanics of Solids

A8312 - Kinematics of Machinery

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

A8327.1 Apply the design aspects of gears used in mechanical drives

A8327.2 Estimate the effective strength of gears based on dynamic and wear criterion's

A8327.3 Analyze the design procedure of different components used in IC engine

A8327.4 Demonstrate the working principle of brakes and clutches in locomotive

A8327.5 Explain the functions of bearing and its selection.

**3. Course Syllabus**

**Gears:** Spur Gears: Spur Gears, Tooth forms, System of gear teeth, contact ratio, Standard proportions of gear systems, Interference in involute gears, Backlash, Selection of gear materials, Design considerations, Beam strength of gear tooth, Dynamic tooth load, Wear strength of gear tooth, Failure of gear tooth, Design of spur gears. Helical Gears: Helical Gears Terminology, Proportions for helical gears, Forces components on a tooth of helical gear, Virtual number of teeth, Beam strength and wear strength of helical gears, Dynamic load on helical gears, Design of helical gears.

**Bevel and Worm Gears:**

Bevel Gears: Bevel gears Terminology of bevel gears, Force analysis, Virtual number of teeth, Beam strength and wear strength of bevel gears, Effective load of gear tooth, Design of a bevel gear system. Worm Gears: Worm Gears Types of worms, Terminology, Gear



tooth proportions, Efficiency of worm gears, Heat dissipation in worm gearing, Strength and wear tooth load for worm gears, Design of worm gearing system.

**Design of IC Engine Components:** Design of cylinder and Cylinder head, Design of piston, Design of connecting rod and crank shaft.

**Clutches and Brakes:** Clutches: Types of clutches, Torque transmitting capacity, Multi disk clutches, cone clutches. Brakes: Types of brakes, Energy equation, Block brake with short and long shoes.

**Bearings:** Rolling Contact Bearings: Types of rolling contact bearing, Equivalent bearing load, Load life relationship, Selection of bearing, Reliability of bearing Sliding Contact Bearings: Modes of lubrication, Types of sliding contact bearing, Design procedure for journal bearing.

## 4. Books and Materials

### Text Books:

1. V.B. Bhandari, Design of Machine elements: 4<sup>th</sup> Edition, McGraw Hill Education (India) Private Limited, New Delhi.
2. J.E. Shigley, Mechanical Engineering Design: 10<sup>th</sup> Edition, McGraw Hill Education (India) Private Limited, New Delhi.

### Reference Books:

1. Robert L. Norton, Machine Design: An Integrated Approach: 5<sup>th</sup> Edition, Pearson India Education Services Pvt. Ltd.
2. N C Pandya and C S Shah, Machine Design:, 20<sup>th</sup> Edition, Charotar Publishing House Pvt. Ltd., New Delhi, India.
3. R S Khurmi and J K Gupta, A text book of Machine Design:, 14<sup>th</sup> Edition, Eurisia Publishing House, New Delhi.

### DATA BOOKS PERMITTED:

- 1 V B Bhandari (2014), Machine Design Data Book , McGraw Hill Edition, India.
- 2 S. M. D. Jalaludin (2014), Design Data Hand Book- 2<sup>nd</sup> Edition- Anuradha Publishers- Kumbakonam- Chennai-India.

**Course Structure****A8328 - Finite Element Methods**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
2	0	0	45	0	2	3	40	60	100

**1. Course Description****Course Overview**

Finite element methods course is one of the important courses in mechanical engineering. This course introduces student's finite element methods for analysis of solid, structural, fluid and heat transfer problems. It deals analysis of one dimensional, two dimensional problems like truss, beams and plane stress and plane strain problems, steady state Heat Transfer and dynamic analysis problems. This course is an integrated course having the-ory and practical components that integrates hands on experience to observe the stress analysis of solid and structural members due external loads. This course forms how to model the given problem for analyses of one dimensional, two dimensional, steady state heat transfer and dynamic problems

**Course Pre/co-requisites**

A8002 - Ordinary Differential Equations and Vector Calculus

A8307 - Mechanics of Solids.

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8328.1 Illustrate the general procedure of finite element method, one dimensional problems and shape functions.
- A8328.2 Solve structural elements including trusses and beams.
- A8328.3 Apply finite element method to solve two dimensional and axi-symmetric problems
- A8328.4 Analyze heat transfer in 1D and 2D problems.
- A8328.5 Simulate the dynamic analysis of the components as per the boundary conditions.

**3. Course Syllabus**

**Introduction To FEM:** Stress and Equilibrium, boundary conditions, Strain-Displacement relations. Stress - strain relations. Finite element modeling coordinates and shape functions. Potential Energy approach: Finite Elements: 1- Dimensional, 2 - Dimensional, 3-



Dimensional and Interpolation Elements; One Dimensional Problem, Assembly of Global stiffness matrix and load vector. Finite element equations, Treatment of boundary conditions, Quadratic shape functions.

**Analysis of Trusses and Beams:** Stiffness Matrix for plane truss and space truss elements, stress calculations. Analysis of Beams: Shape functions-Element stiffness matrix for two nodes, two degrees of freedom per node beam element, load vector, deflection, stresses.

**2-D Problems:** CST-Stiffness matrix and load vector, Iso-perimetric element representation, convergence requirements, Problems. Finite Element Modelling: Axi-symmetric solids subjected to Axi-symmetric loading with triangular elements. Two dimensional four noded ISO-parametric elements and numerical integration.

**Steady State Heat Transfer Analysis::** 1-D analysis of a slab, fin and 2-D analysis of thin plate. Analysis of a uniform shaft subjected to torsion.

**Dynamic Analysis:** Formulation of finite element model, element matrices, Lumped and consistent mass matrices, evaluation of Eigen values and Eigen vectors for a stepped bar and a beam.

## 4. Books and Materials

### Text Books:

1. Tirupathi R. Chandrapatla and Ashok Belegundu, Introduction to Finite Elements in Engineering, 4<sup>th</sup> Edition, Pearson Education, India.
2. S. S. Rao, The Finite Element Methods in Engineering, 5<sup>th</sup> Edition, Elsevier, USA.

### Reference Books:

1. V. David. Hutton , Fundamentals of finite elements analysis, 1<sup>st</sup> Edition, Tata McGraw-Hill education (P) Ltd, New Delhi, India.
2. J. N. Reddy, An introduction to Finite Element Method, 3<sup>rd</sup> Edition, Tata McGraw hill education (P) Ltd, New Delhi, India.
3. Chennakesava R. Alavala, Finite elements methods, 1<sup>st</sup> Edition, second reprint, Prentice Hall of publishers, New Delhi, India.



## Course Structure

### A8329 - Heat Transfer Laboratory

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

## 1. Course Description

### Course Overview

The Heat Transfer Laboratory is a specialized facility for studying the principles and applications of heat transfer in various engineering scenarios. It provides hands-on experiments to analyze conduction, convection, and radiation phenomena. Students explore heat exchangers, thermal conductivity, and heat transfer in different materials, gaining practical insights into thermal system behavior. The laboratory enhances comprehension of theoretical concepts related to heat transfer in engineering applications.

### Course Pre/co-requisites

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8329.1. Estimate the thermal conductivity of different materials
- A8329.2. Determine the heat transfer coefficient in transient heat conduction
- A8329.3. Correlate the heat transfer coefficients in natural and forced convection
- A8329.4. Analyze the performance of heat pipe and double pipe heat exchanger
- A8329.5. Compare the emissivity of the test plate with the black plate.

## 3. List of Experiments

1. To determine the thermal resistance and thermal conductivity of composite slab.
2. To determine the thermal conductivity of lagged pipe.
3. To determine the thermal conductivity of insulating powder using concentric sphere.
4. To determine the thermal conductivity of a metal rod along its length.
5. To determine the efficiency of a pin-fin.
6. To determine the heat transfer coefficient in Transient Heat Conduction.
7. To determine the heat transfer coefficient for forced convection through pipe.
8. To determine the heat transfer coefficient for natural convection through pipe.
9. To determine the effectiveness and overall heat transfer coefficient of double pipe heat exchanger with Parallel and counter flow arrangement.



10. To determine the emissivity of a metal plate.
11. To determine the critical Heat flux at different temperatures of water.
12. To compare the heat transfer through heat pipe with copper and stainless steel pipes.

#### 4. Laboratory Equipment/Software/Tools Required

1. Composite slab Apparatus
2. Lagged pipe Apparatus
3. Concentric sphere Apparatus
4. Metal rod Apparatus
5. Pin fin Apparatus
6. Transient Heat Conduction Apparatus
7. Forced convection Apparatus
8. Natural convection Apparatus
9. Double pipe heat exchanger with Parallel and counter flow arrangement
10. Emissivity Apparatus
11. Critical Heat flux Apparatus
12. Heat pipe Apparatus



## Course Structure

### A8330 - Numerical Simulation Laboratory

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

## 1. Course Description

### Course Overview

The Numerical Simulation Laboratory is a dedicated space for conducting virtual experiments and simulations in engineering and scientific domains. It employs computational methods to model and analyze complex systems, enhancing understanding of real-world phenomena. Students utilize software tools to simulate structural mechanics, and other disciplines, bridging the gap between theory and practical applications. The laboratory provides a platform for hands-on experience in numerical methods and their application to solve engineering problems.

### Course Pre/co-requisites

A8328 - Finite Element Methods

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8330.1. Illustrate the stress effect on the components
- A8330.2. Analyze the deflections occurring on the beams
- A8330.3. Examine the 2D problems under different boundary conditions
- A8330.4. Compare the heat transfer problems
- A8330.5. Formulate MATLAB code for the mechanical applications

## 3. List of Experiments

1. Stress analysis of a plate with a circular hole
2. Stress analysis of rectangular L bracket
3. Stress analysis of cantilever beam
4. Stress analysis of simply supported beam
5. Stress analysis of fixed beam
6. Stress analysis of an axi-symmetric component
7. Thermal stress analysis of a 2D component
8. Conductive heat transfer analysis of a 2D component
9. Convective heat transfer analysis of a 2D component



10. Mode frequency analysis of cantilever beam
11. Mode frequency analysis of simply supported beam
12. Harmonic analysis of a 2D component
13. Stress analysis of a truss
14. Simulation of Spring-mass system using MAT LAB
15. Simulation of cam and follower mechanism using MATLAB

Note: Minimum ten experiments needs to be conducted.

#### 4. Laboratory Equipment/Software/Tools Required

1. ANSYS
2. MATLAB



## Course Structure

### A8012 - Advanced English Communication Skills Laboratory

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

## 1. Course Description

### Course Overview

This Lab focuses on grooming the students professionally and empowering them through language development. This course facilitates them to hone their vocabulary and listening skills enabling them to prepare for competitive examinations. This course also polishes the students' presentation skills in different professional contexts besides developing proficiency in reading and writing. Further, they would be outfitted to communicate their ideas relevantly in group discussions and develop proficiency in preparing for interviews, thus making students ready for industry.

### Course Pre/co-requisites

A8010 - English for Skill Enhancement

A8011 - English Language and Communication Skills Laboratory

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8012.1. Improve comprehensive skills in listening and reading.
- A8012.2. Develop effective technical writing skills and e- correspondence.
- A8012.3. Build communication skills in different socio-cultural and professional contexts.
- A8012.4. Organize the dynamics of group discussion for effective participation.
- A8012.5. Analyze strategies to succeed in interviews.

## 3. Course Syllabus

### Theory

The following course content to conduct the activities is prescribed for the Advanced English Communication Skills Laboratory **Activities on Listening and Reading Comprehension:** Active Listening – Development of Listening Skills Through Audio clips - Benefits of Reading – Methods and Techniques of Reading – Basic Steps to Effective Reading – Common Obstacles – Discourse Markers or Linkers - Sub-skills of reading - Reading for facts, negative facts and Specific Details- Guessing Meanings from Context, Inferring Meaning - Critical Reading — Reading Comprehension – Exercises for Practice.

**Activities on Writing Skills:** Vocabulary for Competitive Examinations - Planning for Writing – Improving Writing Skills - Structure and presentation of different types of writing – Free Writing and Structured Writing - Letter Writing – Writing a Letter of Application – Resume vs. Curriculum Vitae – Writing a Résumé – Styles of Résumé - e-Correspondence – Emails – Blog Writing - (N)etiquette – Report Writing – Importance of Reports – Types



and Formats of Reports– Technical Report Writing– Exercises for Practice.

**Activities on Presentation Skills:** Starting a conversation – responding appropriately and relevantly – using the right language and body language – Role Play in different situations including Seeking Clarification, Making a Request, Asking for and Refusing Permission, Participating in a Small Talk – Oral presentations (individual and group) through JAM sessions- PPTs – Importance of Presentation Skills – Planning, Preparing, Rehearsing and Making a Presentation – Dealing with Glossophobia or Stage Fear – Understanding Nuances of Delivery - Presentations through Posters/Projects/Reports – Checklist for Making a Presentation and Rubrics of Evaluation.

**Activities on Group Discussion (GD):** Types of GD and GD as a part of a Selection Procedure - Dynamics of Group Discussion- Myths of GD - Intervention, Summarizing - Modulation of Voice, Body Language, Relevance, Fluency and Organization of Ideas – Do's and Don'ts - GD Strategies – Exercises for Practice.

**Interview Skills:** Concept and Process - Interview Preparation Techniques - Types of Interview Questions – Pre-interview Planning, Opening Strategies, Answering Strategies - Interview Through Tele-conference & Video-conference - Mock Interviews.

## 4. Laboratory Equipment/Software/Tools Required

1. Audio Visual Equipment (Public Address System, LCD Projector and Camcorder).
2. One PC with latest configuration for the teacher.
3. Delta's key to the Next Generation TOEFL, Test: Advanced Skill Practice.
4. TOEFL & GRE (KAPLAN, AARCO & BARRONS, USA, Cracking GRE by CLIFFS).
5. Oxford Advanced Learner's Dictionary, 10th Edition.
6. Cambridge Advanced Learner's Dictionary.
7. Lingua TOEFL CBT Insider, by Dreamtech.

## 5. Books and Materials

### Text Books:

1. M. Ashraf Rizvi, Effective Technical Communication, 2<sup>nd</sup> Edition, McGraw Hill Education, 2018.
2. Suresh Kumar E, Engineering English, 1<sup>st</sup> Edition, Orient BlackSwan Pvt. Ltd, 2015.
3. Bailey, Stephen, Academic Writing: A Handbook for International Students (5th Edition), Routledge, 2018.
4. Koneru, Aruna, Professional Communication, McGraw Hill Education (India) Pvt. Ltd, 2016.

### Reference Books/Additional Resources:

1. Meenakshi Raman & Sangeeta Sharma, Technical Communication, 3<sup>rd</sup> Edition, Oxford University Press, 2015.
2. Paul V. Anderson, Technical Communication, 8<sup>th</sup> Edition, Cengage Learning pvt. Ltd., New Delhi. 2013.
3. McCarthy, Michael; O'Dell, Felicity & Redman, Stuart, English Vocabulary in Use Series.



Cambridge University Press, 2017.

4. Sen, Leela, Communication Skills, PHI Learning Pvt Ltd., New Delhi, 2009.
5. Elbow, Peter, Writing with Power. Oxford University Press, 1998.
6. Goleman, Daniel, Emotional Intelligence: Why it can matter more than IQ. Bloomsbury Publishing, 2013.



## Course Structure

### A8331 - Fundamentals of HVAC

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	30	0	0	1	40	60	100

## 1. Course Description

### Course Overview

The Fundamentals of HVAC (Heating, Ventilation, and Air Conditioning) course covers essential principles in maintaining indoor environmental comfort. Students learn about heating and cooling systems, air distribution, and energy efficiency. The curriculum explores psychrometrics, refrigeration cycles, and HVAC system design to equip individuals with skills in climate control. Practical applications and problem-solving exercises are integrated to prepare students for HVAC engineering and design challenges.

### Course Pre/co-requisites

A8313 - Thermal Engineering-I

A8322 - Thermal Engineering-II

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8331.1 Classify refrigeration systems based on operating principles
- A8331.2 Correlate various heating and cooling processes on the psychrometric chart
- A8331.3 Compare air-conditioning systems based on advantages and limitations
- A8331.4 Choose appropriate fittings based on design features
- A8331.5 Explain piping parameters for air distribution system

## 3. Course Syllabus

1. Study of various refrigeration systems
2. Study of Vapor compression Refrigeration System
3. Study of Vapor Absorption refrigeration system
4. Study of refrigerants and their properties
5. Study of psychrometric properties of Air
6. Study of air-conditioning processes on psychrometric chart
7. Study of various Air conditioning systems
8. Study of humidity measurement using Sling psychrometric
9. Study of Air conditioning duct system
10. Study of Air conditioning distribution system



## Course Structure

### A8035 - Research Methodology

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
2	0	0	30	0	0	0	-	100	100

## 1. Course Description

### Course Overview

Research is an art of scientific investigation. Research is an original contribution to the existing stock of knowledge making for its advancement. It is the pursuit of truth with the help of study, observation, comparison, and experiment. This course will help students to understand the research process, tools, and importance of ethics. Also, this course helps students to write technical reports.

### Course Pre/Co-requisites

This course has no core requisites/pre-requisites

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8035.1. Identify an appropriate research problem in their suitable domain.
- A8035.2. Explain the concepts and procedures of sampling, data collection, analysis, and reporting.
- A8035.3. Analyze the complex issues inherent in selecting a research problem, research design, and implementing a research project.
- A8035.4. Construct a well-structured research paper and scientific presentations.
- A8035.5. Express the importance of research ethics in the scientific community.

## 3. Course Syllabus

**Research Methodology:** Introduction, meaning, objectives, motivation, types of research, research approaches, significance of research, research methods versus methodology, research and scientific method, research process, criteria of good research. **Defining a Research Problem:** Research problem, selecting the problem, necessity of defining the problem, technique involved in defining a problem.

**Research Design:** Meaning of research design, need for research design, features of a good design, important concepts relating to research design, different research designs, basic principles of experimental designs.

**Measurement and Scaling:** Measurement in research, measurement scales, sources of error in measurement, techniques of developing measurement tools, scale classification bases, scaling techniques.

**Data Collection:** Collection of primary data, observation method, interview method, collection of secondary data, selection of appropriate method for data collection, case study



method.

**Interpretation and Report Writing:** Meaning of interpretation, technique of interpretation, precaution in interpretation, significance of report writing, different steps in writing report, layout of the research report, types of reports, oral presentation, mechanics of writing a research report, precautions for writing research reports. **Research Tools and Techniques:** Methods to search required information effectively, reference management software like Zotero, Mendeley and EndNote, LaTeX (writing paper, thesis, report, bibliography), BEAMER for presentation, software for detection of plagiarism. ethical issues related to publishing, plagiarism and self-plagiarism.

## 4. Books and Materials

### Text Books:

1. C.R. Kothari, Gaurav Garg “Research Methodology: Methods and Techniques” 4th Edition, New Age International, 2018
2. Ranjit Kumar “Research Methodology a step-by step guide for beginners”, 3rd Edition, SAGE Publications Ltd, 2011.

### Reference Books:

1. Trochim, Research Methods: the concise knowledge base, Atomic Dog Publishing, 2005
2. Fink A “Conducting Research Literature Reviews: From the Internet to Paper” Stage Publications, 2009

**IV YEAR I SEMESTER**



## Course Structure

### A8332 - Instrumentation and Control Systems

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

Instrumentation and control refer to the analysis, measurement, and control of industrial process variables using process control instruments and software tools such as temperature, pressure, flow, and level sensors, analyzers, electrical and mechanical actuators.

### Course Pre/co-requisites

No Pre requisites.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8332.1 Know the basic knowledge of the functional blocks of measurement systems
- A8332.2 Describe the working of various physical variable Temperature and pressure measuring instruments
- A8332.3 Explain the working of various physical variable Level, flow, Speed and Acceleration measuring instruments
- A8332.4 Understand the working of various physical and Electrical variables Stress, Humidity, Force, Torque and Power measuring instruments
- A8332.5 Understand the concept of control system and calculate transfer functions of mechanical and Translational systems with different techniques.

## 3. Course Syllabus

**Introduction:** Definition – Basic principles of measurement – Measurement systems, generalized configuration and functional description of measuring instruments – examples. Static and Dynamic performance characteristics– sources of errors, Classification and elimination of errors. Measurement of Displacement: Theory and construction of various transducers to measure displacement – Using Piezo electric, Inductive, capacitance, resistance, ionization and Photo electric transducers; Calibration procedures.

**Measurement of Temperature:** Various Principles of measurement-Classification: Expansion Type: Bimetallic Strip- Liquid in glass Thermometer; Electrical Resistance Type: Thermistor, Thermocouple, RTD; Radiation Pyrometry: Optical Pyrometer; Changes in



Chemical Phase: Fusible Indicators and Liquid crystals. Measurement of Pressure: Different principles used- Classification: Manometers, Dead weight pressure gauge Tester (Piston gauge), Bourdon pressure gauges, Bulk modulus pressure gauges, Bellows, Diaphragm gauges. Low pressure measurement – Thermal conductivity gauges, ionization pressure gauges, McLeod pressure gauge.

**Measurement of Level:** Direct methods – Indirect methods – Capacitive, Radioactive, Ultrasonic, Magnetic, Cryogenic Fuel level indicators –Bubbler level indicators. Flow measurement: Rotameter, magnetic, Ultrasonic, Turbine flowmeter, Hot – wire anemometer, Laser Doppler Anemometer (LDA). Measurement of Speed: Mechanical Tachometers, Electrical tachometers, Non-contact type Stroboscope; Measurement of Acceleration and Vibration: Different simple instruments – Principles of Seismic instruments – Vibrometer and accelerometer using this principle- Piezo electric accelerometer.

**Stress-Strain measurements:** Various types of stress and strain measurements –Selection and installation of metallic strain gauges; electrical strain gauge – gauge factor – method of usage of resistance strain gauge for bending, compressive and tensile strains – Temperature compensation techniques, Use of strain gauges for measuring torque, Strain gauge Rosettes. Measurement of Humidity: Moisture content of gases, Sling Psychrometer, Absorption Psychrometer, Dew point meter. Measurement of Force, Torque and Power- Elastic force meters, load cells, Torsion meters, Dynamometers.

**Elements of Control Systems:** Introduction, Importance – Classification – Open and closed systems- Servomechanisms – Examples with block diagrams – Temperature, speed and position control systems- Transfer functions- First and Second order mechanical systems

## 4. Books and Materials

### Text Books:

1. Principles of Industrial Instrumentation & Control Systems/Chennakesava R alaavala, - Cengage Learning/1st Edition.
2. Basic Principles – Measurements (Instrumentation) & Control Systems /S. Bhaskar/ Anuradha Publications.

### Reference Books:

1. Measurement Systems: Applications & design, E. O. Doebelin, TMH, Tata Mcgraw Hill 6th Edition.
2. Instrumentation, Measurement & Analysis, B.C. Nakra & K.K. Choudhary, TMH, 4th Edition.
3. Experimental Methods for Engineers / Holman



# VARDHAMAN COLLEGE OF ENGINEERING

(AUTONOMOUS)

Affiliated to JNTUH, Approved by AICTE, Accredited by NAAC with A++ Grade, ISO 9001:2015 Certified  
Kacharam, Shamshabad, Hyderabad - 501218, Telangana, India

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4. Mechanical and Industrial Measurements / R. K. Jain/ Khanna Publishers.

**Course Structure****A8333 - CIM And Robotics**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

The CIM and Robotics theory course provides a comprehensive understanding of computer-integrated manufacturing and robotic systems. Students delve into concepts such as CAD/CAM integration, automation principles, and the role of sensors and control systems in manufacturing. The curriculum emphasizes theoretical foundations in Industry 4.0, covering topics like IoT integration and smart manufacturing. Through lectures and discussions, students gain insights into the theoretical underpinnings of automation engineering and the application of robotic technologies. The course prepares students for roles involving the design, analysis, and optimization of advanced manufacturing processes.

**Course Pre/co-requisites**

No Pre requisites.

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8333.1 Explain CIM and robotics system, it's classification and design guidelines
- A8333.2 Describe CIM implementation process and system troubleshooting
- A8333.3 Apply suitable sensors to the work cell and summarize the work-cell support system
- A8333.4 Illustrate work-cell controller programming and system integration
- A8333.5 Analyze and justify the capital equipment in work-cell system and case studies of work-cell design

**3. Course Syllabus**

**Introduction to Computer integrated Manufacturing Systems:** Manufacturing Systems, Types of Manufacturing Systems, Machine Tools and related equipment's, Material Handling Systems, Computer monitoring and control, Manufacturing support systems, The Product Cycle and CAD/ CAM. Functions of computers in CIMS: CIMS Data Files, System Reports, Benefits of Computer integrated Manufacturing Systems, NC/ CNC Machine Tools: General architecture of CNC Machine, Components of the CNC Systems: Machine Control Unit, CNC Driving system components: Hydraulic, Servo Motors, Stepper Motors,



Feedback Devices: Encoder, Resolver, Inductors, Tachometers

**Part programming:** Introduction, NC/ CNC programming methods: Introduction, NC/ CNC programming methods: Manual part programming for turning and milling centers, G codes, M codes, canned cycles, Programming with CAD/CAM integration, CAM packages for CNC part program generation, Practical Exercises on CNC part programming. Direct Numerical Control (DNC Systems): Configuration of DNC system, Functions of DNC, Communication between DNC computer & MCU, Advantages of DNC, Adaptive control machining systems. Adaptive control optimization system, adaptive control constraint system, applications to machining processes, Benefits of Adaptive control machining.

**Introduction to Robotics:** Introduction, Classification of Robots, Advantages and Disadvantages of Robots, Application of Robots, Robot characteristics, Degree of freedom, Robot coordinates, Types of Robot arms, Robot workspace, Robot Components, End effectors- Grippers.

**Motion Analysis:** Homogeneous Transformation as applicable to Rotation and Translation, problems. Manipulator Kinematics: Specifications of matrices, D-H notation joint coordinates and world coordinates, Forward and inverse kinematics, Problems.

**Robot Work Cell Design and Control:** Robot Cell Layouts, Multiple Robots and Machine Interface, Some Consideration in Work Cell Design, Interlocks, Error Detection and Recovery, Robot Cycle Time Analysis.

## 4. Books and Materials

### Text Books:

1. Mikell.P.Groover "Automation, Production Systems and Computer Integrated Manufacturing", 3<sup>rd</sup> Edition, Prentice Hall of India.
2. Nicholas Odrey, Mitchell Weiss, Mikell Groover, Roger Nagel, Ashish Dutta, "Industrial Robotics -Technology ,Programming and Applications", 2<sup>nd</sup> Edition, McGraw Hill Education.

### Reference Books:

1. P.Groover, Automation, Production systems and Computer integrated Manufacturing, 3<sup>rd</sup> Edition, Pearson Publications, India,
2. Radhakrishnan, Subramanian, CAD / CAM / CIM, New Age International Pvt. Ltd, New Delhi, India.
3. Saeed B. Niku, Introduction to Robotics, 2<sup>nd</sup> Edition, John Wiley & Sons, USA.
4. M.M.M. Sarcar, K. Mallikarjuna Rao, K. Lalit Narayan, "Computer Aided Design and Manufacturing", PHI pvt ltd, New Delhi



## Course Structure

### A8334 - Instrumentation Laboratory

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

## 1. Course Description

### Course Overview

The Instrumentation and Production Drawing Laboratory provides hands-on training in the fields of instrumentation and technical drawing. Students engage in lab covering sensor calibration, control systems, and production drawing. Emphasis is placed on safety protocols, collaborative work, and the integration of practical skills with theoretical concepts. The lab aims to prepare students for industry standards, fostering proficiency in instrument handling, troubleshooting, and precision drawing techniques. Instructors guide students through applications, aligning the curriculum with the evolving needs of the engineering and production sectors.

### Course Pre/co-requisites

This course has no specific prerequisite and co-requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8334.1 Calibration of Pressure Gauges, temperature, LVDT, capacitive transducer, rotameter
- A8334.2 use of various source of measurement by measuring instruments with precision
- A8334.3 Characterize and calibrate measuring devices
- A8334.4 Identify and analyze errors in measurement
- A8334.5 Analyze measured data using regression analysis.

## 3. List of Experiments

1. Calibration of Pressure Gauges
2. Calibration of transducer for temperature measurement
3. Study and calibration of LVDT transducer for displacement measurement
4. Calibration of strain gauge for temperature measurement
5. Calibration of thermocouple for temperature measurement
6. Calibration of capacitive transducer for angular displacement
7. Study and calibration of photo and magnetic speed pickups for the measurement of speed.
8. Calibration of resistance temperature detector for temperature measurement



9. Study and calibration of a rotameter for flow measurement
10. Study and use of a Seismic pickup for the measurement of vibration amplitude of an engine bed at various loads
11. Study and calibration of McLeod gauge for low pressure.

Note: Minimum ten experiments needs to be conducted.

#### 4. Laboratory Equipment/Software/Tools Required

1. LVDT Transducer
2. Thermo Couple
3. Strain Gauge
4. Magnetic Speed pickups
5. Rotameter
6. Temperature sensors
7. RTD
8. McLeod gauge
9. Capacitive Transducer
10. Accelerometer
11. Dead weight pressure gauge

**Course Structure****A8335 - CIM and Robotics Laboratory**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
0	0	2	0	0	30	1	40	60	100

**1. Course Description****Course Overview**

The CIM and Robotics Laboratory focuses on Computer Integrated Manufacturing and Robotics technologies. Students engage in hands-on experiments to understand automation, robotic systems, and their integration into manufacturing processes. The lab explores concepts like industrial robotics, CNC machining, and programmable logic controllers (PLCs). Through practical applications, students gain insights into modern manufacturing methods and the role of robotics in enhancing efficiency and precision.

**Course Pre/co-requisites**

A8303 - Engineering Workshop

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8335.1 Apply basic maintenance procedures for CNC Lathe machines, including routine checks, lubrication, and minor repairs to ensure optimal machine performance
- A8335.2 Develop the ability to write, edit, and troubleshoot CNC programs using G-code
- A8335.3 Explain the selection and use of cutting tools, as well as the principles of work-holding devices, fixtures, and tool changes in CNC Milling machining.
- A8335.4 Analyze the kinematics of Robot
- A8335.5 Demonstrate the working of Robot Arm

**3. List of Experiments**

1. To write the manual part program to the given dimensions and execute in CNC Lathe for simple Turning Cycle.
2. To write the manual part program to the given dimensions and execute in CNC Lathe for Multiple Turning Cycle.
3. To write the manual part program to the given dimensions and execute in CNC Lathe for Taper Turning Cycle.



4. Write the manual part program to the given dimensions and execute in CNC Lathe for Multiple Grooving Cycle.
5. To write the manual part program to the given dimensions and execute in CNC Milling for Linear Interpolation.
6. To write the manual part program to the given dimensions and execute in CNC Milling for Circular Interpolation.
7. To write the manual part program to the given dimensions and execute in CNC Milling for Circular Pocketing.
8. To write the manual part program to the given dimensions and execute in CNC Milling for Rectangular Pocketing.
9. Pick and Place operation using Robot arm
10. Palletizing operation using Robot programming
11. Kinematic analysis of a robot

Note: Minimum ten experiments needs to be conducted.

#### 4. Laboratory Equipment/Software/Tools Required

1. CNC TRAIN SIMULATION SOFTWARE
2. CNC LATHE
3. CNC MILLING
4. ROBOT ARM

## Professional Electives

**Course Structure****A8351 - Mechatronics**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

Mechatronics is now at the intersection of mechanical engineering, electronic engineering and software engineering. This course will cover technologies involved in developing intelligent electro-mechanical systems, and techniques used to apply this technology to mechatronic system design. Course includes a lab component with a large, open-ended team project.

**Course Pre/co-requisites**

“The course has no specific prerequisite and co-requisites”

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8351.1 Identify the key elements of mechatronics system and its representation in terms of block diagram
- A8351.2 Interfacing of Sensors, Actuators using appropriate DAQ micro-controller
- A8351.3 Understanding the concept of signal processing and use of interfacing systems such as ADC, DAC, digital I/O
- A8351.4 Development of PLC programming and implementation of real life system.
- A8351.5 Apply PID control implementation on real time systems.

**3. Course Syllabus****INTRODUCTION:**

Definition, Trends, Control Methods: Standalone, PC Based (Real Time Operating Systems, Graphical User Interface, and Simulation) - Applications: SPM, Robot, CNC, FMS, CIM. PRECISION MECHANICAL SYSTEMS : Pneumatic Actuation Systems , Electro-pneumatic Actuation Systems , Hydraulic Actuation Systems , Electro-hydraulic Actuation Systems - Timing Belts , Ball Screw and Nut , Linear Motion Guides , Linear Bearings , Harmonic Transmission , Bearings- Motor / Drive Selection.

**SIGNAL CONDITIONING :**

Introduction , Hardware ,Digital I/O , Analog input , ADC , resolution , sped Channels Filtering Noise using passive components , Resistors, capacitors - Amplifying signals using



OP amps , Software , Digital Signal Processing , Low pass , high pass , notch filtering

**ELECTRONIC INTERFACE SUBSYSTEMS** : TTL, CMOS interfacing - Sensor interfacing , Actuator interfacing , solenoids ,motors Isoation schemes- opto coupling, buffer IC's - Protection schemes , circuit breakers , over current sensing , resettable fuses , thermal dissipation , Power Supply - Bipolar transistors / mosfets **ELECTROMECHANICAL DRIVES** : Relays and Solenoids , Stepper Motors - DC brushed motors , DC brushless motors, DC servo motors , 4-quadrant servo drives , PWM's , Pulse Width Modulation , Variable Frequency Drives, Vector Drives , Drive System load calculation.

### **MICROCONTROLLERS OVERVIEW:**

8051 Microcontroller , micro processor structure , Digital Interfacing - Analog Interfacing - Digital to Analog Convertors , Analog to Digital Convertors , Applications. Programming, Assembly, C (LED Blinking, Voltage measurement using ADC). **PROGRAMMABLE LOGIC CONTROLLERS** : Basic Structure , Programming : Ladder diagram , Timers, Internal Relays and Counters , Shift Registers ,Master and Jump Controls , Data Handling , Analog input / output - PLC Selection ,Application.

**PROGRAMMABLE MOTION CONTROLLERS** : Introduction, Feedback Devices , Position , Velocity Sensors , Optical Incremental encoders , Proximity Sensors , Inductive , Capacitive , Infrared , Continuous and discrete processes ,Control System Performance and tuning , Digital Controllers , P , PI , PID Control.

## **4. Books and Materials**

### **Text Books:**

1. W. Bolton, Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering, 4<sup>th</sup> Edition, Pearson Education, New Delhi, India.
2. N. Shanmugam, Mechatronics, 2<sup>nd</sup> Edition, Anuradha Agencies Publishers, Chennai, India.

### **Reference Books:**

1. Bradley, Mechatronics, 4<sup>th</sup> Edition,prentice Hall of India, New Delhi, India,2010.
2. HMT. Ltd, Mechatronics, 1<sup>st</sup> Edition, Tata Mc Graw Hill Publishing Company Ltd., New Delhi, India.
3. M. D. Singh, J. G. Joshi, Mechatronics, 1<sup>st</sup> Edition, Prentice Hall of India Pvt Ltd., New Delhi, India.

**Course Structure****A8352 - Operations Research**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

This course builds foundation of basic concepts of operations research and at the same time provides an indication of the relevance and importance of the theory in solving practical problems in different fields. The mathematical modeling skills sustained from this course acquaint the students with the knowledge of various tools and techniques which helps in optimal utilization of the scarce resources of an organization

**Course Pre/co-requisites**

A8001: Matrices and Calculus

A8003: Probability Distributions and Statistics

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8352.1 Illustrate operations research features, models, methods, applications, advantages and limitations
- A8352.2 Build mathematical models to obtain optimum solution for various real world problems
- A8352.3 Develop operational policies for efficient management of personnel, materials, machines, production, distribution, and service systems, optimizing service rate and server count to minimize queuing and service
- A8352.4 Evaluate various alternatives available to aid in decision making situations
- A8352.5 Choose the best strategies to maximize the profit thereby minimizing losses in the presence of a competitor.

**3. Course Syllabus**

**Introduction to Operation Research:** Basic definition, scope, objectives, phases, models and limitations of Operations Research. Linear Programming Problem, Formulation and Graphical solution of Linear Programming Problem, Simplex Method, Artificial variables Techniques, Big -M method.

**Transportation Problem:** Formulation, Solution, Unbalanced Transportation problem. Finding basic feasible solutions, North-West corner rule, Least cost method and Vogel's



approximation method, Optimality test – MODI method. ASSIGNMENT MODEL: Formulation, Hungarian method for optimal solution, solving unbalanced problem.

**Sequencing Models:** Solution of Sequencing Problem, Processing  $n$  Jobs through two machines, Processing  $n$  Jobs through three machines, Processing two Jobs through  $m$  machines, Processing  $n$  Jobs through  $m$  Machines. QUEUING THEORY: Introduction, Single Channel, Poisson arrivals, exponential service times with infinite population and finite population models

### Replacement and Inventory Models:

Replacement Models: Replacement of Items that Deteriorate whose maintenance costs increase with time without change in the money value, Replacement of items that fail suddenly, individual replacement policy, group replacement policy. Inventory Models: Inventory costs, Models with deterministic demand model: (a) Demand rate uniform and production rate infinite, (b) Demand rate non-uniform and production rate infinite.

**Game Theory:** Competitive game, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle, Rectangular games without saddle point, mixed strategy for  $2 \times 2$  games

## 4. Books and Materials

### Text Books:

1. J K. Sharma , Operations Research – Theory and Applications, 6<sup>th</sup> Edition, Trinity Press Ltd New Delhi, India.
2. Frederick S Hillier; Gerald J Lieberman, Introduction to Operations Research, 10<sup>th</sup> Edition, McGraw- Hill , New York.

### Reference Books:

1. Hamdy Abdelaziz Taha , Operations Research: an Introduction, 9<sup>th</sup> Edition, Pearson, Boston.
2. Prem Kumar Gupta and D S Hira, Operations Research, Revised edition, S. Chand Publishing, New Delhi, India.
3. P ShankaraIyer, Operations Research, 1<sup>st</sup> Edition, Tata McGraw Hill, Publishing Company, NewDelhi, India.



## Course Structure

### A8353 - Automation in Manufacturing

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

This course introduces students to the basic concept of Automation, types and it is capable of greatly improving the efficiency of manufacturing operations at the same time it reduced costs. It also allows one single facility to produce a variety of products and boost output (a machine capable of packing a large number of units per minute or hour can improve a company's bottom line. It also refers to putting new products into high volume production while ensuring that the parts are designed for the available manufacturing process

### Course Pre/co-requisites

A8315 - Production Technology

A8320 - Metrology and Machine Tools

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

A8353.1 Illustrate the basic concepts of automation in machine tools

A8353.2 Analyze various automated flow lines, Explain assembly systems and line balancing methods.

A8353.3 Describe the importance of automated material handling and storage systems.

A8353.4 Interpret the importance of adaptive control systems, automated inspection systems.

A8353.5 Apply the concepts of image processing applications of machine vision.

## 3. Course Syllabus

### Introduction:

Introduction to Automation, Single-Station Manufacturing Cells, types and strategies of automation, Automation in machine tools, automation principles, Mechanical feeding and tool changing, machine tool control, elements in product realization. Automated Flow Lines: Methods of work part transfer, transfer mechanisms, buffer storage, control function, Design and fabrication consideration. Analysis of automated Flow Lines, General terminology, analysis of transfer lines with and without buffer storage, partial automation, implementation of automated flow lines.



## **Assembly Systems And Line Balancing:**

Assembly process, Manual Assembly Lines, Line balancing methods, ways for improving line balance, flexible assembly lines. Automated Material Handling: Types of equipment, functions, analysis and design of material handling systems, conveyor systems, automated guided vehicle systems.

## **Automated Storage Systems:**

Automated storage and retrieval systems, work in process storage, interfacing handling and storage with manufacturing.

## **Adaptive Control Systems:**

Introduction – Adaptive control with optimization, Adaptive control with constraints, Application of Adaptive control in machining operations. Uses of various parameters such as cutting force, Temperature, vibration and acoustic emission, Adaptive control.

## **Automated Inspection:**

Fundamentals, types of inspection methods and equipment, CMM, Types, methods of CMM control, Machine vision- Introduction, image acquisition and image processing, applications of machine vision.

## **4. Books and Materials**

### **Text Books:**

1. M. P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, 3<sup>rd</sup> Edition, Prentice Hall of India, New Delhi, India.
2. P. N. Rao, CAD/CAM Principles and applications, 3<sup>rd</sup> Edition, Tata McGraw- Hill Publishing Company Ltd., New Delhi, India.

### **Reference Books:**

1. Yoram Coreom, Computer control of Manufacturing Systems, 2<sup>rd</sup> Edition, Prentice Hall of India, New Delhi, India.
2. Buekinsham, Automation, 3<sup>rd</sup> Edition, Prentice Hall of India, New Delhi, India.



## Course Structure

### A8354 - Additive Manufacturing

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

Additive manufacturing broadly known 3D printing, is transforming how products are designed, produced, and serviced. Additive manufacturing enables on-demand production without dedicated equipment or tooling, unlocks digital design tools, and offers breakthrough performance and unparalleled flexibility across industries.

### Course Pre/co-requisites

A8315 - Production Technology

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

A8354.1 Illustrate the fundamental Concepts of additive manufacturing process.

A8354.2 Classify the various process used in additive manufacturing.

A8354.3 Analyze and select suitable process and materials used in additive manufacturing

A8354.4 Identify, analyze and solve problems related to additive manufacturing.

A8354.5 Apply knowledge of additive manufacturing for various real-life applications.

## 3. Course Syllabus

**Introduction to additive manufacturing:** Fundamentals of additive manufacturing, Need for 3d printing Generic 3d printing process, Distinction between additive manufacturing and CNC, Classification of additive manufacturing Processes, Steps in additive manufacturing process, Advantages of additive manufacturing, standards on additive manufacturing, Major Applications. Vat Photo polymerization 3D printing Processes: Stereo lithography (SL), Materials, SL resin curing process, Process Benefits and Drawbacks, Applications of Photo polymerization Processes, Two-Photon Vat Photopolymerization.

**Material Jetting Additive Manufacturing Processes:** Material Jetting additive manufacturing Processes: Evolution of Printing as an additive manufacturing Process, Materials, Process Benefits and Drawbacks, Applications of Material Jetting Processes. Binder Jetting additive manufacturing Processes: Materials, Process Benefits and Drawbacks, Research



achievements in printing deposition, Technical challenges in printing, Applications of Binder Jetting Processes.

**Extrusion-Based additive manufacturing Processes:** Fused Deposition Modelling (FDM), Principles, Materials, Plotting and path control, Bio-Extrusion, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes Powder Bed Fusion additive manufacturing Processes: Selective laser Sintering (SLS), Materials, Powder fusion mechanism, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes. Directed Energy Deposition additive manufacturing Processes: Process Description, Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Electron Beam Based Metal Deposition, Benefits and drawbacks, Applications of Directed Energy Deposition Processes. Wire arc based additive manufacturing methods, Advantages and disadvantages, comparison with conventional 3D printing and WAAM.

**Post Processing of additive manufacturing Parts:** Support Material Removal, Surface Texture Improvement, Accuracy Improvement, Aesthetic Improvement, Preparation for use as a Pattern, Property Enhancements using Non-thermal and Thermal Techniques. Inspection of 3D printing parts: Different destructive and non-Destructive testing of 3D printing parts, acceptance standards for 3D printing parts.

**Additive manufacturing Applications:** Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Re-manufacturing. Application examples for Aerospace, defense, automobile, Bio-medical and general engineering industries.

## 4. Books and Materials

### Text Books:

1. Ian Gibson, David W Rosen, Brent Stucker, "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", 2<sup>nd</sup> Edition, Springer.

### Reference Books:

1. Ali K. Kam rani, EmandAbouel Nasr, "Rapid Prototyping: Theory and Practice", Springer.
2. D.T. Pham, S.S. Dimov, "Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling", Springer.
3. Rafiq Noorani, "Rapid Prototyping: Principles and Applications in Manufacturing", John Wiley and Sons.

**Course Structure****A8355 - Automobile Engineering**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

Automobile engineering is a course that intends to provide knowledge and information about an automobile and its parts functioning in an engineering approach for both conventional and electrical vehicles. It also provides the technical details of all the components of an automobile in detail. By selecting a type of an automobile component, it also helps to understand its working principle and how they are interconnected. It also facilitates, analyzing the system's connectivity to enable the vehicle into motion. It also enhances the insight of the e-vehicles, which demands the future generation transport system

**Course Pre/co-requisites**

A8308 - Thermodynamics

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8355.1 Distinguish various subsystems and components of automobile and electric vehicle.
- A8355.2 Analyze the engine ignition and transmission system of automobile
- A8355.3 Categorize energy storage devices and cooling system components of automobile.
- A8355.4 Classify braking systems and steering mechanisms used in automobile
- A8355.5 Identify the influence of suspension system used in automobile.

**3. Course Syllabus**

**Introduction** Introduction to conventional, electrical automobiles and its components, types of auto- mobile drive modes and its operation. Supercharging and Turbo charging. Energy Storage and Electric Power Systems: Battery based, fuel cell, super capacitor, fly wheel based energy storage and its analysis. Concepts of hybrid energy.

**Fuel Supply System:**

Spark ignition fuel system, fuel Pumps, fuel filters, types of carburetors, multi point fuel injection (MPFI). Diesel injection fuel system, types of injection systems, fuel pump, types



of nozzles, spray formation, multi point fuel injection (MPFI)

**Cooling and Ignition System:** Cooling System: Cooling medium requirements, methods used for circulating cooling medium around the engine cylinder, Components of water cooling systems, Types of Radiators, Anti freeze solutions

Ignition System: Introduction to charging system and its components, battery ignition system, magneto coil ignition system, electronic ignition system.

**Transmission System and Braking System:** Transmission System: Introduction to the transmission system, types of clutches, types of gearbox for transmission, Propeller shaft, Hotchkiss drive, torque tube drive, universal joints, final drive and differential, rear axle

Braking System: Brakes and its components, Classification of brakes, types of cylinders and its applications, Introduction to electric brakes.

**Steering System and Suspension System:** Steering System: Steering geometry, types of steering mechanisms, types of steering gears

Suspension systems introduction, types of suspension springs, types of shock absorbers, Rigid axle suspension system, torsion bar, Independent suspension system

## 4. Books and Materials

### Text Books:

1. Kirpal Singh, Automobile Engineering - Vol. 1 & 2, 14<sup>th</sup> Edition, standard publishers, New Delhi India.
2. RN Bahl, Automobile Engineering , 1<sup>st</sup> Edition, Dream tech press distributed by wiley, New Delhi.

### Reference Books:

1. Barry Hollembeak, Automotive Electrical and Electronics, 7<sup>th</sup> Edition, Cengage Publishers, Boston, USA.
2. S.K.Gupta , Automobile Engineering, 2<sup>nd</sup> Edition, S. Chand Publishing, New Delhi.
3. K.K. Jain, Automobile Engineering, 3<sup>rd</sup> Edition, McGraw Hill Publications, Noida

**Course Structure****A8356 - Turbomachinery**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

The objective of the course is to provide a framework to discuss different kinds of turbomachinery through a unified approach. The material presented is intended for undergraduate and graduate students apart from professional engineers in the industry engaged in the analysis and development of turbomachinery. Coverage begins with the fundamental concepts, the equations of motion in a rotating system, and the Euler equation for turbomachinery. This is followed by the gas turbine cycle, similarity rules, and cascade flow analysis. The reader is then focused on flows through compressors and turbines, including a brief discussion on the secondary flow, tip clearance, blade cooling, surge, and stall. The course will be concluded with a discussion on CFD in the design and analysis of turbomachinery.

**Course Pre/co-requisites**

A8308 - Thermodynamics

A8326 - Heat Transfer

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8356.1 Ability to design and calculate different parameters for turbo machines
- A8356.2 Prerequisite to CFD and Industrial fluid power courses
- A8356.3 Ability to formulate design criteria
- A8356.4 Ability to understand thermodynamics and kinematics behind turbo machines
- A8356.5 Ability to understand and analyse axial flow gas turbines.

**3. Course Syllabus**

**Introduction to Turbomachinery:** Classification of turbo-machines, second law of thermodynamics applied to turbine and compressors work, nozzle, diffuser work, fluid equation, continuity, Euler's, Bernoulli's, equation and its applications, expansion and compression process, reheat factor, preheat factor

**Fundamental Concepts of Axial and Radial Machines:** Euler's equation of energy transfer, vane congruent flow, influence of relative circulation, thickness of vanes, number



of vanes on velocity triangles, slip factor, Stodola, Stanitz and Balje's slip factor, suction pressure and net positive suction head, phenomena of cavitation in pumps, concept of specific speed, shape number, axial, radial and mixed flow machines, similarity laws.

**Gas Dynamics:** Fundamental thermodynamic concepts, isentropic conditions, mach numbers, and area, Velocity relations, Dynamic Pressure, Normal shock relation for perfect gas. Supersonic flow, oblique shock waves. Normal shock recoveries, detached shocks, Aerofoil theory. Centrifugal compressor: Types, Velocity triangles and efficiencies, Blade passage design, Diffuser and pressure recovery. Slip factor, Stanitz and Stodolas formula's, Effect of inlet mach numbers, Pre whirl, Performance

**Axial Flow Compressors:** Flow Analysis, Work, and velocity triangles, Efficiencies, Thermodynamic analysis. Stage pressure rise, Degree of reaction, Stage Loading, General design, Effect of velocity, Incidence, Performance Cascade Analysis: Geometrical and terminology. Blade force, Efficiencies, Losses, Free end force, Vortex Blades.

**Axial Flow Gas Turbines:** Work done. Velocity triangle and efficiencies, Thermodynamic flow analysis, Degree of reaction, Zweifel's relation, Design cascade analysis, Soderberg, Hawthorne, Ainley, Correlations, Secondary flow, Free vortex blade, Blade angles for variable degree of reaction. Actuator disc, Theory, Stress in blades, Blade assembling, Material and cooling of blades, Performances, Matching of compressors and turbines, off design performance.

## 4. Books and Materials

### Text Books:

1. Dennis G. Shepherd, "Principles of Turbomachinery", Collier Macmillan Ltd.
2. S. M. Yahya, Turbines, Compressors and Fans , 4<sup>th</sup> Edition, McGraw Hill Education, New Delhi, India.

### Reference Books:

1. Ganesh C. Gopalakrishnan, A Treatise on Turbomachines, Scitech Publications (India) Pvt Ltd.
2. H Cohen, GFC Rogers, Paul Straznicky, HIH Saravanamuttoo, Andrew Nix , "Gas Turbine Theory", 7<sup>th</sup> Edition, Pearson Publishing, New Delhi.
3. A Valan Arasu, Turbo Machines, 32<sup>nd</sup> Edition, Vikas Publishing, India.



## Course Structure

### A8357 - Refrigeration and Air Conditioning

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

This course consists of basic concepts and applications of refrigeration and air-conditioning. It includes air refrigeration systems, vapour compression refrigeration system, vapour absorption system, steam jet refrigeration system, thermoelectric refrigeration, vortex tube refrigeration, components of various refrigeration systems, comparison among various refrigeration systems, types of refrigerants. Air-Conditioning focuses on its basic concepts and types of air conditioning systems, and various components.

### Course Pre/co-requisites

A8308 - Thermodynamics

A8314 - Fluid Mechanics and Hydraulic Machines

A8313 - Thermal Engineering-I

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8357.1 Identify the necessity and applications of air refrigeration system
- A8357.2 Evaluate the performance of refrigeration systems using refrigeration tables and charts
- A8357.3 Choose the refrigerants and refrigeration equipment based on refrigeration type
- A8357.4 Compare various psychrometric properties and processes by using psychrometric chart
- A8357.5 Classify air-conditioning types based on human comfort and industrial requirements.

## 3. Course Syllabus

**Introduction to Refrigeration:** Necessity and applications – unit of refrigeration and C.O.P. – Mechanical refrigeration – types of ideal cycles of refrigeration. air refrigeration: bell coleman cycle – open and dense air systems – refrigeration systems used in air crafts and problems.



**Vapour Compression Refrigeration:** Working principle and essential components of the plant – simple vapour compression refrigeration cycle – COP – representation of cycle on T-S and p-h charts – effect of sub cooling and super heating – cycle analysis – actual cycle influence of various parameters on system performance – use of p-h charts – numerical problems.

**VCR System Components and Refrigerants:** VCR System Components: Compressors – general classification – comparison – advantages and disadvantages. condensers – classification – working principles evaporators – classification – working principles expansion devices – types – working principles

Refrigerants – Desirable properties – classification – refrigerants used – nomenclature – ozone depletion – global warming

**Vapor Absorption System** Vapor Absorption System: Calculation of maximum COP – description and working of NH<sub>3</sub> – water system and Li Br –water ( Two shell & Four shell) System, principle of operation three fluid absorption system, salient features.

Steam Jet Refrigeration System: Working Principle and basic components. principle and operation of (i) thermoelectric refrigerator (ii) vortex tube.

**Introduction to Air Conditioning:** Psychometric properties & processes – characterization of sensible and latent heat loads — need for ventilation, consideration of infiltration – load concepts of RSHF, GSHP- problems, concept of ESHF and ADP temperature. Requirements of human comfort and concept of effective temperature- comfort chart –comfort air conditioning – requirements of industrial air conditioning, air conditioning load calculations.

## 4. Books and Materials

### Text Books:

1. A Course in Refrigeration and Air conditioning / S C Arora & Domkundwar / Dhanpatrai
2. Refrigeration and Air Conditioning / C P Arora / TMH.

### Reference Books:

1. Refrigeration and Air Conditioning / Manohar Prasad / New Age.
2. Principles of Refrigeration /Dossat / Pearson Education.
3. Basic Refrigeration and Air-Conditioning / Ananthanarayanan / TMH

**Course Structure****A8358 - Fluid Power Systems**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

This course discuss the introduction to fluid power generation, transmission and control aspects. Pipes, compressors, pumps, motors and control valves will be analyzed in detail. Hydraulic Circuit Components and circuit design will be discussed.

**Course Pre/co-requisites**

A8314 - Fluid Mechanics and Hydraulic Machines

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8358.1 Identify the functional requirements of a fluid power transmission system
- A8358.2 Classify Pumps, Accumulators and Actuators for fluid power transmission applications
- A8358.3 Select the applicable control valve in the power transmission hydraulic circuit
- A8358.4 Organize hydraulic circuits with single or double acting hydraulic cylinders
- A8358.5 Compare Pneumatic power systems based on advantages, limitations and applications.

**3. Course Syllabus****Introduction to fluid power systems:**

Fluid power system: components, advantages and applications. Transmission of power at static and dynamic states. Pascal's law and its applications. Fluids for hydraulic system: types, properties, and selection. Additives, effect of temperature and pressure on hydraulic fluid. Seals, sealing materials, compatibility of seal with fluids. Types of pipes, hoses, and quick acting couplings. Pressure drop in hoses/pipes. Fluid conditioning through filters, strainers; sources of contamination and contamination control;

**Pumps, Accumulators and Actuators:**

Classification of pumps, Pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps,



Pump performance characteristics, pump selection factors, problems on pumps. Accumulators: Types, selection/ design procedure, applications of accumulators. Types of Intensifiers, Pressure switches /sensor, Temperature switches/sensor, Level sensor. Actuators: Classification cylinder and hydraulic motors, Hydraulic cylinders, single and double acting cylinder, mounting arrangements, cushioning, special types of cylinders, problems on cylinders. Construction and working of rotary actuators such as gear, vane, piston motors, and Hydraulic Motor. Theoretical torque, power, flow rate, and hydraulic motor performance; numerical problems. Symbolic representation of hydraulic actuators (cylinders and motors).

**Hydraulic Circuit Components:** Classification of control valves, Directional Control Valves-symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, and check valves. Pressure control valves - types, direct operated types and pilot operated types. Flow Control Valves -compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation.

**Hydraulic Circuit Design:** Control of single and Double -acting hydraulic cylinder, regenerative circuit, pump unloading circuit, double pump hydraulic system, counter balance valve application, hydraulic cylinder sequencing circuits, cylinder synchronizing circuit using different methods, hydraulic circuit for force multiplication; speed control of hydraulic cylinder- metering in, metering out and bleed off circuits. Pilot pressure operated circuits. Hydraulic circuit examples with accumulator.

**Introduction to Pneumatic systems:** Pneumatic power system, advantages, limitations, applications, Choice of working medium. Characteristics of compressed air and air compressors. Structure of pneumatic control System, fluid conditioners-dryers and FRL unit. Pneumatic Actuators: Linear cylinder –types of cylinders, working, end position cushioning, seals, mounting arrangements, and applications. Rotary cylinders- types, construction and application, symbols.

## 4. Books and Materials

### Text Books:

1. Anthony Esposito, “Fluid Power with applications”, 7<sup>th</sup> Edition, Pearson.
2. Majumdar S.R., “Pneumatic systems - Principles and Maintenance”, 2<sup>nd</sup> Edition, Tata McGraw-Hill, New Delhi.

### Reference Books:

1. John Pippenger, Tyler Hicks, “Industrial Hydraulics”, 1<sup>st</sup> Edition, McGraw Hill Interna-



tional Edition.

2. Andrew Par, Hydraulics and pneumatics, 2<sup>nd</sup> Edition Jaico Publishing House.
3. John Watton, "Fundamentals of Fluid Power Control" 1<sup>st</sup> Edition, Cambridge University Press.

**Course Structure****A8359 - Mechanical Vibrations**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

The objective of this course is to make students to gain basic knowledge and overview of Vibration and noise of the systems. The knowledge of Mechanical vibrations enables them to design, analysis various mechanical systems. Vibration response of the systems can be evaluated by applying numerical methods to various physical systems.

**Course Pre/co-requisites**

A8002 - Ordinary Differential Equations and Vector Calculus

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8359.1 Illustrate the basic concepts of mechanical vibrations of damped and un-damped system
- A8359.2 Determine the vibratory responses of TDOF and MDOF system to harmonic, periodic and nonperiodic excitation.
- A8359.3 Formulate mathematical models and develop the equations of motion for vibrating systems by different principles.
- A8359.4 Analyze vibrations in structures, machines, vehicles by using numerical methods.
- A8359.5 Analyze the control systems.

**3. Course Syllabus****Single Degree of Freedom:**

Simple harmonic motion, degrees of freedom. Free vibrations and forced vibrations- examples of single degree of freedom mechanical vibrations, equation of motion. Undamped and damped free vibrations, forced vibrations coulomb damping, Response to excitation, rotating unbalance and support excitation; vibration isolation and transmissibility.



### **Two Degree of Freedom:**

Principal coordinates, derivations of equation of motion, coordinate coupling, lagrange's equation.

### **Multi Degree of Freedom:**

Derivation of equation of motion, influence coefficients methods, properties of vibrating systems: flexibility and stiffness matrices, reciprocating theorem, Eigen value problem; normal modes and their properties, Free and forced vibration by Modal analysis, Method of matrix inversion, Torsional vibrations of multi- rotor systems and geared systems.

### **Numerical Methods:**

Rayleigh's Method, Stodola's Method, Matrix iteration Method, Dunkerlys Method and Holzer's methods. Vibration Measuring Instruments: Vibrometers, velocity meters and accelero meters.

### **Continuous Systems:**

Vibration of strings – longitudinal and torsional vibrations of rods- transverse vibrations of beams- torsional vibrations of shafts.

## **4. Books and Materials**

### **Text Books:**

1. G. K. Grove, Mechanical Vibrations, 8<sup>th</sup> Edition, Nem Chand and Bros, Roorkee, India.
2. Singh V.P., Mechanical Vibrations, 3<sup>rd</sup> Edition, Dhapat Rai and Co, India.
3. Ambekar A.G., Mechanical Vibrations And Noise Engineering, PHI, India.

### **Reference Books:**

1. S S. Rao, Mechanical Vibrations, 4<sup>th</sup> Edition, Pearson Publications.
2. Meirovitch, Elements of Vibration Analysis, 2<sup>nd</sup> Edition (SIE), Tata McGraw Hill, New Delhi, India.
3. Stephen Timoshenko, Vibration problems in Engineering, 2<sup>nd</sup> Edition, Oxford City Press, New York, USA.

**Course Structure****A8360 - Composite Materials**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

Course Overview Composite materials are materials comprising two or more material phases with different physical properties. Because they usually exhibit remarkable physical properties, in general superior to the properties of their individual components, they appear pervasively in engineering applications (e.g., reinforced concrete in construction, fiber-reinforced materials for aircraft structures, reinforced rubber in car tires, . . . ). Despite being comprised multiple material phases with different physical properties, these materials may be considered for practical purposes as homogeneous materials with physical material-like effective properties. The course will focus primarily on the elastic properties of a wide range of composites (laminated materials, particulate/fiber-reinforced composites, multidirectional laminates) and will cover a number of engineering methods for the computation of the effective properties of these materials based on the properties and spatial arrangement (volume fraction, shape, orientation, . . . ) of their underlying constituents.

**Course Pre/co-requisites**

A8002 - Ordinary Differential Equations and Vector Calculus

A8307 - Mechanics of Solids

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8360.1 Identify with the specifics of mechanical behavior of layered composites compared to isotropic materials
- A8360.2 Apply constitutive equations of composite materials and understand mechanical behavior at micro, macro and meso level
- A8360.3 Determine stresses and strains in composites
- A8360.4 Analyze failure criteria and critically evaluate the results
- A8360.5 Recognizes the mechanical behavior of composites due to variation in temperature and moisture.



### 3. Course Syllabus

**Basic Concepts and Characteristics:** Geometric and Physical definitions, natural and man-made composites, Aerospace and structural applications, types and classification of composites. Reinforcements: Fibres – Glass, Silica, Kevlar, carbon, boron, silicon carbide, and boron carbide fibres. Particulate composites, Polymer composites, Thermoplastics, Thermosets, Metal matrix and ceramic composites.

**Micro mechanics:** Unidirectional composites, constituent materials and properties, elastic properties of a lamina, properties of typical composite materials, laminate characteristics and configurations. Characterization of composite properties. Manufacturing methods: Autoclave, tape production, moulding methods, filament winding, man layup, pultrusion, RTM.

**Coordinate Transformation:** Hooke's law for different types of materials, Hooke's law for two dimensional unidirectional lamina, Transformation of stress and strain, Numerical examples of stress strain transformation, Graphic interpretation of stress – strain relations. Off – axis, stiffness modulus, off – axis compliance. Elastic behavior of unidirectional composites: Elastic constants of lamina, relationship between engineering constants and reduced stiffness and compliances, analysis of laminated composites, constitutive relations.

**Strength of Unidirectional Lamina:**

Micro mechanics of failure, Failure mechanisms, strength of an orthotropic lamina, strength of a lamina under tension and shear maximum stress and strain criteria, application to design. The failure envelope, first ply failure, free-edge effects. Micro mechanical predictions of elastic constants.

**Analysis of Laminated Composite Plates:** Analysis of Laminated Composite Plates: Introduction thin plate theory, specially orthotropic plate, cross and angle ply laminated plates, problems using thin plate theory.

### 4. Books and Materials

**Text Books:**

1. R. M. Jones, Mechanics of Composite Materials, 2<sup>nd</sup> Edition, Mc Graw Hill Company, New York.
2. Isaac and M Daniel, Engineering Mechanics of Composite Materials, 2<sup>nd</sup> Edition, Oxford University Press.

**Reference Books:**

1. B. D. Agarwal and L. J. Broutman, Analysis and performance of fibre Composites, 2<sup>nd</sup>



Edition, Wiley-Interscience, New York.

2. Autar K. Kaw, Mechanics of Composite Materials, 2<sup>nd</sup> Edition, Publisher: CRC.
3. L. R. Calcote, Analysis of Laminated Composite Structures, 1<sup>st</sup> Edition, Van Nostrand Reinhold, New York.

**Course Structure****A8361 - Engineering Tribology**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

Tribology is the science and technology of interacting surfaces in relative motion. This includes study of friction, lubrication, contact mechanics, surface damage processes and surface optimization. It is highly multidisciplinary and spans many applications including physics, chemistry, materials science, biology and engineering.

**Course Pre/co-requisites**

A8008 - Engineering Chemistry

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8361.1 Illustrate the basic concepts of friction, wear and lubrication.
- A8361.2 Discuss the different type of lubricants, selection of lubricants and their properties.
- A8361.3 Apply the basic theories of friction, wear and lubrication to predict the frictional behavior of commonly encountered sliding interfaces.
- A8361.4 Solve the Tribo-logical problems by using laws of friction, wear and lubrication.
- A8361.5 Analyze the behavior of tribological components subjected to different working conditions.

**3. Course Syllabus****Friction and Wear:**

Friction: Introduction, Laws of friction, kinds of friction, causes of friction, friction measurement, theory of friction. Wear: Wear, types of wear, theories of wear, wear measurement, wear prevention.

**Lubrication and Lubricants** Introduction, Types of lubricants and their industrial uses; SAE classification, Objectives and selection of lubricant, Physical properties of lubricants.



properties of liquid and grease lubricants; lubricant additives.

**Boundary lubrication:** Boundary lubrication; classic hydrodynamics, hydrostatic and elasto hydrodynamic lubrication.

**Hydrodynamic Theory of Lubrication:** Various theories of lubrication, Petroffs equation, Reynold's equation in two dimensions. Effects of side leakage - Reynolds equation in three dimensions, Friction in sliding bearing, hydro dynamic theory applied to journal bearing, minimum oil film thickness, oil whip and whirl antifricition bearing.

**Hydrostatic Lubrication:** Hydrostatic step bearing, application to pivoted pad thrust bearing and other applications, hydrostatic lifts, hydrostatic squeeze films and its application to journal bearing. Bearing Materials: Commonly used bearings materials, and properties of typical bearing materials. Advantages and disadvantages of bearing materials.

## 4. Books and Materials

### Text Books:

1. Prasanta Sahoo, Engineering Tribology, 3<sup>rd</sup> Edition, PHI Learning Private Ltd, New Delhi.
2. J. A. Williams , "Engineering Tribology", 1<sup>st</sup> Edition, Oxford Univ. Press.

### Reference Books:

1. B. J. Hamrock, Fundamentals of Fluid Film Lubrication, 1<sup>st</sup> Edition, McGraw Hill International, india.
2. B. Bhushan, Introduction to Tribology, 1<sup>st</sup> Edition, John Wiley and Sons, Inc., New York.
3. B. C. Majumdar, A. H. Wheeler, "Introduction to Tribology of Bearings", Wheeler publishing.

**Course Structure****A8362 - Advanced Mechanics of Solids**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

This course covers the analysis of stress, strain and material properties, problems in elasticity, failure criteria, bending of beams, torsion of prismatic bars, explanation to solving mechanical problems, by presenting the theory of stress and strain. These basics will be used to derive generalized elastic constitutive relations in materials with anisotropic and time dependent.

**Course Pre/co-requisites**

A8307 - Mechanics of Solids

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8362.1 Determine the position of the shear centre for axis-symmetric and Unsymmetrical sections
- A8362.2 Analyze the bending stresses in a beam subjected to unsymmetrical bending
- A8362.3 Examine the torsion problems with linear elastic solution of non-circular cross section and explain with different analogies
- A8362.4 Evaluate the beam on elastic foundation at different loading conditions
- A8362.5 Analyze the influences of contact stress induced in structures.

**3. Course Syllabus**

**Shear Center:** Bending Axis and Shear Center- Shear Center for Axis-Symmetric and Unsymmetrical Sections. Unsymmetrical Bending: Bending Stresses in Beams Subjected to unsymmetrical Bending; Deflection of Straight Beams due to unsymmetrical Bending.

**Curved Beam Theory:** Winkler Bach Formula for Circumferential Stress, Limitations, Correction Factors, Radial Stress in Curved Beams, Closed Ring Subjected to Concentrated and Uniform Loads Stresses in Chain Links. Torsion: Linear Elastic Solution; Prandtl Elastic Membrane (Soap-Film) Analogy; Narrow Rectangular Cross-section ; Hollow Thin wall



Torsion Members, Multiply connected Cross Section.

**Beams on Elastic Foundation:** General theory - Infinite Beam Subjected to Concentrated Load: Boundary conditions - Infinite Beam Subjected to a Distributed Load Segment - Semi-infinite Beam Subjected to loads of its End - Semi-infinite Beam with Concentrated load near its End - Short Beams.

**Contact Stresses:** Introduction; Problem of Determining contact stresses; Assumptions on which a solution for contact stresses is based; Expressions for principal stresses; Method of computing contact stresses; Deflection of bodies in point contact; Stresses for two bodies in contact over narrow rectangular area (Line contact), Loads normal to area; Stresses for two bodies in line contact, Normal and Tangent to contact area.

**Theory of Elasticity:** Analysis of stress, analysis of strain, Elasticity Problems in two dimensions and three dimensions, Mohr's circle for three dimensional stresses. Stress tensor, Airy's stress function in rectangular and polar coordinate. performance.

## 4. Books and Materials

### Text Books:

1. Arthur P. Boresi, Richard J. Schmidt, "Advanced Mechanics of Materials" ,6<sup>th</sup> Edition, Wiley, India Ltd, New Delhi, India.
2. Stephan Timoshenko, J. N. Goodier , "Theory of elasticity", 3<sup>rd</sup> Edition, Tata McGraw Hill Education Private Limited, New Delhi, India.

### Reference Books:

1. Jacob Pieter Den Hartog, Advanced strength of materials, New Edition, Dover Publications, New York.
2. Stephan Timoshenko, Theory of Plates & Shells, 2<sup>nd</sup> Edition, Tata McGraw-Hill Education Private Limited, New Delhi, India.
3. Henry Taylor Bovey, Theory of Structures and Strength of Materials, Photo Copy Edition, Nabu Press, USA.
4. Sadhu Singh, Strength of Materials, 10<sup>th</sup> Edition, Khanna Publishers, New Delhi, India.

**Course Structure****A8363 - Industry 4.0**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

This course provides a comprehensive overview of the role of digitization, big data, cyber-physical manufacturing systems, robots, human robot collaboration, artificial intelligence and all relevant Industry 4.0 technologies.

**Course Pre/co-requisites**

“The course has no specific prerequisite and co-requisites”

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8363.1 Illustrate concept of Industry 4.0 for Smart Manufacturing
- A8363.2 Demonstrate the need of various communication protocols. hardware and software, IoT Layers and their relative importance
- A8363.3 Identify the various hardware used in Smart Manufacturing
- A8363.4 Design cloud-computing IoT platform for Smart Manufacturing
- A8363.5 Apply machine learning concepts in to smart factories.

**3. Course Syllabus****Introduction to Industry 4.0:**

Concept, Globalization and emerging issues, The Fourth Revolution, LEAN manufacturing, Smart and connected business perspectives, Smart factories

**Automation :**

Programable Logic Controller (PLC) and its Programming software, Communication of different devices with PLC, Sensor, Smart Sensor, HMI design, Cyber Physical System – key components, ISA-95 architecture, CPS-5C architecture, Concept of Digit Twin.

**Communication:**

Protocols – MQTT, OPC UA, EtherNet/IP, Profinet, EtherCAT, etc; MQTT – History, MQTT broker, Message types, Quality of Service (QoS), Application; OPC UA – History,



Specification, Client, Server, Programming with – Free and open-source software, Propriety software; Augmented Reality

### **IoT Platform:**

Data Modelling, IoT platforms – Thing, basic functionalities, Abstract definition of Thing, Networks, etc; IoT Gateway, Machine interfaces – Cloud-based Mosquitto brokers, Programming with – Free and open-source software, Propriety software

### **Machine Learning Foundation :**

Learning algorithms – Supervised, Unsupervised, Self learning, Feature learning, etc. Models – Artificial Neural Networks, Decision trees, Regression analysis, Genetic algorithms, etc.; Programming with – Free and open-source software, Propriety software.

## **4. Books and Materials**

### **Text Books:**

1. Christoph Jan Bartodziej, “The Concept Industry 4.0 – An Empirical Analysis of Technologies and Application in Production Logistics”, 1<sup>st</sup> Edition, Springer Gabler.
2. Alasdair Gilchrist, “Industry 4.0 – The Industrial Internet of Things”, 1<sup>st</sup> Edition, Springer Link.

### **Reference Books:**

1. W. Botton, “Programmable Logic Controllers”, 4<sup>th</sup> Edition, Elsevier.
2. Daniel Minoli, “Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications”, ISBN: 978-1-118-47347-4, 1<sup>st</sup> Edition, Willy Publications.
3. Olivier Hersent, David Boswarthick, Omar Elloumi, “The Internet of Things: Key Applications and Protocols”, ISBN: 978-1-119-99435-0, 2<sup>nd</sup> Edition, Willy Publications.



## Course Structure

### A8364 - Fuzzy Logic and Neural Networks

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

This course deals the various fundamental concepts of fuzzy logic and artificial neural networks. This will help you to get sufficient knowledge to analyze and design the various intelligent control systems

### Course Pre/co-requisites

“The course has no specific prerequisite and co-requisites”

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8364.1 Illustrate the basic concept of fuzzy sets, fuzzy logic and defuzzification
- A8364.2 Identify basics of Artificial Neural of theory and programming of Microprocessors
- A8364.3 Analyze various techniques in feedback and feed forward Neural networks
- A8364.4 Discuss the principle of competitive neural networks and Adaptive resonance theory
- A8364.5 Develop the architecture and algorithm of Cognitron, Neo cognitron and the concepts of fuzzy associative memory and fuzzy systems.

## 3. Course Syllabus

### FUNDAMENTALS OF FUZZY LOGIC:

Basic concepts: fuzzy set theory- basic concept of crisp sets and fuzzy sets- complements- union intersection- combination of operation- general aggregation operations- fuzzy relations- compatibility relations-orderings- morphisms- fuzzy relational equations-fuzzy set and systems.

### ARCHITECTURE OF NEURAL NETWORKS:

Motivation for the development of natural networks-artificial neural networks-biological neural networks-area of applications-typical Architecture-setting weights-common activations functions Basic learning rules- Mcculloch-Pitts neuron- Architecture, algorithm, applications- single layer net for pattern classification- Biases and thresholds, linear separability - Hebb's rule-



algorithm -perceptron - Convergence theorem-Delta rule.

**BASIC NEURAL NETWORK TECHNIQUES:** Back propagation neural net: standard back propagation-architecture algorithm- derivation of learning rules number of hidden layers-associative and other neural networks- hetro associative memory neural net, auto associative net- Bidirectional associative memory-applications-Hopfield nets-Boltzman machine.

**COMPETITIVE NEURAL NETWORKS:** Neural network based on competition: fixed weight competitive nets Kohonen self organizing maps and applications-learning vector quantization-counter propagation nets and applications adaptive resonance theory: basic architecture and operation-architecture, algorithm, application and analysis of ART1 and ART2.

**SPECIAL NEURAL NETWORKS:** Cognitron and Neocognitron - Architecture, training algorithm and application-fuzzy associate memories, fuzzy system architecture- comparison of fuzzy and neural systems.

## 4. Books and Materials

### Text Books:

1. Kliryvan- Fuzzy System and Fuzzy logic,1<sup>st</sup> Edition, Prentice Hall of India.
2. Lawrence Fussett,fundamental of Neural network, 1<sup>st</sup> Edition, Prentice Hall,India.

### Reference Books:

1. Bart Kosko, Neural network and Fuzzy System,1<sup>st</sup> Edition, Prentice Hall-1994
2. J.Klin and T.A.Folger,Fuzzy sets, University and information, 1<sup>st</sup> Edition,Prentice Hall.
3. J.M.Zurada,Introduction to artificial neural systems-1<sup>st</sup> Edition,Jaico Publication house,Delhi.

**Course Structure****A8365 - Renewable Energy Sources**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

The energy demand has increased manifold in last two decades due to rapid urbanization and growth in industrial/service sector. It has become a challenging task to meet ever increasing energy demands with limited conventional fuels and natural resources. Due to fast depletion of fossil fuels and a tremendous gap between supply and demand of energy, it is essential to adopt conservation techniques in almost every field like industries, commercial and residential sectors etc. This course covers the concepts of energy conservation and various renewable energy resources.

**Course Pre/co-requisites**

A8308 - Thermodynamics

A8313 - Thermal Engineering-I

A8314 - Fluid Mechanics and Hydraulic Machines

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8365.1 Understand the energy strategy and the importance of energy conservation.
- A8365.2 Apply solar energy techniques to domestic applications
- A8365.3 Classify hydro power and wind energy conversion systems based on orientation
- A8365.4 Identify biomass and urban waste energy conversion techniques
- A8365.5 Compare the tidal, ocean thermal and geothermal energy resources for utilization.

**3. Course Syllabus**

**Energy Conservation:** Classification of energy, Indian energy scenario, Sectorial energy consumption (domestic, industrial and other sectors), Energy needs of growing economy, Energy intensity, Long term energy scenario, Energy conservation and its importance, Future energy strategy.



**Solar Energy:** Introduction, Solar radiation, Sun path diagram, Solar radiation geometry and its relation, Measurement of solar radiation on horizontal and tilted surfaces, Principle of conversion of solar radiation into heat, Solar collectors, Collector efficiency, Solar water heating system, Solar driers, Solar PV systems and applications.

**Hydro Power and Wind Energy:**

Introduction to hydro power, Capacity and potential, environmental and social impact, Introduction to wind energy, Basic Wind Energy Conversion Systems (WECS), Classification and parts of WECS.

**Bio-Mass Energy:**

Introduction, Biomass energy, Photosynthesis process, Biomass fuels, Biomass energy conversion technologies and applications, Urban waste to energy conversion, Biomass gasification, Types and applications, Biomass to ethanol production, Biogas production.

**Tidal, Ocean, Thermal and Geothermal Energy:** Introduction to tidal energy, classification, components of tidal power plant, Capacity and potential, Introduction to ocean thermal energy, Ocean Thermal Energy Conversion (OTEC), Methods of OTEC power generation, Introduction to geothermal energy, Capacity and potential, geothermal energy resources.

## 4. Books and Materials

**Text Books:**

1. John Twidell and Tony Weir, Renewable Energy Sources, 3<sup>rd</sup> Edition, Routledge publication.
2. B. H. Khan, Non-Conventional Energy Resources, 3<sup>rd</sup> Edition, The McGraw Hill Publication.
3. R. K. Rajput, Non-Conventional Energy Sources and Utilisation, S Chand and Company.

**Reference Books:**

1. G.D. Rai, Non-Conventional Energy Sources, 6<sup>th</sup> Edition, Khanna Publications, New Delhi.
2. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", 3<sup>rd</sup> Edition, Oxford University Press.
3. Sukhatme. S.P., Solar Energy, 4<sup>th</sup> Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi.



## Course Structure

### A8366 - Electric and Hybrid vehicles

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

Hybrid vehicle combines any two power (energy) sources. Possible combinations include diesel/electric, gasoline/fly wheel, and fuel cell (FC)/battery. Typically, one energy source is storage, and the other is conversion of a fuel to energy. The combination of two power sources may support two separate propulsion systems. Thus to be a True hybrid, the vehicle must have at least two modes of propulsion

### Course Pre/co-requisites

A8355 - Automobile Engineering

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8366.1 Illustrate the concept of electric vehicles and its propulsion systems
- A8366.2 Choose a suitable drive scheme for developing an electric hybrid vehicle depending on resources
- A8366.3 Develop basic schemes of electric vehicles and hybrid electric vehicles
- A8366.4 Choose proper energy storage systems for vehicle applications
- A8366.5 Identify various communication protocols and technologies used in vehicle networks.

## 3. Course Syllabus

### Introduction:

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

**Hybrid Electric Drive-trains:** Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel



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

**Electric Propulsion unit:** Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices.

**Sizing the drive system:** Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology.

**Communications, supporting subsystems:** In vehicle networks- CAN, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies

## 4. Books and Materials

### Text Books:

1. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2<sup>nd</sup> Edition.
2. James Larminie, John Lowry, "Electric Vehicle Technology", 1<sup>st</sup> Edition, Wiley publications.
3. Mehrdad Ehsani, Yimi Gao, Sebastian E Gay, Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals Theory and Design", 2<sup>nd</sup> Edition, CRC Press.

### Reference Books:

1. B D Mc Nicol, D A J Rand, "Power Sources for Electric Vehicles", 1<sup>st</sup> Edition, Elsevier publications.
2. Seth Leitman, "Build Your Own Electric Vehicle" 1<sup>st</sup> Edition, McGraw Hill.
3. Jeffrey Gonder, Tony Markel, "Energy Management Strategies for Plug-In Hybrid Electric Vehicles", 1<sup>st</sup> Edition, National Renewable Energy Laboratory.

**Course Structure****A8367 - Solar Energy Technology**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

This course introduces students about the solar energy technologies and potentials. The course aims to introduce the concepts of Photo Voltaic cells, their properties, and its societal needs. The applications of solar cells will be explained in detail also the environmental issues of solar systems will be explained. It also covers the economic analysis of a solar energy system and its environmental benefits.

**Course Pre/co-requisites**

“The course has no specific prerequisite and co-requisites”

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8367.1 Analyze solar energy potential and its environmental impact based on solar radiation data
- A8367.2 Compare solar energy conversion methods through various solar collectors
- A8367.3 Select the solar cell type through solar cell properties and design
- A8367.4 Design solar cell module for solar cell applications
- A8367.5 Examine the grid aspects for large scale deployment of active solar energy.

**3. Course Syllabus****Principles of Solar Radiation:**

Role and potential of solar energy, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on tilted surface, instruments for measuring solar radiation and Sun shine, solar radiation data.

**Solar Energy Collectors:**

Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors. Storage and Applications: Different methods of solar energy storage, Sensible, latent heat and stratified storage, solar ponds. Solar



Applications- solar heating /cooling technique, solar distillation and drying.

**Photo Voltaics (PV):** Fundamentals of solar cells, types of solar cells, absorption of photons, excitations and photo emission of electrons. PV Cell Properties: Solar cell properties and design, p-n junction photodiodes, depletion region, electrostatic field across the depletion layer, electron and holes transports, device physics, charge carrier generation, recombination and other losses, I-V characteristics, Output power

**Solar Cell Applications:** PV cell interconnection, module structure and module fabrication, Equivalent circuits, load matching, efficiency, fill factor and optimization for maximum power, Design of stand-alone PV systems, system sizing, device structures, device construction, DC to AC conversion, inverters.

**Active solar energy in systems:** How large-scale deployment of active solar energy is possible in Sweden and globally. Buying and selling heat and electric energy. Grid aspects of large scale deployment of solar cells as well as environmental and socioeconomic aspects.

## 4. Books and Materials

### Text Books:

1. G. D. Rai, Non-Conventional Energy Sources, 4<sup>th</sup> Edition, Khanna Publishers, New Delhi.
2. Martin A. Green, Solar Cells: Operating Principles, Technology and system Applications, 1<sup>st</sup> Edition, Prentice Hall, New Delhi.

### Reference Books:

1. B. H. Khan, Non Conventional Energy Resources-3<sup>rd</sup> Edition, McGraw Hill Education (India) Private Limited.
2. Sukatme,, Solar Energy, 3<sup>rd</sup> Edition, McGraw Hill Companies, New Delhi.
3. D.Yogi gosuami, Frank Kreith, Jan F. Kreider, Principles of Solar Engineering, 3<sup>rd</sup> Edition, Taylor and Francis, USA

**Course Structure****A8368 - Computational Fluid Dynamics**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

Fundamentals of CFD' course provides an introduction to the governing equations of fluid flows, and the numerical methods developed for solving flow problems on computers, the computational aspects of fluid dynamics.

**Course Pre/co-requisites**

A8002 - Ordinary Differential Equations and Vector Calculus

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8368.1 Compare experimental, theoretical and numerical approaches solve fluid flow problems
- A8368.2 Classify numerical methods and types of boundary conditions in fluid dynamics
- A8368.3 Apply the discretization methods to solve fluid dynamics problems.
- A8368.4 Utilize finite volume technique to solve the fluid flow governing equations
- A8368.5 Select the appropriate numerical grid generation technique for defining a numerical mesh.

**3. Course Syllabus****Basic Concepts :**

What is CFD? Experimental, Theoretical and Numerical Approach, Fundamental principles of conservation, Reynolds transport theorem, Conservation of mass, Conservation of Energy, and momentum equations

**Classification and Overview of Numerical Methods :**

Classification into various types of equation; parabolic elliptic and hyperbolic; boundary and initial conditions; over view of numerical methods.

**Finite Difference Technique:**

Basics of Discretization (FDM, FVM & FEM), Finite Difference representation of PDEs, Truncation error, Round-off error, Discretization error, Explicit and Implicit Methods, Sta-



bility analysis, TDMA (Tridiagonal matrix algorithm), ADI (Alternative Direction Implicit) methods

### **Finite volume Technique:**

Basic concepts of Finite Volume method (FVM), Finite Volume method for 1-D steady state diffusion type problem, Finite Volume method for 2-D steady state diffusion type problem, Types of Boundary Conditions

### **Numerical Grid Generation and Basics of Turbulence Modeling:**

Definition of Grid, need for grid, Geometric modelling and surface grid, Algebraic grid generation, Structured and Unstructured grid, Introduction to Reynolds Averaged Navier Stokes Modelling, Zero, One and Two equation models.

## **4. Books and Materials**

### **Text Books:**

1. Anderson J.D., Computational Fluid Dynamics: The Basics with Applications, McGraw-Hill Inc.
2. Anderson, D.A, Tannehill, J.C. and Pletcher, R.H., Computational Fluid Mechanics and Heat Transfer, Taylor and Francis.

### **Reference Books:**

1. S. V. Patankar, Numerical Heat Transfer and Fluid Flow, McGraw-Hill



## Course Structure

### A8369 - Unconventional Machining Processes

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

This course deals the classification of unconventional machining processes based on the elementary mechanism and the machinability of materials with different unconventional processes, presents for each process the basic principles, the most relevant industrial solutions, and the main applications. The relevance of imposed tolerances on costs and production time and the modeling of unconventional machining processes are also taken into consideration.

### Course Pre/co-requisites

A8315 - Production Technology

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8369.1 Illustrate the significance of the modern machining processes
- A8369.2 Identify the latest machining technologies for Innovations
- A8369.3 Gain Knowledge of metal removal mechanism for various machining techniques
- A8369.4 Selection of machining process for various work materials
- A8369.5 Apply suitable machining process for the typical component.

## 3. Course Syllabus

### Introduction:

Need for non-traditional machining methods-Classification of modern machining processes, considerations in process selection, Materials, Applications.

### Ultrasonic Machining:

Elements of the process, mechanics of metal removal process parameters, economic considerations, applications and limitations, recent development. Abrasive jet machining, Water jet machining and abrasive water jet machine: Basic principles, equipments, process variables, mechanics of metal removal, MRR, application and limitations.



**Electro Chemical Processes:** Fundamentals of electro chemical machining, electrochemical grinding, electro chemical honing and deburring process. Metal removal rate in ECM, Tool design, Surface finish and accuracy economic aspects of ECM, Simple problems for estimation of metal removal rate. Fundamentals of chemical, machining, advantages and applications.

**Thermal Metal Removal Processes :** 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.

**Generation and Control of Electron Beam for Machining:** Theory of electron beam machining, comparison of thermal and non-thermal processes, General Principle and application of laser beam machining -thermal features, cutting speed and accuracy of cut. Application of plasma for machining, metal removal mechanism, process parameters, accuracy and surface finish and other applications of plasma in manufacturing industries. Chemical machining, principle, mask ants, etchants, applications.

## 4. Books and Materials

### Text Books:

1. P. C. Pandey, H. S. Shah, Modern machining process, 1<sup>st</sup> Edition, Tata McGraw- Hill Publishing Company Ltd., New Delhi, India.
2. M Adithan, Unconventional Machining Process, 2<sup>nd</sup> Edition, Atlantic Publications, New Delhi.

### Reference Books:

1. V. K. Jain, Advanced machining processes, 3<sup>rd</sup> Edition, Allied Publishers, New Delhi, India.
2. A. Bhattacharya, New Technology, 2<sup>nd</sup> Edition, the Institution of Engineers, India.
3. John R Walkar , Machining Fundamentals, 2<sup>nd</sup> Edition PHI Publications, New Delhi, India.



## Course Structure

### A8370 - Micro-Electro Mechanical Systems

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

This course will explore the world of micro electro mechanical systems (MEMS) . This requires an awareness of design, fabrication, and materials issues involved in micro systems. The course will cover fabrication technologies, material properties, structural mechanics, basic sensing and actuation principles, packaging, and MEMS markets and applications.

### Course Pre/co-requisites

“The course has no specific prerequisite and co-requisites”

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8370.1 Illustrate the construction, working and applications of different MEMS structures
- A8370.2 Identify problems and suggest suitable MEMS material/ Devices/Process to get the Requisite Solution for a given application
- A8370.3 Design the micro devices, micro systems using the MEMS fabrication process
- A8370.4 Gain a knowledge of basic approaches for various actuator/Sensor design
- A8370.5 Apply fundamental concepts of MEMS to solve real life engineering problems.

## 3. Course Syllabus

**Introduction:** Overview of microelectronics, manufacture and Microsystems technology, Definition - MEMS materials, Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication - Silicon based MEMS processes –Applications of MEMS in various industries.

**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.



**Thermal 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.

**Magnetic Sensors And Actuators:** Magnetic materials for MEMS and properties, magnetic sensing and detection, magneto resistive Mechanical Engineering sensor, more on hall effect, magneto diodes, magneto transistor, MEMS magnetic sensor, pressure sensor utilizing MOKE, mag MEMS actuators, by directional micro actuator, feedback circuit integrated magnetic actuator, large force reluctance actuator, magnetic probe based storage device.

**Micro Fluidic Systems:** Applications, considerations on micro scale fluid, fluid actuation methods, dielectro phoresis (DEP), electro wetting, electro thermal flow, thermo capillary effect, electro osmosis flow, opto electro wetting (OEW), tuning using micro fluidics, typical micro fluidic channel, micro fluid dispenser, micro needle, molecular gate, micro pumps.

## 4. Books and Materials

### Text Books:

1. Nitaigour Premchand Mahalik, MEMS, 1<sup>st</sup> Edition, Tata McGraw Hill Publication, India.
2. Stephen D Senturia, 'Microsystem Design', 1<sup>st</sup> Edition, Springer Publication, India.

### Reference Books:

1. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, India.
2. James J. Allen, "Micro Electro Mechanical System Design", CRC Press Publisher.
3. Maluf N, "An Introduction to Micro electromechanical Systems Engineering", Norwood, MA: Artech House.



## Course Structure

### A8371 - Artificial Intelligence in Mechanical Systems

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

This course provides a comprehensive knowledge of Artificial Intelligence and Robotics and to address the underlying concepts, methods and application of different Artificial Intelligence and Robotics.

### Course Pre/co-requisites

“The course has no specific prerequisite and co-requisites”

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8371.1 Demonstrate fundamentals of artificial intelligence
- A8371.2 Identify different areas of Artificial Intelligence and Robotics
- A8371.3 Develop algorithms used in classification and regression problems
- A8371.4 Illustrate the Knowledge Representation skills through Predicate logics
- A8371.5 Apply AI concepts in Mechanical Engineering applications.

## 3. Course Syllabus

**Scope of AI:** Games theorem, natural language processing, vision and speech processing, robotics, expert systems, AI techniques- search knowledge, abstraction.

**Problem Solving :** State space search; Production systems, search space control: depth first, breadth-first search, heuristic search - hill climbing, best-first search, branch and bound. Problem Reduction, Constraint Satisfaction End, Means-End Analysis

**Knowledge Representation:** Predicate Logic: unification, modus ponens, resolution, dependency directed backtracking. Rule based Systems: forward reasoning, conflict resolution, backward reasoning, use of no backtracks. Structured Knowledge Representation: semantic net slots, exceptions and default frames, conceptual dependency, scripts.



**Applications:** Human Machine Interaction, Predictive Maintenance and Health Management, Fault Detection, Dynamic System Order Reduction, Image based part classification, Process Optimization, Material Inspection, Tuning of control algorithms.

**Robotics:** Robot Classification, Robot Specification, notation. Direct and Inverse Kinematics: Co-ordinates Frames, Rotations, Homogeneous Coordinates

## 4. Books and Materials

### Text Books:

1. B Joshi, Machine Learning and Artificial Intelligence, ,1<sup>st</sup> Edition, Springer.
2. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, 1<sup>st</sup> Edition, CRC Press.

### Reference Books:

1. Parag Kulkarni and Prachi Joshi, “Artificial Intelligence – Building Intelligent Systems”, 1<sup>st</sup> Edition, PHI learning Pvt. Ltd.
2. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach,” 3<sup>rd</sup> Edition, Pearson.
3. Zsolt Nagy, Artificial Intelligence and Machine Learning Fundamentals, 1<sup>st</sup> Edition, Apress.



### Course Structure

#### A8372 - Machine Learning in Mechanical Engineering

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

Machine Learning in Mechanical Engineering explores the integration of artificial intelligence techniques to enhance design, analysis, and optimization processes. The course delves into applications such as predictive maintenance, materials selection, and automated quality control. Students learn to leverage machine learning algorithms for data-driven decision-making in mechanical systems. Practical implementation and case studies offer insights into the intersection of machine learning and mechanical engineering applications.

### Course Pre/co-requisites

“The course has no specific prerequisite and co-requisites”

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8372.1 Demonstrate the fundamental concepts and principles of machine learning
- A8372.2 Apply machine learning technics to preprocess the mechanical engineering data
- A8372.3 Implement supervised machine learning algorithms to solve mechanical engineering problems
- A8372.4 Utilize unsupervised machine learning technics to extract insights form mechanical engineering data
- A8372.5 Analyze the advanced machine learning applications in mechanical engineering domain.

## 3. Course Syllabus

**Introduction to Machine Learning:** Overview of machine learning and its applications in mechanical engineering, Types of machine learning: supervised, unsupervised, and reinforcement learning, Machine learning algorithms: linear regression, logistic regression, decision trees, k-nearest neighbors, support vector machines, artificial neural networks, Machine learning model evaluation metrics.

**Data Preprocessing and Feature Engineering:** Data preprocessing techniques: data cleaning, data normalization, data imputation, data transformation, Feature engineering



techniques: feature selection, feature extraction, feature creation, Importance of data quality and data preprocessing for machine learning

**Supervised Machine Learning for Mechanical Engineering:** Regression modeling for predicting continuous outcomes, such as predicting material properties, predicting machine performance, Classification modeling for predicting discrete outcomes, such as predicting defect detection, predicting component failure, Application of supervised machine learning in predictive maintenance, fault diagnosis, and design optimization.

**Unsupervised Machine Learning for Mechanical Engineering:** Clustering algorithms for grouping similar data points, such as customer segmentation, product segmentation, Anomaly detection algorithms for identifying outliers and unusual data patterns, such as detecting machine malfunctions, detecting fraud, Dimensionality reduction techniques for reducing the number of features while preserving information, such as principal component analysis (PCA).

**Machine Learning for Advanced Mechanical Engineering Applications:** Reinforcement learning for control systems and robotics, Deep learning for image and video analysis, such as defect detection in images, anomaly detection in videos, Transfer learning for leveraging knowledge from pre-trained models to solve new problems.

## 4. Books and Materials

### Text Books:

1. "Machine Learning for Mechanical Engineers" by R. S. G. P. Kumar and M. S. K. S. Gupta
2. "Mechanical Engineering Applications of Artificial Intelligence" by J. A. Duffy and A. B. C. L. Chandler

### Reference Books:

1. "Intelligent Systems in Mechanical Engineering" by A. K. Nandi and S. K. Sahu
2. "Machine Learning for Predictive Maintenance" by S. S. R. K. Varma and S. V. S. S. S. Prasad
3. "Smart Machines: Machine Learning and its Application in Mechanical Engineering" by S. K. Singh and A. K. Sharma

**Course Structure****A8373 - Production Planning and Control**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

This course deals with functions of production planning and control, types of production systems and organizations in an industries, forecasting and their techniques in planning functions, significance of inventory management, line balancing in production processes, importance of scheduling and dispatching functions in an organization and also follow-up and expediting

**Course Pre/co-requisites**

A8315 - Production Technology

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8373.1 Illustrate the various elements of Production planning and control
- A8373.2 Estimate the demand for products using forecasting techniques
- A8373.3 Determine operating policies for inventory control systems to manage inventories efficiently
- A8373.4 Devise procedures and strategies for various functions of Production planning and control
- A8373.5 Apply line balancing techniques for the efficient management of assembly lines.

**3. Course Syllabus**

**Introduction:** Definition, Objectives of production Planning and Control, Functions of production planning and control, Types of production Systems, Organization of production planning and control department.

**Forecasting:** Definition , Uses of forecasting ,Factors affecting the forecasting Types of forecasting and their uses - Demand patterns, General principles of forecasting, Forecasting techniques , Quantitative techniques , Qualitative techniques , Measures of forecasting errors.

**Inventory Management:** Functions of inventories, relevant inventory costs, ABC analysis, VED analysis, Basic EOQ model, Inventory control systems, Continuous preview sys-



tems and periodic preview systems MRP, ERP, JIT Systems. LINE BALANCING: Definition methods of line balancing, RPW method, Largest candidate method Routing, Routing procedure, Factors effecting routing - Procedure for routing sheets.

**Aggregate Planning:** Definition, Aggregate planning strategies, Aggregate planning methods, Transportation model. **SCHEDULING:** Definition, Scheduling policies, Types of Scheduling methods, Differences with loading, Flow shop scheduling, job shop scheduling Line of balance (LOB), Objectives, Steps involved.

**Dispatching:** Definition, Activities of dispatcher, Dispatching procedure, Various Forms used in dispatching. **FOLLOWUP AND EXPEDITING:** Definition, Types of follow-up, Expediting, Definition, Expediting procedures, Applications of computers in planning and control.

## 4. Books and Materials

### Text Books:

1. S. L. Narasimha, Production planning and inventory control, 2<sup>nd</sup> Edition, Prentice Hall of India Publishers, New Delhi, India.
2. Samuel Eilon, Elements of Production Planning and Control, 2<sup>nd</sup> Edition, Universal book corporation, Mumbai, India.

### Reference Books:

1. Ravi Shankar, Industrial Engineering and management, 7<sup>th</sup> Edition, Galgotia Publishers, New Delhi, India.
2. Panner Selvanm, Production Operation Management, 2<sup>nd</sup> Edition, Prentice Hall of India Publishers, New Delhi, India.
3. Joseph S. Martinich, Production and Operations Management, 2<sup>nd</sup> Edition John Willey and Sons, New York.

**Course Structure****A8374 - Total Quality Management**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

Total quality management (TQM) is a philosophy, methodology and system of tools aimed to create and maintain mechanism of organization's continuous improvement. Basic concepts of quality, quality controlling, consultation, quality assurance, statistical process control, total quality management, statistical quality management, quality systems and service quality.

**Course Pre/co-requisites**

"The course has no specific prerequisite and co-requisites"

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8374.1 Discuss quality, total quality management(TQM) and quality systems for better quality
- A8374.2 Evaluate quality using Statistical Tools
- A8374.3 Choose TQM methodologies for continuous improvement of Quality
- A8374.4 Utilize TQM tools for Quality Control
- A8374.5 Analyse various inventory control models for effective management of materials.

**3. Course Syllabus**

**Introduction:** Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs - Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership-Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

**TQM Principles:** Customer satisfaction-Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement-Motivation, Empowerment, Teams, Reward and Incentive, Performance Appraisal, Benefits, Continuous Process Improvement - Juran Trilogy, PDCA Cycle, 5S, Kaizen, Supplier Partnership - Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures-Basic Concepts,



Strategy, Performance Measure.

**Statistical Process control :** The seven tools of quality, Statistical Fundamentals - Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of sixsigma, Newseven Management tools.

**TQM Tools:** Benchmarking - Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) -House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM)-Concept, Improvement Needs, Failure mode and effect analysis (FMEA)- Stages of FMEA.

**Iso And Its Concept of Quality Management:** Quality systems, need for ISO 9000, ISO 9001-9008; Quality system- elements, documentation, Quality auditing, ISO 14000- concepts, requirements and benefits; TQM implementation in manufacturing and service sectors.

## 4. Books and Materials

### Text Books:

1. Dale H. Besterfield, et al., Total Quality Management, 7<sup>th</sup> Edition, Pearson Education, Inc.
2. Gopallakrishnan P and Sundaresan M – Materials Management – an integrated concept, 1<sup>st</sup> Edition, PHI Learning, India.

### Reference Books:

1. James R. Evans & William M. Lindsay, The Management and Control of Quality, 5<sup>th</sup> Edition, South-Western (Thomson Learning).
2. Feigenbaum, A.V. "Total Quality Management, 1<sup>st</sup> Edition, McGraw Hill.
3. Oakland, J.S. "Total Quality Management, 1<sup>st</sup> Edition, Butterworth-Heinemann Ltd., Oxford.

## Open Electives



### Course Structure

#### A8181 - Smart Cities

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

The purpose of this course is to provide a deep understanding about smart and sustainable cities. The course will begin with the basic concepts and theories of urbanization and elements. The course will cover the global practices in the smart cities and technologies in shaping new and existing cities. The course will include the feasibility for smart cities and financing approaches for urban development. The course will also include the role of electric vehicles and energy rating system for smart cities.

### Course Pre/co-requisites

This course has no specific prerequisite and co-requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8181.1 Interpret the concepts, history and evolution of smart cities.
- A8181.2 Identify the elements of smart city such as smart people, smart living, smart economy, smart infrastructure, smart governance and smart environment.
- A8181.3 Analyze the concepts, discourses and practices of smart cities across globe.
- A8181.4 Develop the road map for planning smart cities and benchmarking their performance for Indian context.
- A8181.5 Apply relevance for smart cities of developing economies considering issues as inclusiveness, feasibility and sustainability.

## 3. Course Syllabus

**Introduction to Smart and Sustainable Cities:** Concepts and theories of Urbanization, City Planning, Emergence of Sustainability, Liveability, Green to Smart Cities; Understanding smart cities – Concepts, History and Evolution of Smart Cities.

**Dimensions of Smart Cities:** Elements of Smart City – Smart People, Smart Living, Smart Economy, Smart Infrastructure, Smart Governance, Smart Environment.



**Global Experience of Smart Cities:** Case studies from European, Middle East and Asian Contexts, specifically cases of Barcelona, Amsterdam, Majhdhar, and Singapore, Review of Global Standards.

**Smart City Planning and Development:** How to plan for smart cities, Concepts of Retrofitting, Redevelopment, Extension and Pan city approaches, Review of Smart financing approaches, Tools, concepts of special purpose vehicles, Land pooling-based financing approaches of urban development.

**Sustainable Development in Smart Cities:** Energy storage and utilization, role of electric vehicles, autonomous vehicles in urban mobility, Green Audit, Energy saving system.

## 4. Books and Materials

### Text Books:

1. M.Barlow and C. Levy-Bencheton. Smart Cities, Smart Future: Showcasing Tomorrow
2. Gassmann, J.Böhm Smart Cities: Introducing Digital Innovation to Cities

### Reference Books:

1. UN-Habitat; Inclusive and sustainable urban planning: a guide for municipalities; Volume 3: Urban Development Planning (2007); United Nations Human Settlements Programme (ISBN: 978- 92-1-132024-4)
2. Giffinger, Rudolf; Christian Fertner; Hans Kramar; Robert Kalasek; Nataša Pichler-Milanovic; Evert Meijers (2007). "Smart cities – Ranking of European medium-sized cities". Smart Cities. Vienna: Centre of Regional Science
3. Draft Concept Note on Smart City Scheme. Government of India - Ministry of Urban Development.

**Course Structure****A8182 - Disaster Management**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

The course has been framed with an intention to provide a general concept in the dimensions of disasters caused by nature beyond human control as well as the disasters and environmental hazards induced by human activities with emphasis on Natural disaster, Man-made disaster, vulnerability and risks of disasters, Disaster Management Mechanism, Capacity Building and disaster coping Strategies and Disaster management planning.

**Course Pre/co-requisites**

A8032 - Environmental Science and Technology

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8182.1 Identify basic concepts of hazards, vulnerabilities and risks of disaster phenomena.
- A8182.2 Interpret various types of disasters and disaster coping strategies.
- A8182.3 Examine Disaster Impacts and suggest suitable capacity building framework for disaster management.
- A8182.4 Select appropriate steps in Disaster management cycle for Disaster Risk Reduction.
- A8182.5 Develop Strategies for disaster management planning and sustainable development.

**3. Course Syllabus**

**Introduction:** Concepts and definitions: disaster, hazard, vulnerability, resilience, risks severity, frequency and details, capacity, impact, prevention, mitigation, disaster phenomena, events global National & Regional.

**Disasters:** Disasters classification; natural disasters (floods, draught, cyclones, volcanoes, earthquakes, tsunami, landslides, coastal erosion, soil erosion, forest fires etc.); manmade disasters (industrial pollution, artificial flooding in urban areas, nuclear radiation, chemical spills, transportation accidents, terrorist strikes, etc.); hazard and vulnerability profile



of India, Covid 2019 in India, mountain and coastal areas, ecological fragility, coping with disaster- strategies, safety norms & survival kits.

**Disaster Impacts:** Disaster impacts (environmental, physical, social, ecological, economic, political, etc.); health, psycho-social issues; demographic aspects (gender, age, special needs); hazard locations; global and national disaster trends; climate change and urban disasters, capacity building – concepts, assessment –structural & non-structural measures, legislative support.

**Disaster Risk Reduction:** Disaster management cycle – its phases; prevention, mitigation, preparedness, relief and recovery; structural and non-structural measures; risk analysis, vulnerability and capacity assessment; early warning systems, Post disaster environmental response (water, sanitation, food safety, waste management, disease control, security, communications); Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority.

**Disasters, Environment and Development:** Factors affecting vulnerability such as impact of developmental projects and environmental modifications (including of dams, land-use changes, urbanization etc.), sustainable and environment friendly recovery; reconstruction and development methods.

## 4. Books and Materials

### Text Books:

1. Manual on Disaster Management, National Disaster Management Authority, Govt of India.
2. Disaster Management by Mrinalini Pandey Wiley 2014.
3. Disaster Science and Management by T. Bhattacharya, McGraw Hill Education (India) Pvt Ltd Wiley 2017.
4. National Disaster Management Plan, Ministry of Home affairs, Government of India.

### Reference Books:

1. Earth and Atmospheric Disasters Management, N. Pandharinath, CK Rajan, BS Publications 2009.



## Course Structure

### A8183 - Environmental Pollution Management

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

The course has been designed to improve the understanding of the students about different pollution control strategies and the skills of application of remediation techniques to combat pollution in three environmental compartments i.e., air, water and soil. The course will also be dealing about the sources of pollution in air, soil, water, and noise and the impacts these sources on the environment and health. In addition, the students will be given the knowledge to develop the particular skills required in pollution related structured research and environmental management.

### Course Pre/co-requisites

A8032 - Environmental Science and Technology

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8183.1 Identify water pollution sources, types and treatment methods.
- A8183.2 Apply knowledge on Prevention and control of air pollution.
- A8183.3 Inspect sources, effects and mitigation methods of noise pollution.
- A8183.4 Examine soil pollution sources, effects and control measures.
- A8183.5 Develop Environmental management plan to minimize environmental pollution.

## 3. Course Syllabus

**Water pollution:** Water Pollution - Introduction - Sources and types of water pollutants Physical, Chemical and Biological. Ground water - Surface water - lake water - seawater. Effects of water pollution. Water Quality standards (Drinking and Industrial) - water treatment - physical, chemical and biological. Water Pollution Prevention and Control Act, 1974.

**Air pollution:** Structure and composition of atmosphere – classification, sources and effects of air pollution – Acid rain – greenhouse effect – global warming – Ozone depletion, Prevention and control of air pollution particulate control – settling chamber, scrubber, bag filter, cyclones electrostatic precipitators. Gaseous emission control methods. Air pollution



prevention and control Act 1981.

**Noise Pollution:** Noise Pollution Basics of acoustics- propagation of indoor and outdoor sound- noise profiling effects of noise – measurement, index and mitigation methods- health effects of noise- Vibration and its Effects, Whole body vibration problems in opencast mines- ground vibration and Air blast. Green Belt Development–Principles and design considerations, Industrial Noise Pollution Control methods.

**Soil Pollution:** Sources - solid waste disposal and their effects - pesticides - types and effect of pollutants on Plants - animals and human beings - biomagnification - fertilizers and its Effect of pollutants on plants - animals and human beings - soil pollution Control measures - soil microbes and function - biofertilizer.

**Environmental management:** Environmental impact assessment and statement; Government strategies in pollution control: subsidies, polluter pays principle and regulations; Government Agencies and Programs – The Tiwari committee – creation of NCEPC, Department of Environment & Forest – Function of State Pollution Control Board. Sources of environmental information and regulations; Sustainable development and environmental protection.

## 4. Books and Materials

### Text Books:

1. C. S. Rao, Environmental Pollution Control Engineering, 3<sup>rd</sup> Edition, New Age International Pvt Ltd, 2018.
2. Rao, M. N and H.V.N. Rao, Air Pollution, Tata McGraw – Hill Publishing Company Limited. New Delhi, 2017.
3. Kudesia, V.P and Ritu Kudesia, Water Pollution, Pragati Prakashan Publication, Meerut, 2017.
4. Murphy, E., King, E., Environmental Noise Pollution, 1<sup>st</sup> Edition, Amsterdam : Elsevier, 2014.

### Reference Books:

1. H.S Peavy, D. R. Rowe, G. Tchobanoglous, Environmental Engineering, Indian Edition, McGraw Hill Education (India) Pvt Ltd, 2014.
2. De Nevers, N., Air Pollution Control Engineering, 3<sup>rd</sup> edition, Waveland Press Inc 2017.
3. Sagar Pal Singal, Noise Pollution and Control Strategy, 2<sup>nd</sup> Edition, Alpha Science International Ltd, 2005.



## Course Structure

### A8155 - Green Building and Sustainability

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

This course introduces concepts of sustainability in the context of construction building materials. It also discusses the role of low carbon cements and recycled aggregate in minimizing consumption of natural resources. The course also emphasizes the concepts of embodied, operational, life cycle energy and minimizing energy consumption. It also intends to make students aware of rating systems like LEED, GRIHA etc.

### Course Pre/co-requisites

This course has no specific prerequisite and co-requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8155.1 Identify green building and green building materials.
- A8155.2 Make use of different rating agencies to classify the type of building.
- A8155.3 Analyze sustainability and its implications for the practice of engineering.
- A8155.4 Evaluate the potential of the alternative construction materials for sustainability.
- A8155.5 Examine the green building rating systems and its contribution to sustainability.

## 3. Course Syllabus

**Green Building:** Concept of Green building, Principles of green buildings, Eco-friendly materials, Certification systems – Green Rating for Integrated Habitat Assessment (GRIHA) and Leadership in Energy and Environmental Design (LEED).

**Green Building Materials:** Green Building Materials and Equipment in India, what are key requisites for Constructing a Green Building, Important Sustainable features for Green Building. **Building Services:** Fire protection – classes of fire and causes, development of fire, fire resisting materials, means of escape, Standing Fire Advisory Council norms. Water supply -Water distribution and plumbing fixtures.



**Applications in the Built Environment:** Concepts of green buildings, climate responsive building - Reduction of energy consumption, direct and indirect methods - Reduction of water consumption, direct and indirect methods - Carbon footprint and eco footprints of buildings - New concepts and trends in green buildings, national and international.

**Sustainability:** The Concept of Sustainability; Definition of Sustainability, Dimension of Sustainability. Three Pillars of Sustainability, Principles of Sustainability - 5R, Construction Materials Resource Efficiency, Operational Reuses of the Construction Materials, Sustainability Goals for construction Industry.

**Sustainability in Built Environment:** Environmentally sensitive design, low impact development, green infrastructure and conservation design, Green buildings and land use planning, Energy use and buildings.

## 4. Books and Materials

### Text Books:

1. Frederick S. Merritt, Jonathan T. Ricketts, Building design and construction Handbook, McGraw-Hill Inc., 5<sup>th</sup> edition, 1994.
2. Fred hall and Roger Greeno, Building Services Handbook, Routledge, 7<sup>th</sup> edition, 2013.
3. Bradley A. Striebig, Adebayo A. Ogundipe and Maria Papadakis, Engineering Applications in Sustainable Design and Development, 1<sup>st</sup> edition, 2016.

### Reference Books:

1. Handbook on Green Practices published by Indian Society of Heating Refrigerating and Air conditioning Engineers, 2009.

**Course Structure****A8224 - Electric Vehicles**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

This course introduces the fundamental concepts, principles, architectures and analysis of electric vehicles. Student will explore the working principle of electric vehicles, delve into key roles played by motors as propulsion systems and requirements for battery and its management systems. In addition to this, focuses on various charging systems and charging infrastructure. This course also emphasizes the EV business and the future trends in the development of electric vehicles.

**Course Pre/co-requisites**

A8213-Electrical Machines-II

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8224.1. Infer the electric vehicle system and its impact on environment.
- A8224.2. Analyze the various hybrid vehicle configurations and its performance.
- A8224.3. Interpret the electric drives used in hybrid and electric vehicles.
- A8224.4. Choose proper energy storage systems for electric vehicle applications.
- A8224.5. Identify the different charging systems and charging infrastructure for EVs.

**3. Course Syllabus**

**Introduction To Electric Vehicles:** EV System: EV Configuration-Fixed & variable gearing, single & multiple motor drive, In-wheel drives. Components of an EV, Components of ICEVs, EV History, the early years, recent EVs and HEVs, Types of EVs, EV Advantages, Comparison of EVs and ICEVs w.r.t to efficiency, pollution, capital & operating cost.

**Hybrid Electric Vehicles:** Types of Hybrids Vehicles- Series, parallel, series-parallel and complex HEVs, Advantages and Disadvantages of HEVs, Concept of Hybrid Electric Drive Trains, Architectures and power flow control of Hybrid Electric Drive Trains.

**Electric Propulsion Systems:** Choice of electric propulsion systems, block diagram of



EV propulsion system, BLDC Machine Construction and Classification, Basic Principles of BLDC Motor Drives, application to Electric Vehicles. Switched Reluctance Motor Drives, Basic Magnetic Structure, Torque Production, SRM Drive Converter, Modes of Operation, Generating Mode of Operation.

**Introduction To Energy Storage Requirements:** Electrochemistry of battery cells, Battery parameters, Types of Batteries- Lead-Acid Batteries, Ni Cd Batteries, NiMH Batteries and Lithium-Ion Batteries. EV Charging: Types of charging systems- Conductive charging On board & off-board charging, inductive charging, Wireless charging.

**Charging Infrastructure:** Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and charge zone. Key Battery Management Technologies, Typical Structure of Battery Management Systems. Business: E-mobility business, electrification challenges, Connected Mobility and Autonomous Mobility- case study, E-mobility Indian Roadmap, social dimensions of EVs.

## 4. Books and Materials

### Text Books:

1. Emadi, A. (Ed.), Miller, J., Ehsani, M., "Vehicular Electric Power Systems" Boca Raton, CRC Press, 2003
2. Iqbal Husain, "ELECTRIC and HYBRID VEHICLES: Design Fundamentals", CRC PRESS Boca Raton London New York Washington, D.C., 2003
3. Larminie, James, and John Lowry, "Electric Vehicle Technology Explained" John Wiley and Sons, 2012.

### Reference Books:

1. Larminie, James, and John Lowry, "Electric Vehicle Technology Explained" John Wiley and Sons, 2012.
2. Reissland, Martin.U (2010), Electrical Measurements: Fundamentals, Concepts, Applications, New Age International (P) Limited, New Delhi.
3. Shen, Weixiang Xiong, Rui, "Advanced battery management technologies for electric vehicles" 2019, John Wiley & Sons



## Course Structure

### A8281 - Solar Energy and Applications

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

This course introduces students about the solar energy technologies and potentials. The course aims to introduce the concepts of Photo Voltaic cells, their properties, and its societal needs. The applications of solar cells will be explained in detail also the environmental issues of solar systems will be explained. It also covers the economic analysis of a solar energy system and its environmental benefits.

### Course Pre/co-requisites

“The course has no specific prerequisite and co-requisites”

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8281.1. Compare the present and future available electrical power from solar energy based on the knowledge of global solar horizontal irradiation.
- A8281.2. Assimilate and acquire the skills for design and engineering of solar thermal and solar photovoltaic technology and systems.
- A8281.3. Identify the problems involved in solar thermal energy conversion technique used in the solar heating and cooling systems for buildings/societal needs.
- A8281.4. Examine the components of a solar photo voltaic system and their function by utilizing the previous literature knowledge on different photovoltaic solar cells.
- A8281.5. Analyze the techno-economics performance and issues in the solar energy system.

## 3. Course Syllabus

### Theory

**Principles of Solar Radiation:** Role and potential of solar energy, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on tilted surface, instruments for measuring solar radiation and Sun shine, solar radiation data.

**Solar Energy Collectors:** Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors. Different methods of solar energy storage, Sensible, latent heat and stratified storage, solar ponds. Solar Applications- solar heating /cooling technique, solar distillation and drying.



**Photo Voltaics (PV):** Fundamentals of solar cells, types of solar cells, absorption of photons, excitations and photo emission of electrons.

**PV Cell Properties:** Solar cell properties and design, p-n junction photodiodes, depletion region, electrostatic field across the depletion layer, electron and holes transports, device physics, charge carrier generation, recombination and other losses, I-V characteristics, output power.

**Solar Cell Applications:** PV cell interconnection, module structure and module fabrication, Equivalent circuits, load matching, efficiency, fill factor and optimization for maximum power, Design of stand-alone PV systems, system sizing, device structures, device construction, DC to AC conversion, inverters.

**Cost Analysis and Environmental Issues:** Cost analysis and pay back calculations for different types of solar panels and collectors, installation and operating costs, Environmental and safety issues, protection systems, performance monitoring.

## 4. Books and Materials

### Text Books:

1. G. D. Rai (2009), Non-Conventional Energy Sources, 4<sup>th</sup> Edition, Khanna Publishers, New Delhi.
2. Martin A. Green (2008), Solar Cells: Operating Principles, Technology and system Applications, 1<sup>st</sup> Edition, Prentice Hall, New Delhi.

### Reference Books:

1. B. H. Khan (2016)- Non Conventional Energy Resources-3<sup>rd</sup> Edition, McGraw Hill Education (India) Private Limited.
2. Sukatme (2008), Solar Energy, 3<sup>rd</sup> Edition, McGraw Hill Companies, New Delhi.
3. D. Yogi gosuami, Frank Kreith, Jan F. Kreider (2000), Principles of Solar Engineering, 3<sup>rd</sup> Edition, Taylor & Francis, USA.

**Course Structure****A8282 - Energy Storage Systems**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

This course introduces students to impart fundamental knowledge on energy storage systems considering the operation and design of various energy storage devices. This course provides a foundation for understanding the general principles and fundamentals of lithium-ion rechargeable battery engineering, fuel cells and super capacitors.

**Course Pre/co-requisites**

“The course has no specific prerequisite and co-requisites”

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8282.1. Apply the knowledge of concepts of science to understand the concepts of electro chemical cell.
- A8282.2. Apply the knowledge of electro chemistry to describe the components and process in batteries.
- A8282.3. Describe the electrical, thermal, and mechanical behavior of Li-Ion batteries under various operating conditions.
- A8282.4. Apply the knowledge of basic science concepts to distinguish various types of fuel cells and their functionalities
- A8282.5. Apply the knowledge of science to interpret the operation and characteristics of super capacitors.

**3. Course Syllabus****Theory**

**Battery Technology Overview:** Battery definitions, terms and terminology, Primary cells, Secondary cells. Electro chemistry - Electro chemical energy sources, Voltage and potential energy, Reduction and oxidation, Reduction potentials and electro chemical couples.

**Battery Construction :** Electro chemical cell, Cell mechanical structure, Resistance and polarization, Electrode design, Discharging and charging. Major Battery Chemistries and performance comparison.

**Lithium-Ion Batteries:** Lithium-ion cell reaction, construction - pouch cells, cylindrical, flexible foil. Principle of operation, Charge and discharge characteristics, State of charge (SOC), State of health (SOH), State of function (SOF), Charging procedures, Safety of



lithium-ion batteries, Lifetime. Types of Lithium-ion Batteries .

**Fuel Cells:** Introduction – working, performance characteristics and efficiency, types of fuel cell – Alkaline Fuel Cell, Polymer Electrolyte Membrane Fuel Cell, Molten Carbonate Fuel Cell, Solid-Oxide Fuel Cell, hydrogen fuel cells.

**Super Capacitors:** Introduction, Electro chemical Double-Layer Super capacitors, Charge-Discharge characteristics, Energy and power density, Design Considerations, Stacking and Voltage cell balancing.

## 4. Books and Materials

### Text Books:

1. John Warner, The Handbook of Lithium-Ion Battery Pack Design: Chemistry, Components, Types and Terminology, 1<sup>st</sup> Edition, Elsevier Science, 2015.
2. Reiner Korthauer, Lithium-Ion Batteries: Basics and Applications, 1<sup>st</sup> Edition, Springer, 2018.

### Reference Books:

1. R. O'hayre, S.W. Cha, W.G. Colella, F.B. Prinz, Fuel Cell Fundamentals, 3<sup>rd</sup> Edition, Wiley, 2016.
2. Masaki Yoshio, Ralph J. Brodd, Akiya Kozawa, Lithium-Ion Batteries: Science and Technologies, 1<sup>st</sup> Edition, Springer, 2009.
3. Aiping Yu, Victor Chabot, JiuJun Zhang, Electrochemical Supercapacitors for Energy Storage and Delivery: Fundamentals and Applications, CRC Press, 2013.



## Course Structure

### A8283 - Power Generation Systems

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

Electrical Energy plays a significant role in day-to-day life of entire mankind. This course deals with the generation of power along with its economic aspects. It deals with the basic theory of various conventional power stations and the different components present in them. The course also helps the students to familiarize with different types of substations and its advantages and disadvantages. It also deals with the economic aspects of power system, power factor correction techniques and suitable pricing methods.

### Course Pre/co-requisites

The course has no specific prerequisite and co requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8283.1 List the different components of an electric power system.
- A8283.2 Categorize the conventional methods of generating electrical power to meet the required load demand.
- A8283.3 Categorize the Non-conventional methods of generating electrical power to meet the required load demand.
- A8283.4 Model a power system to reduce economic losses.

## 3. Course Syllabus

**Introduction:** Conventional Energy Sources and their availability, Non-Conventional Energy Sources and their availability, Environmental impact of conventional and Non-Conventional energy sources. Hydro Electric Power Plants: Site selection, Plant layout, various components, Types of turbines, Governor and speed regulation, Pumped storage, Small scale hydroelectric plants (mini and micro).

**Thermal Power Plant:** Site selection, Plant layout, Coal its storage, Preparation, Handling, Feeding and burning, Cooling towers, Ash handling, Water treatment plant, High pressure boilers and steam turbines.

**Nuclear Power Plant:** Main components of nuclear power plant, Nuclear reactors types and applications, Radiation shielding, Radioactive and waste disposal safety aspect.

**Non-Conventional Energy:** Types of Non conventional Energy generation: solar, wind, tidal, biomass and wave energy.



**Economic Aspects of Power Generation and Tariff Methods:** Base load and peak load on power station. Interconnected grid system, Load curve, load duration and integrated load duration curves, demand, diversity, capacity, utilization and plant use factors. Costs of electrical energy - Fixed, Semi-fixed and Running Costs, Selection of type of generation and generation equipment, Performance and operating characteristics of power plants, Economic scheduling principle. Tariff, Characteristics, Types - Flat Rate, Block-Rate, two-part, three-part, and power factor tariff methods.

#### 4. Text Books:

1. M. L. Soni, P. V. Gupta, U. S. Bhatnagar, A. Chakrabarti (2010), "A Text Book on Power System Engineering", 2<sup>nd</sup> Edition, Dhanpat Rai & Co. Pvt. Ltd, New Delhi.
2. C. L. Wadhwa (2010), "Generation, Distribution and Utilization of Electrical Energy", 3<sup>rd</sup> Edition, New Age International (P) Limited, New Delhi.

#### Reference Books:

1. Leonard L. Grigsby (2012), "Electric Power Generation Transmission and Distribution, 3<sup>rd</sup> Edition, CRC press.
2. J. B. Gupta (2010), "A Course in Power Systems", 10<sup>th</sup> Edition, S. K. Kataria & Sons, New Delhi.

**Course Structure****A8381 - Hybrid Vehicles**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

The Basics of Hybrid Vehicles course introduces fundamental concepts in hybrid technology, combining internal combustion engines with electric propulsion. Students learn about hybrid vehicle architectures, regenerative braking, and battery systems. The curriculum covers energy management strategies, efficiency considerations, and the environmental impact of hybrid vehicles. Practical insights and case studies provide a foundation for understanding the design and operation of hybrid transportation systems.

**Course Pre/co-requisites**

This course has no specific prerequisite and co-requisite.

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8381.1 Identify different types of hybrid vehicles and their power train configurations
- A8381.2 Analyze the energy management strategy for hybrid vehicles
- A8381.3 Develop and optimize the hybrid vehicles subsystems
- A8381.4 Apply advanced technologies and materials in hybrid vehicles design
- A8381.5 Evaluate the performance and environmental impact of hybrid vehicle.

**3. Course Syllabus****Introduction to Hybrid Vehicles:**

Overview of hybrid vehicles and their advantages, types of hybrid vehicles (series, parallel, series-parallel), comparison with conventional vehicles and electric vehicles, historical background and evolution of hybrid vehicles, current market trends and future prospects.

**Powertrain and Energy Storage Systems:** Overview of powertrain configurations for hybrid vehicles, electric motors and their control systems, internal combustion engines and their optimization for hybrid use, energy storage systems (batteries, capacitors, flywheels) and their selection criteria, power electronics and electrical systems for energy conversion and distribution.



**Energy Management and Control Systems:** Overview of energy management strategies for hybrid vehicles, energy flow diagrams and efficiency maps, control systems for hybrid powertrains (electronic controls, sensors, actuators), algorithm development for optimal energy management, real-time operating systems and software architectures for vehicle control.

**Aerodynamics and Thermal Management:** Overview of aerodynamic principles relevant to hybrid vehicles, drag reduction techniques and wind tunnel testing, cooling system design and optimization for hybrid vehicles, climate control systems and cabin comfort considerations, NVH (noise, vibration, harshness) management in hybrid vehicles.

**Challenges and Opportunities in Hybrid Vehicle Design:** Discussion of challenges unique to hybrid vehicle design (e.g., packaging, weight, cost), opportunities for innovation and advancement in hybrid technology, case studies of successful hybrid vehicle designs and their lessons learned, future outlook for hybrid vehicles and their role in sustainable transportation, emerging trends in alternative propulsion technologies (fuel cells, hydrogen fuel cell vehicles, autonomous vehicles)

## 4. Books and Materials

### Text Books:

1. C. Mi, M. A. Masrur and D. W. Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, John Wiley & Sons.
2. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management

### Reference Books:

1. . M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press.
2. T. Denton, “Electric and Hybrid Vehicles”, Routledge.

**Course Structure****A8382 - Fundamentals of Robotics**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

This course introduces students to the basics, types and elements of robots. The course exposes students to the theoretical concepts of robot kinematics. Path planning and trajectory planning concepts gives the perception on control of robotics. The concepts on actuators and sensors gives clear understanding and design ability for mobility systems. It gives an overview on application of robotics in manufacturing industry.

**Course Pre/co-requisites**

A8002 - Ordinary Differential Equations and Vector Calculus

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8382.1 Illustrate the basic concepts and components of a robotic system
- A8382.2 Select appropriate actuators and sensors for designing robot mobility system
- A8382.3 Solve transformation problems to describe the robot position and orientation of robot
- A8382.4 Apply the concepts of robot work cell design and control
- A8382.5 Choose appropriate robots for various applications suitable to modern manufacturing systems.

**3. Course Syllabus**

**Introduction to Robotics:** Classification of Robots, Advantages and Disadvantages of Robots, Degree of freedom, joints, Robot coordinates, Robot workspace, Robot characteristics, Robot Components, types of robot arms, end effectors, grippers.

**Actuators:** Characteristics of Actuating Systems, Comparison of Actuating Systems, Hydraulic and Pneumatic Devices, Electric Motors in Robotics. **Sensors:** Sensor Characteristics, Position Sensors, Velocity Sensors, Acceleration Sensors, Touch and Tactile Sensors, Proximity Sensors, Range Finder.



**Manipulator Kinematics:** Specifications of matrices, Homogeneous Transformation, D-H notation, joint coordinates and world coordinates, Forward and inverse kinematics, Simple problems. **Path Planning:** Trajectory planning and avoidance of obstacles, Path planning, introduction to robot programming.

**Robot Work Cell Design and Control:** Robot Cell Layouts, Multiple Robots and Machine Interface, Some Consideration in Work Cell Design, Interlocks, Error Detection and Recovery, Robot Cycle Time Analysis.

**Robotic Applications:** Robots in manufacturing and non- manufacturing applications, Health Service, Intelligent Home Applications, Military Applications, Space Application, Entertainment robots, Service robots, Domestic or household robots.

## 4. Books and Materials

### Text Books:

1. Richard D. Klafter, Robotic Engineering, 2<sup>nd</sup> Edition, Prentice Hall of India, New Delhi.
2. M.P. Groover, Industrial Robotics, 3<sup>rd</sup> Edition, Pearson Education, New Delhi.

### Reference Books:

1. R.K. Mittal, I.J. Nagrath, Robotics and Control, 1<sup>st</sup> Edition, Tata Mc Graw Hill, New Delhi.
2. P. Coiffet, M. Chaironze, An Introduction to Robot Technology, 3<sup>rd</sup> Edition, Kogam Page Ltd, London.
3. Ganesh S. Hegde, A Textbook of Industrial Robotics, 2<sup>nd</sup> Edition, University Science Press.

**Course Structure****A8383 - 3D Printing**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

3D printing is an additive manufacturing process whereby objects are built up from plastic filament, liquid resin, layers of powder, or even bio-compatible and edible materials. Desktop 3D printing is today's printing press, putting rapid prototyping, customizable products, and individualized medical appliances in reach of the general public. Literacy in basic 3D modeling and manufacturing is an essential skill for future STEM success in this country. In this course students will learn how to be "makers" by using various types of 3D modeling software and imaging equipment, printing actual physical objects that they have designed and modeled themselves, and participating in educational outreach in the institute and the community.

**Course Pre/co-requisites**

A8302 - Computer Aided Drawing

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8383.1 Illustrate the fundamental concepts of Additive Manufacturing and 3-D printing, its advantages and limitations
- A8383.2 Apply engineering knowledge, techniques, skills and modern tools to analyze problems in 3D Printing
- A8383.3 Appraise additive manufacturing through 3d printing
- A8383.4 Solve Complex manufacturing problems for significant technological and societal development
- A8383.5 Evaluate engineering products using the knowledge of mathematics, science, engineering and IT tools.

**3. Course Syllabus**

**Introduction to 3D Printing:** Fundamental of 3D printing, Need for 3D printing Generic 3d printing process, Distinction between 3D printing and CNC, Classification of 3D printing Processes, Steps in 3D printing process, Advantages of 3D printing, standards for 3D printing, Major Applications. VAT Photo Polymerization 3d Printing Processes: Stereo



lithography (SL), Materials, SL resin curing process, Process Benefits and Drawbacks, Applications of Photo polymerization Processes.

**Material and Binder Jetting 3D Printing Processes:** Evolution of Printing as a 3D printing Process, Materials, Process Benefits and Drawbacks, Applications of Material Jetting Processes. Binder Jetting 3d Printing Processes: Materials, Process Benefits and Drawbacks, Research achievements in printing deposition, Technical challenges in printing, Applications of Binder Jetting Processes.

**Extrusion-Based 3D Printing Processes:** Fused Deposition Modeling (FDM), Principles, Materials, Plotting and path control, Bio-Extrusion, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes. Powder Bed Fusion 3d Printing Processes: Selective laser Sintering (SLS), Materials, Powder fusion mechanism, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes.

**Directed Energy Deposition 3D Printing Processes:** Process Description, Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Electron Beam Based Metal Deposition, Benefits and drawbacks, Applications of Directed Energy Deposition Processes. Wire arc based additive manufacturing methods, Advantages and disadvantages, comparison with conventional 3D printing and WAAM. Post Processing of 3d Printing Parts: Support Material Removal, Surface Texture Improvement, Accuracy Improvement, Aesthetic Improvement, Preparation for use as a Pattern, Property Enhancements using Non-thermal and Thermal Techniques. Inspection of 3D printing parts: Different destructive and non-Destructive testing of 3D printing parts, acceptance standards for 3D printing parts.

**3D Printing Applications:** Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Re-manufacturing. Application examples for Aerospace, defense, automobile, Bio-medical and general engineering industries.

## 4. Books and Materials

### Text Books:

1. Ian Gibson, David W Rosen, Brent Stucker, Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, 2<sup>nd</sup> Edition, Springer.
2. Ali K. Kamrani, EmandAbouel Nasr, Rapid Prototyping: Theory & Practice, 2<sup>nd</sup> Edition, Springer.



## Reference Books:

1. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, 1<sup>st</sup> Edition, Springer.
2. Rafiq Noorani, Rapid Prototyping: Principles and Applications in Manufacturing, 1<sup>st</sup> Edition, John Wiley & Sons.



## Course Structure

### A8402 - Digital Electronics

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

This course aims to teach students the fundamentals of digital electronics. Starting from learning the basic postulates of Boolean algebra, to cover map method for simplifying Boolean expressions, to outline the formal procedures for the analysis and design of combinational and sequential circuits, to design combinational and sequential programmable devices. These digital components are the basic building blocks from which more complex digital systems are constructed.

### Course Pre/co-requisites

This course has no specific prerequisite and co-requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8402.1. Apply fundamental theorems and properties of Boolean algebra to simplify a Boolean function.
- A8402.2. Apply the map method to obtain simplified and optimized logical expressions.
- A8402.3. Build combinational circuits using logic gates for real time digital systems.
- A8402.4. Analyze the behaviour of latches and flipflops for designing sequential logic. .
- A8402.5. Make use of programmable logic devices in the design of digital systems.

## 3. Course Syllabus

**Boolean Algebra and Logic Gates:** Introduction, basic definitions, axiomatic definition of Boolean algebra, basic theorem and properties, Boolean functions, canonical and standard forms, digital logic gates.

**Gate-Level Minimization:** The map method, two-variable, three-variable and four-variable K-maps, sum-of-products, product-of-sums simplification, don't-care conditions, NAND and NOR implementation.

**Combinational Logic:** Combinational circuits, analysis procedure, design procedure, binary adder-subtractor, magnitude comparator, decoders, encoders, multiplexers, demulti-



plexers.

**Synchronous Sequential Logic:** Sequential circuits, storage elements – latches and flip-flops, analysis of clocked sequential circuits. **Registers and Counters:** Registers, shift registers, ripple counters, synchronous counters.

**Memory and Programmable Logic:** Random-Access Memory, read-only memory, programmable logic array, programmable array logic.

## 4. Books and Materials

### Text Books:

1. M. Morris Mano, Michael D. Ciletti (2017), Digital Design With an introduction to the Verilog HDL, 6th Edition, Pearson Education/ PHI, India

### Reference Books:

1. Ronald J Tocci, Ronald J Tocci, Neal S Widmer , Gregory L Moss , Digital Systems - Principles an Applications , 10th Edition, Pearson Education International
2. Charles H RothJr, Larry L Kinney, Fundamentals of Logic Design,6th Edition, Cengage Learning



## Course Structure

### A8481 - Basic Electronics

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

This course covers fundamental topics that are common to a wide variety of analog and digital electronics. This course starts with basics of semiconductors, review the operation and characteristics of semiconductor devices (namely, semiconductor diodes and BJTs), and buildup to more advanced topics in analog circuit designs.

### Course Pre/co-requisites

A8006 - Applied Physics.

A8204 - Basic Electrical Engineering.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8481.1 Analyze the operation and characteristics of electronic devices.
- A8481.2 Construct electronic circuits making use of diodes and transistors.
- A8481.3 Analyze single stage amplifiers using small signal low frequency transistor model.
- A8481.4 Analyze the effect of negative and positive feedback on amplifiers.
- A8481.5 Design single stage amplifier for given specifications.

## 3. Course Syllabus

**Diode and its Characteristics:** P-N junction diode, operation in forward and reverse bias conditions, V-I characteristics, Zener diode and its characteristics, rectifiers - half wave, full wave and bridge rectifiers (simple problems), Filters (qualitative treatment), voltage regulation using Zener diode.

**Transistors:** Bipolar Junction Transistor (BJT) - construction, operation, CE, CB and CC transistor configurations and characteristics. **BJT Biasing:** Need for biasing, operating point, load line analysis, biasing and stabilization techniques: fixed bias, collector to base bias, self-bias.

**BJT Amplifiers:** Transistor as an amplifier, BJT h-parameter model, analysis of transistor amplifier using h- parameter model, CE, CB and CC amplifiers, comparison of CB, CE and CC configurations, Simplified h parameter model.

**Feedback Amplifiers** Concept of feedback, classification of feedback amplifiers, general Characteristics of negative feedback amplifiers, effect of negative feedback on input and output resistances.



**Oscillators:** Condition for oscillations, RC Phase shift oscillator with transistor, Wein bridge oscillator, Hartley and Colpitts oscillator.

## 4. Books and Materials

### Text Books:

1. Robert L. Boylestad and Louis Nashelsky, Electronic Devices and Circuit Theory, 11<sup>th</sup> Edition, PHI, 2013.
2. Jacob Milliman, Christos C .Halkias, Satyabrata Jit (2011), Electronic Devices and Circuits, 3<sup>rd</sup> edition, Tata McGraw Hill, New Delhi

### Reference Books:

1. G.K.Mittal (1999), Electronic Devices and Circuits, 22nd edition, Khanna Publications, New Delhi
2. S. Shalivahanan, N. Suresh Kumar, A. Vallavaraj (2007), Electronic Devices and Circuits, 3rd edition, McGraw Hill, New Delhi, India.

**Course Structure****A8482 - Principles of Communication Engineering**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

This course provides a foundation in the theoretical aspects of Electronic Communication Systems. This course focuses on Analog and Digital Communications, Pulse and Data Communications. This course forms the basis for the study of advanced communication systems like Telephone Switching networks, Computer Communications, Radar Communications, Cellular and Mobile Communications, Optical Communications and Satellite Communications.

**Course Pre/co-requisites**

The course has no specific prerequisite and co requisite.

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8482.1 Summarize the fundamental concepts and acquire competencies for each topic of analog and digital modulation techniques.
- A8482.2 Illustrate elements of analog, digital and data communications systems and identify their real-time applications.
- A8482.3 Compare analog and digital communication systems with respect to performance parameters and applications.
- A8482.4 Analyze the error control and coding techniques including Source Coding Technique, Huffman Source Coding, Error Control, and Coding.
- A8482.5 Distinguish the features of advanced communication systems.

**3. Course Syllabus**

**Introduction to Electronic Communications:** Historical Perspective, Electromagnetic Frequency Spectrum, Signal and its Representation, Elements of Electronic Communications System, Primary Communication Resources, Signal Transmission Concepts, Analog and Digital Transmission, Modulation, Concept of Frequency Translation, Signal Radiation and Propagation, Classification and Sources of Noise, Signal-to-Noise Ratio (SNR), Noise Figure.

**Principles of Analog Communication:** Types of Analog Modulation, Principles of Amplitude Modulation, AM Power Distribution, Limitations of AM, DSBSC Modulation, SSB Modulation, Vestigial-Sideband Modulation, Comparison of Analog Modulations, Applications, Principles of Angle Modulation, Theory of FM—Basic Concepts, Spectrum Analysis, Narrowband and Wideband FM, Theory of Phase Modulation, Relationship between FM and PM, Comparisons and Applications of FM and PM.



**Sampling Theorem and Pulse Modulation Techniques:** Digital Versus Analog Transmissions, Sampling Theorem, Classification of Pulse-Modulation Techniques: Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM), Pulse-Code Modulation (PCM), Quantization of Signals, Delta Modulation, Comparison of PCM Techniques, Vocoders.

**Digital Modulation Techniques and Information Theory:** Types of Digital Modulation, Amplitude Shift Keying, Frequency Shift Keying, Phase Shift Keying, Quadrature Phase Shift Keying, M-Ary PSK, Quadrature Amplitude Modulation, Minimum Shift Keying, Information, Entropy and Its Properties, Channel Capacity Theorem, Objectives of Source Coding, Source Coding Technique, Huffman Source Coding, Error Control and Coding.

**Advanced Communication Systems:** Spread Spectrum Communication: General Model, Features, Multiple Access techniques, Telephone Switching, Computer Communications, Optical Communications, Mobile Communications-the Cellular Concept, Satellite Communications, RADAR systems.

## 4. Books and Materials

### Text Books:

1. T L Singal, "Analog and Digital Communications", 1st edition, Tata McGraw-Hill, 2012
2. H. Taub, D L Schilling and G Saha, "Principles of Communication Systems", 3rd Edition, Tata McGraw-Hill, 2008.

### Reference Books:

1. George Kennedy, Electronic Communication Systems, Tata McGraw-Hill.
2. B. P.Lathi, "Modern Analog and Digital Communication Systems", 3rd Edition, Oxford University Press, 2007.



## Course Structure

### A8483 - Fundamentals of IoT

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

This course introduces you to Advance concepts and design techniques for creating Internet of Things systems and applications, as well as programming languages and tools optimized for the IoT industry. Participants are also exposed to new IoT-specific applications, physical layer protocols, communication technologies, and legacy protocols. This course will primarily present the fundamental IOT architecture building blocks and its theoretical components, such as Raspberry Pi programming using the Python Language Interface and other IOT peripherals.

### Course Pre/co-requisites

The course has no specific prerequisite and co requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8483.1 Identify the basic building blocks and its characteristics.
- A8483.2 Determine the most appropriate IoT Devices and Sensors based on Application.
- A8483.3 Make use of Python standard libraries for implementing various IoT Applications.
- A8483.4 Analyze the appropriate protocol for establishing communication between various IoT Devices.
- A8483.5 Interpret cloud infrastructure, services, APIs and architectures of commercial and industrial cloud platforms.

## 3. Course Syllabus

**Introduction to Internet of Things:** Introduction, Physical Design of IoT, Logical Design of IoT, IoT enabled Technologies, IoT Levels and Templates, IoT Platforms Design Methodology.

**Introduction to Python:** Language features of Python, Data types & data structures, Control of flow, Functions, Modules, Packages, File Handling, Data/Time operations, Classes, Python packages of interest for IoT(JSON,XML).

**IoT and M2M:** Introduction, M2M, Difference between IoT and M2M, SDN and NFV for IoT, IoT System Management with NETCONF- YANG-Need for IoT Systems Management, SNMP, Network Operator Requirements, NETCONF, YANG, IoT Systems Management with NETCONF-YANG.



**IoT Physical Devices and Endpoints:** Introduction to IoT Device, Exemplary Device: Raspberry Pi, Components of Raspberry Pi Board, Linux on Raspberry Pi, Raspberry Pi Interfaces, Programming – Raspberry Pi with Python.

**IoT Physical Servers and Cloud Offerings:** Introduction to Cloud Storage models and communication APIs, WAMP – AutoBahn for IoT, Xively Cloud for IoT, ThingSpeak IoT Python web application framework-Django, Designing a RESTful web API.

## 4. Books and Materials

### Text Books:

1. Arshdeep Bahga and Vijay Madisetti: Internet of Things, A Hands-on Approach; University Press, 2016
2. Mark Lutz, "Learning Python", 4th edition, O'REILLY, 2009.

### Reference Books:

1. Getting Started with Raspberry Pi: Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014.



## Course Structure

### A8484 - Introduction to Embedded Systems

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

Introduction to Embedded systems course introduces the basic concepts like purpose and quality attributes of embedded systems. It covers the differences between the general purpose computers and specific purpose computers and selection of memory according to the requirement for a system. This course presents ASICs, PLDs, COTS, Memory Interface, and communication interface. This course provides a comprehensive introduction to microcontroller (8051) and their architecture with an emphasis on its interfacing with external devices. Focus is on 8051 microcontroller family which includes internal architecture, pin diagram, instruction set, register organization, addressing modes, operating modes, interrupt structure, assembly language programming and etc. Various aspects of hardware design, such as interfacing of memory and different types of I/O devices will be covered in detailed.

### Course Pre/co-requisites

A8401 - Digital Logic Design.

A8416 - Computer Organization and Microprocessors.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8484.1 Classify the embedded systems based on the performance, complexity and the era in which they evolved.
- A8484.2 Understand different factors to be considered for the selection of memory, sensors, actuators and their interfacing.
- A8484.3 Apply the fundamentals of microcontroller to investigate existing designs.
- A8484.4 Demonstrate assembly language programming to assemble and driver circuitry to microcontroller I/O ports to interface external devices.
- A8484.5 Develop a product with functional requirements using optimal hardware and software components.

## 3. Course Syllabus

**Introduction to Embedded Systems:** Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification of Embedded Systems, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.

**Typical Embedded System:** Core of the Embedded System: General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the type of Interface, Memory Shadowing,



Memory selection for Embedded Systems, Sensors and Actuators, Communication Interface: Onboard and External Communication Interfaces.

**The 8051 Architecture:** Introduction, 8051 micro controller hardware, external memory interfacing, Data transfer and logical instructions, arithmetic operations, decimal arithmetic, jump and call instructions and simple programs. The Assembly Language Programming: Programming tools and techniques, counter and timers programming, interrupts, interrupt programming.

**I/O Interfaces:** 8051 interfacing with seven segment LED displays, stepper motor, D/A converter interfacing, Interfacing DC motor, Interfacing 4\*4 Matrix Keypad, Interfacing to Alphanumeric Displays (LCD) interfacing.

**Basic Design Using a Real-Time Operating System:** Tasks and Task states, Tasks and Data, Semaphores and Shared Data, Message Queues, Mailboxes and Pipes, Timer Functions, Events, Memory Management, Interrupt Routines in an RTOS Environment, Host and Target machines, Linker/Locators for Embedded Software, Getting Embedded Software into the Target System.

## 4. Books and Materials

### Text Books:

1. Introduction to embedded systems Shibu K V Tata Mcgraw-Hill First Edition 2012
2. Kenneth J. Ayala (2008), The 8051 Microcontroller, 3rd edition, Cengage Learning, India.
3. David E. Simon (1999), An Embedded Software Primer, Pearson Education, India

### Reference Books:

1. M. A. Mazidi J. G. Mazidi, Rolin D. McKinlay (2000), The 8051 Microcontroller and Embedded System, Prentice Hall of India, New Delhi.
2. Ajay V. Deshmukh (2004), Microcontrollers Theory and applications, Tata McGraw Hill Edition, New Delhi
3. Embedded Systems Rajkamal Tata Mcgraw-Hill Second Edition 2012

**Course Structure****A8510 - Operating Systems**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

Operating Systems is a graduate-level introductory course that teaches the concepts in operating systems like abstractions, mechanisms, and various services provided. This course deals with Process Management & Synchronization, Inter process communication, Memory Management, Virtual Memory, File & Disk Management and Deadlock handling methods. Using these concepts, the student will be able to understand the internal working of various operating systems. The course provides the concepts and terminology required for advanced courses.

**Course Pre/co-requisites**

A8506 - Computer Organization

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8510.1. Identify the services provided by the operating system for user and system.
- A8510.2. Examine the concepts of IPC and Synchronization for process cooperation
- A8510.3. Make use of Memory Management techniques for efficient use of main memory.
- A8510.4. Select File and Disk Management methods for effective storage and access.
- A8510.5. Identify a Deadlock Handling Method in allocating resources among processes.

**3. Course Syllabus**

**Operating Systems Overview and Process Management:** Definition, Operating System Types, Operating System operations, Operating system services, System calls and System Programs. Process concepts- Process, Process State Diagram, PCB and Operations on processes, Process Scheduling- Scheduling Criteria, Scheduler Types and Scheduling Algorithms.

**Process Synchronization:** Inter Process Communication- Pipes, Message Passing and Shared Memory. Concept of Synchronization, Critical section problem, Peterson's solution,



Semaphores, Classic problems of Synchronization-The Bounded Buffer Problem, The Readers –Writers Problem, Dining - Philosophers Problem.

**Memory Management:** Introduction to Memory Management, Swapping, Contiguous Memory Allocation, paging, segmentation, virtual memory, demand paging, Page-replacement algorithms, allocation of frames, thrashing.

**File and Disk Management:** Concept of a file – File Attributes, File Types, Access Methods, Directory Structures, File System Implementation, Directory Implementation, File Allocation methods, and Free-Space management. Introduction to Magnetic Disks, Disk Structures, Disk Scheduling, Swap Space Management.

**Deadlocks:** System Model, Deadlock Characterization-Necessary Conditions, Resource Allocation Graph, Deadlock Prevention, Deadlock Avoidance - RAG Algorithm, Banker's Algorithm, Detection- Single Instance of a Resource type, Multiple Instances of a resource type, recovery from deadlock.

## 4. Books and Materials

### Text Books:

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne., Operating System Concepts, 8<sup>th</sup> Edition, Wiley India Private Limited, New Delhi,2009.

### Reference Books:

1. William Stallings., Operating Systems, Internals and Design Principles, 5<sup>th</sup> Edition, Pearson Education, India, 2006.
2. Sumitabha Das., Your Unix the Ultimate Guide, Tata Mc Graw Hill, New Delhi, India, 2007.
3. T.Chan., Unix System Programming using C++, PHI, India,1996.



## Course Structure

### A8514 - Database Management Systems

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

This course introduces the core principles and techniques required in the design and implementation of database systems. This course focus on relational database management systems, including database design theory: E-R modeling, query languages like relational algebra, relational calculus and SQL. It also covers essential DBMS concepts such as: Normalization, Transaction Processing, Concurrency Control, Recovery and tree based indexing techniques like ISAM, B+ trees etc which are required for designing an effective database. Students can undertake a semester project to design, build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS.

### Course Pre/co-requisites

A8608 - Java Programming

A8601 - Object Oriented Programming

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8514.1. Design a database for a given problem using E-R diagrams and Relational Model.
- A8514.2. Construct Queries in Relational algebra and SQL for a case study.
- A8514.3. Use Normalization techniques to reduce data redundancy in data base.
- A8514.4. Select transaction control and recovery methods to keep data base consistent.
- A8514.5. Compare various indexing techniques and NoSQL databases for efficient access.

## 3. Course Syllabus

**Introduction and Data Base Design:** Introduction to DBMS, applications of DBMS, database systems versus file systems, view of data, Database users and administrators, database system structure. Introduction to Relational database model, database schema, relations, columns and tuples. SQL data types, Database languages, DDL commands, DML commands, DCL commands, TCL commands. Database Design: Introduction to ER model, entities, attributes and entity sets, relationships and relationship sets, additional features of



the E-R model. logical database design: E-R to relational.

**SQL Programming:** SQL basic operators, SQL set operators-union, intersect and except operators, Integrity constraints in SQL. aggregate operators, GROUP BY, ORDER BY and HAVING Clause, null values, views in SQL, nested queries, SQL joins-inner join, outer join, left outer join, right outer join, storing and retrieving images, storing and retrieving files, Relational algebra operations and basic queries.

**Schema Refinement and Normal Forms:** Introduction to schema refinement & Normalization, Decomposition and properties of decompositions, functional dependencies, Closure of Attributes set. Normal forms: 1NF, 2NF, 3NF, BCNF, 4NF,5NF. Problems on normalization, Schema refinement in database design. PL/SQL basics for writing triggers, cursors.

**Transaction Management:** Transaction concept, transaction states, ACID properties, schedules, Serializability-Conflict serializability, View serializability, recoverability. Concurrency control: lock based protocols, timestamp based protocols, deadlocks handling. SQL stored procedures.

**Indexing and NoSQL:** :Recovery-ARIES recovery algorithm, Log based recovery. File organization techniques, Tree index structures: ISAM and B+ trees. SQL Vs NoSQL, basic CRUD operations using MongoDB.

## 4. Books and Materials

### Text Books:

1. Raghurama Krishnan, Johannes Gehrke., Database Management Systems, 3<sup>rd</sup> Edition, Tata McGraw-Hill, New Delhi, India, 2014.
2. Abraham Silberschatz, Henry F. Korth, S. Sudarshan., Database System Concepts, 7<sup>th</sup> Edition, McGraw- Hill, New Delhi, India, 2019.

### Reference Books:

1. Elmasri Navate., Fundamentals of Database Systems, Database System Concepts, 7<sup>th</sup> Edition, Pearson Education, India,2016.
2. C. J. Date, A. Kannan and S. Swamynathan., An Introduction to Database Systems, 8<sup>th</sup> Edition, Pearson Education, India, 2015.

**Course Structure****A8520 - Software Engineering**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

This course acts as a foundation in the field of software engineering and is aimed at helping students develop an understanding of how software systems are developed from basic, by guiding them through the development process, adopting the fundamental principles of system development. The course will orient the students to the different software process models, software requirements engineering process, systems analysis and design as a problem-solving activity, with focus on quality.

**Course Pre/co-requisites**

This course has no specific prerequisite and co-requisite.

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8520.1. Identify the design issues and process models to develop a software.
- A8520.2. Determine the functional and non functional requirements with appropriate validation for a software product.
- A8520.3. Develop software design documents for the given requirements.
- A8520.4. Prepare test documents at various stages to validate project.
- A8520.5. Illustrate the need of quality management and metrics for product standardization

**3. Course Syllabus**

**Introduction to Software Engineering:** The Evolving nature of software engineering, Changing nature of software engineering, Software engineering Layers, The Software Processes, Software Myths. Process Models: A Generic Process Model, Waterfall Model, Incremental Process Models, Evolutionary Process Models, Spiral Model, the Unified Process.

**Requirements Engineering:** Functional and Non-Functional Requirements, The Software requirements Document, Requirements Specification, requirements Engineering, Requirements Elicitation and Analysis, Requirement Validation, Requirement Management.



**Design and Implementation:** System Modeling: Interaction Models, Structural Models, Behavioral Model, Model Driven Engineering. The Object Oriented Design with UML, Implementation Issues. User Interface Design: The Golden Rules, User Interface Analysis and Design, Interface Analysis, Interface Design Steps, Design Evaluation.

**Software Testing Strategies:** A Strategic approach to Software Testing, Strategic Issues and Test Strategies for Conventional Software, Validation Testing, Unit Testing , Integration Testing, Regression Testing , The Art of Debugging, White Box Testing - Basic Path Testing, Control Structure Testing. Black Box Testing - Equivalence partitioning, Boundary value analysis, Graph Based testing and state transition testing.

**Quality Management:** Quality Concepts, Software Quality, Software Quality Dilemma, Achieving Software Quality, Review Techniques, Reviews: A Formal spectrum, Informal Reviews, Formal Technical Reviews. Software Quality Assurance: Background Issues, Elements of Software Quality Assurance, Tasks, Goals and Metrics, Software Reliability, the ISO 9000 Quality Standards.

## 4. Books and Materials

### Text Books:

1. Roger S. Pressman., Software Engineering, A Practitioner's approach , 7<sup>th</sup> Edition, McGraw Hill International Edition, New Delhi, 2011.
2. Sommerville., Software Engineering, 9<sup>th</sup> Edition, Pearson education, India.

### Reference Books:

1. K. K. Agarwal, Yogesh Singh., Software Engineering, 3<sup>rd</sup> Edition, New Age International Publishers, India, 2007.
2. Lames F. Peters, Witold Pedrycz, Software Engineering an Engineering approach, John Wiley & Sons, New Delhi, India, 2000.
3. Shely Cashman Rosenblatt., Systems Analysis and Design, 6<sup>th</sup> Edition, Thomson Publications, India.

**Course Structure****A8607– Information Security**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

Information security is the practice of protecting information by mitigating risks across computer systems. The course introduces the technical and policy foundations of information network security. This course explains the inner workings of cryptographic systems and how to correctly use them in real-world applications.

**Course Pre/co-requisites**

A8519 - Computer Networks.

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8607.1 Recognize various security threats, services, mechanisms, and classical encryption techniques.
- A8607.2 Apply classical encryption algorithms (Substitution and Transposition ciphers) and DES, AES algorithms to encrypt plain text.
- A8607.3 Explain various key management techniques, exemplifying RSA and Diffie-Hellman.
- A8607.4 Examine the problems of authentication techniques (SHA, Digital signature).
- A8607.5 Analyze different symmetric key distribution and understanding of various authentication applications

**3. Course Syllabus**

**Introduction to Information Security:** Computer security concepts, OSI security architecture, security attacks, security services, security mechanisms, a model for network security. **Classical Encryption Techniques:** Symmetric Cipher Modes, Substitute Techniques, Transposition Techniques.

**Block Cipher and Data Encryption Standards:** Traditional Block Cipher Structure, The Data Encryption Standard, A DES Example, The Strength of DES, Block Cipher Design Principles, tools used for DES. **Advanced Encryption Standards:** Advanced Encryption Standard, Finite Field Arithmetic, AES Structure, AES Transformation Functions, AES Key Expansion, tools used for AES. Blowfish Algorithm, International Data Encryption Algorithm (IDEA).

**Number Theory:** Prime Numbers, Fermat's and Euler's Theorems, Testing for Primality, The Chinese Remainder Theorem, extended Euclid's algorithm. Public-Key Cryptography



and RSA: Principles of Public key crypto Systems, RSA algorithm, Diffie-Hellman Key Exchange.

**Hash Functions:** Cryptographic Hash Functions, Applications of Cryptographic Hash Functions, Two Simple Hash Functions, Requirements and Security, Hash Functions Based on Cipher Block Chaining, Secure Hash Algorithm (SHA). Digital Signature: Digital Signature Requirements, Attacks and Forgeries, Properties.

**Key Management and Distribution :** Symmetric Key Distribution Using Symmetric Encryption, Symmetric Key Distribution Using Asymmetric Encryption, Distribution of Public Keys, X.509 Certificates, Public-Key Infrastructure. Transport-Level Security: Web Security Considerations, Secure Sockets Layer, Transport Layer Security Email Security: Pretty Good Privacy (PGP).

## 4. Books and Materials

### Text Books:

1. William Stallings, Cryptography and network security: principles and Practice Upper Saddle River: Pearson, 6<sup>th</sup> edition.

### Reference Books:

1. Forouzan, Behrouz A., and Debdeep Mukhopadhyay. Cryptography and network security (Sie). McGraw-Hill Education, 2011.
2. AtulKahate., Cryptography and Network Security, 2<sup>nd</sup> edition, Tata Mc-Grawhill, India, 2008.



## Course Structure

### A8608 - Java Programming

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

This course provides Object Oriented Programming concepts using Java. The course focuses on different aspect of core Java Environment suitable to write efficient, maintainable, and portable code. It also ignites Object Oriented thinking and explores with the evolution of Java and its basics. It provides strong foundation on Inheritance, Packages and Interfaces and also illustrates Exception Handling and Multithreaded mechanisms. It also provides Collection framework for manipulating data. This course also focuses on file handling using Java API.

### Course Pre/co-requisites

A8505 - Data Structures

A8508 - Python Programming Laboratory

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8608.1 Make use of various constructs to write a console application.
- A8608.2 Use principles of OOP to develop real time applications.
- A8608.3 Identify the need of exception handling to deal with runtime errors.
- A8608.4 Build applications for parallel processing using Multithreading.
- A8608.5 Choose Collection framework and I/O to manipulate and store data.

## 3. Course Syllabus

**Introduction to OOP :** Evolution of Java, OOP principles, Java Buzzwords, Implementing Java program, JVM, Data Types, Variables, Type conversions and Casting, Operators, Control statements, Arrays. Classes, Objects, Methods, Constructors, this keyword, Overloading Methods and Constructors, Argument passing, Exploring String class.

**Inheritance, Interfaces and Packages:** Inheritance- Inheritance Basics, Using super, Multilevel Hierarchy, Method Overriding, Dynamic Method Dispatch, Abstract classes, final keyword. Packages and Interfaces: Defining a Package, Finding Packages and CLASSPATH,



Access Protection, Importing Packages, Defining and Implementing interfaces, Extending interfaces.

**Exception Handling:** Exception Handling Fundamentals, Exception Types, using try catch, throw throws and finally keywords, Built-in Exceptions, Creating own exception subclasses.

**Multithreading:** Multithreading: Multithreading- Life cycle of a thread, Thread class methods, creating threads, thread priorities, Synchronizing threads, Interthread Communication.

**Collections and I/O :** Collections - Introduction to Collection Framework, Collections Hierarchy, ArrayList, LinkedList, HashSet, TreeSet. The Date and StringTokenizer. I/O – Basics, reading and writing console input and output, PrintWriter class, operations of files – reading, writing and copying files.

## 4. Books and Materials

### Text Books:

1. Herbert Schildt, Java: The Complete Reference, 11th Edition, Tata McGraw-Hill Education, 2019.

### Reference Books:

1. Y.Daniel Liang, Introduction to Java Programming-Comprehensive Version, 10th Edition, Pearson Education, 2018.
2. Kathy Sierra, Bert Bates, OCA Java SE 8 Programmer, 1st Edition, McGraw-Hill Education, 2017.



## Course Structure

### A8651 - Ethical Hacking

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

Ethical hacking strikes all of us as a subject that requires a great deal of prerequisite knowledge about things like heavy duty software, languages that includes hordes of syntaxes, algorithms that could be generated by maestros only. Well that's not the case, to some extent. This course introduces the steps required to complete a penetration test, or ethical hack. Requiring no prior hacking experience, the book explains how to utilize and interpret the results of modern day hacking tools that are required to complete a penetration test. Coverage includes GoogleHacking, Nmap, Nessus, Metasploit, and Hacker Defender rootkit. Simple explanations of how to use these tools and a fourstep methodology for conducting a penetration test provide readers with a better understanding of offensive security.

### Course Pre/co-requisites

A8519-Computer Networks

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8651.1 Use the various security tools to assess the computing system.
- A8651.2 Identify the vulnerabilities across any computing system using penetration testing.
- A8651.3 Choose a prediction mechanism to prevent any kind of attacks.
- A8651.4 Make use of metasploit tool to probe systematic vulnerabilities on networks and servers.
- A8651.5 Identify the wireless network flaws and fill security patches in web access.

## 3. Course Syllabus

**Introduction to Hacking:** Important Terminologies, Penetration Test, Vulnerability Assessments versus Penetration Test, Pre-Engagement, Rules of Engagement, Penetration Testing Methodologies, OSSTMM, NIST, OWASP, Categories of Penetration Test, Types of Penetration Tests, Vulnerability Assessment Summary Reports.

**Information Gathering Techniques:** Information Gathering Techniques, Active Information Gathering, Passive Information Gathering, Sources of Information Gathering, Information Gathering with Whois, Tracing the Location, Traceroute, ICMP Traceroute, TCP Traceroute, Usage, UDP Traceroute, Enumerating and Fingerprinting the Webservers, Google Hacking.



**Network Attacks:** Vulnerability Data Resources, Exploit Databases, Network Sniffing, Types of Sniffing, Promiscuous versus Nonpromiscuous Mode, MITM Attacks, ARP Attacks, Denial of Service Attacks, Hijacking Session with MITM Attack, SSL Strip: Stripping HTTPS Traffic, DNS Spoofing, ARP Spoofing Attack Manipulating the DNS Records, DHCP Spoofing, Remote Exploitation, Attacking Network Remote Services, Overview of Brute Force Attacks, Traditional Brute Force, Attacking SMTP.

**Exploitation:** Introduction to Metasploit, Reconnaissance with Metasploit, Port Scanning with Metasploit, Compromising a Windows Host with Metasploit, Client Side Exploitation Methods, e- Mails with Malicious Attachments. .

**Wireless and Web Hacking:** Wireless Hacking, Introducing Aircrack, Cracking the WEP, cracking a WPA/WPA2 Wireless Network Using Aircrack-ng, Brute Force and Dictionary Attacks, Types of Authentication.

## 4. Books and Materials

### Text Books:

1. Rafay Baloch., Ethical Hacking and Penetration Testing Guide, CRC Press, 2014.

### Reference Books:

1. Kevin Beaver, Ethical Hacking for Dummies, 6<sup>th</sup> Edition, Wiley, 2018.
2. Jon Erickson., Hacking: The Art of Exploitation, 2<sup>nd</sup> Edition, Rogunix, 2007.



## Course Structure

### A8652 - Cyber Security

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

This course provides a comprehensive overview of various cybercrimes, how they are planned, possible vulnerabilities and crimes that occur in mobile and wireless devices. It introduces tools and techniques that are used in cybercrime. It helps in analyzing and designing defensive security mechanisms for protecting information systems resources.

### Course Pre/co-requisites

A8519- Computer Networks

A8607- Information Security

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8652.1 Identify the cybercrimes and offences in network accesses.
- A8652.2 Interpret the criminal plans before going to attack.
- A8652.3 Choose various security measures on mobile devices for a given scenario and make an effective report.
- A8652.4 Identify the various methods and tools in Cyber Crime.
- A8652.5 Examine various defense and analysis techniques to protect our information from attackers

## 3. Course Syllabus

**Introduction to Cybercrime:** Introduction, Cybercrime, and Information Security, who are Cybercriminals, Classifications of Cybercrimes. Cybercrime: The legal Perspectives and Indian Perspective, Cybercrime and the Indian ITA 2000, A Global Perspective on Cyber-crimes.

**Cyber Offenses:** How Criminals Plan Them: Introduction, How Criminals plan the Attacks, Social Engineering, Cyber stalking, Cyber cafe and Cybercrimes. Botnets: The Fuel for Cybercrime, Attack Vector, and Cloud Computing.

**Cybercrime -Mobile and Wireless Devices:** Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.



**Tools and Methods Used in Cybercrime:** Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horse and Backdoors, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Overflow.

**Defense and Analysis Techniques:** Memory Forensics - Why Memory Forensics Is Important, Capabilities of Memory Forensics, Memory Analysis Frameworks, Dumping Physical Memory, Installing and Using Volatility, Finding Hidden Processes, Volatility Analyst Pack, Honey pots, Intrusion Detection Systems.

## 4. Books and Materials

### Text Books:

1. Nina Godbole and Sunil Belapure., Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives,1<sup>st</sup> Edition,Wiley INDIA, 2011.
2. James Graham, Richard Howard and Ryan Otson., Cyber Security Essentials,1<sup>st</sup> Edition,CRC Press,2011.

### Reference Books:

1. Chwan-Hwa(John), Wu,J.David Irwin., Introduction to Cyber Security,1<sup>st</sup> Edition, CRC Press T and F Group, 2013.
2. Richard A. Clarke, Robert Knake., Cyberwar: The Next Threat to National Security and What to Do About It,Ecco 2010.



## Course Structure

### A8656 - Blockchain Technology

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

This course introduces blockchain, a revolutionary technology that enables peer-to-peer transfer of digital assets without any intermediaries, and is predicted to be just as impactful as the Internet. A blockchain is a permanent, sequential list of transaction records distributed over a network. The course introduces consensus, proof of work, mining, in Bitcoin. The course introduces ethereum blockchain and smart contracts.

### Course Pre/co-requisites

A8607 - Information Security

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8656.1 Identify the basic concepts of block chain to process data
- A8656.2 Make use of Bitcoin as cryptocurrency
- A8656.3 Choose Ethereum block chain for security
- A8656.4 Design smart contracts as per the requirements and deploy on Testnet works.

## 3. Course Syllabus

**Introduction to Cryptocurrencies:** Cryptographic Hash Functions, Hash Pointers and Data Structures, Digital Signatures, Public Keys as Identities, A Simple Cryptocurrency. How Bitcoin Achieves Decentralization: Centralization vs. Decentralization, Distributed Consensus, Consensus without Identity: the Block Chain, Incentives and Proof of Work, Putting It All Together.

**Mechanics of Bitcoin:** Bitcoin Transactions, Bitcoin Scripts, Applications of Bitcoin Scripts, Bitcoin Blocks, The Bitcoin Network, Limitations Improvements. Store Usage: How to Store and Use Bitcoins, Hot and Cold Storage, Splitting and Sharing Keys, Online Wallets and Exchanges, Payment Services, Transaction Fees, Currency Exchange Markets.

**Bitcoin Mining:** The Task of Bitcoin Miners, Mining Hardware, Energy Consumption Ecology, Mining Pools, Mining Incentives and Strategies. Bitcoin and Anonymity: Anonymity Basics, How to de-anonymize Bitcoin, Mixing, Decentralized Mixing, Zerocoin and Zerocash, Tor and the Silk Road.

**Ethereum:** What is Ethereum, smart contracts, Solidity Ethereum Virtual machine. Installing solidity ethereum wallet, basics of solidity by example, Layout of a solidity source file



structure of smart contracts, General value types, ether units, Time units, Globally available variables and functions.

**Operators:** Arithmetic, Logical Bitwise operators, Control structure (if-else, for, while, do-while), Scoping and declarations, Input parameters and output parameters, Function calls return types, Function Modifiers, Fallback functions, Abstract contract, Creating contracts via new operator, Inheriting smart contracts, Importing smart contracts compiling contracts, Events logging, exceptions, Examples of smart contract : crowd funding, voting ballot.

## 4. Books and Materials

### Text Books:

1. Narayanan, A., Bonneau, J., Felten, E., Miller, A., Goldfeder, S., Bitcoin and cryptocurrency technologies: a comprehensive introduction, Princeton University Press, 2016.
2. Dave Hoover, Kevin Solorio, and Randall Kanna., Hands-On Smart Contract Development with Solidity and Ethereum, O'Reilly Media, Inc., 2019.

### Reference Books:

1. Andreas M. Antonopoulos, Mastering Bitcoin: Unlocking Digital Cryptocurrencies, 1<sup>st</sup> Edition, O'Reilly Media, Inc., 2019.



## Course Structure

### A8658 - Robotic Process Automation

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

RPA is an advanced form of business process automation that can provide a path for businesses to automate human actions. RPA is ultimately about automating some of the most mundane and repetitive computer-based tasks and processes in the workplace like text, image automation with sequence of actions, keyboard-based automation, and E-mail automation etc. Process automation is able to record tasks performed by a human on their computer, then perform those same tasks without human intervention. This course will help Students to learn how to Automate the Tasks in real time.

### Course Pre/co-requisites

The course has no specific prerequisite and co requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8658.1. Discuss use of RPA platform and its components.
- A8658.2. Apply sequence and control flows as per the requirements.
- A8658.3. Analyse data manipulation concepts to solve real time problems.
- A8658.4. Illustrate user interface explorer and handle events.
- A8658.5. Demonstrate scenario of handling the errors and exceptions and benefits of RPA.

## 3. Course Syllabus

**Introduction to Robotic Process Automation:** Scope and techniques of automation, Benefits of RPA, Components of RPA, RPA platforms, About UiPath. Record and Play: UiPath stack, Downloading and installing UiPath Studio, Learning UiPath Studio, Task recorder, Step-by-step examples using the recorder.

**Sequence & Control Flow:** Sequence, Flowchart, and Control Flow, Sequencing the workflow, Activities, Control flow, various types of loops, and decision making, Step-by-Step example using Sequence and Flowchart, Step-by step example using Sequence and Control flow.

**Data Manipulation:** Variables and scope, Collections, Arguments-purpose and use, Data table usage with examples, Clipboard management, File operation with step-by-step example, CSV/Excel to data table and vice versa (with a step-by-step example).



**Handling events:**Element triggering events, image triggering events, system triggering events, PDF Extraction, Revisit Recorder: Basic recording, Desktop recording, web recording, Screen Scraping, Automation Techniques: Incoming Email automation, Sending Email automation, Workbook and Excel automation (read/write).

**Error and Exception Handling:** Exception handling, Common exceptions and ways to handle them,debugging techniques, Collecting crash dumps, Error reporting. Future of RPA,RPA Compared to BPO, BPM and BPA

## 4. Books and Materials

### Text Books:

1. Alok Mani Tripathi, Learning Robotic Process Automation, Publisher: Packt Publishing  
Release Date: March 2018 ISBN: 9781788470940.
2. Tom Taulli, The Robotic Process Automation Handbook: A Guide to Implementing RPA System, Publisher: A press,2020.

### Reference Books:

1. Frank Casale (Author), Rebecca Dilla (Author), Heidi Jaynes (Author), Lauren Livingston (Author), Introduction to Robotic Process Automation: a Primer, Institute of Robotic Process Automation.
2. Richard Murdoch, Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant.
3. SrikanthMerianda,Robotic Process Automation Tools, Process Automation and their benefits: Understanding RPA and Intelligent Automation.

### Web Resources:

1. <https://www.uipath.com/rpa/robotic-process-automation>

**Course Structure****A8681 - E-Commerce**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

The tremendous growth of the Internet and World Wide Web is making a great impact on businesses, governments and individuals throughout the world. In this course, students will understand the phenomena, technological, economic and social, behind these rapid changes, and how organizations successfully conduct Internet-based activities. This course discusses some of the technology of the Internet. This course provides an overview of e-commerce from both technological and managerial perspectives. It introduces e-commerce frameworks and technological foundations; and examines basic concepts such as strategic formulation for e-commerce enterprises, management of their capital structures and public policy. It is particularly important that the students emphasis on understanding the different E-Commerce system design principles.

**Course Pre/co-requisites**

The course has no specific prerequisite and co requisite.

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8681.1. Elaborate the components and roles of the E-Commerce environment.
- A8681.2. Estimate how to sell products and services on the web as well as to meet the needs of website visitors.
- A8681.3. Analyze the impact of E-commerce on business models and strategy.
- A8681.4. Create a portfolio of the steps required to start-up an on-line business.
- A8681.5. Interpret legal and ethical issues related to E-Commerce and web marketing approaches.

**3. Course Syllabus**

**Introduction to E-Business and E-Commerce:** What is the difference between e-commerce and e-business, Anatomy of E-Commerce applications, E-Business risks and barriers to business adoption, Management responses to E-Commerce and E-Business, Electronic Commerce-Frame work.

**E-Commerce Fundamentals:** Location of trading in the marketplace, Business models for ecommerce, Focus on auction business models, Focus on Internet start-up companies.

E-Business Infrastructure - Introduction, Internet technology, Web technology, Internet-access software applications, Managing e-business infrastructure, Focus on web services, SaaS and service oriented Architecture (SOA), Focus on mobile commerce.



**E-Environment:** Social and legal factors, Environmental and green issues related to Internet Usage, Focus on e-commerce and globalization, Political factors.

**E-Business Strategy** - What is e-business strategy, Strategic analysis, Strategic objectives, Strategy definition, Strategy implementation, Focus on information systems strategy and e-business strategy.

**E-Security:** Securing the Business on Internet- Security Policy, Procedures and Practices, Transaction Security, Cryptology, Digital Signatures, Security Protocols for Web Commerce. Supply Chain Management- What is supply chain management?, Focus on the value chain, Using e- business to restructure the supply chain, Supply chain management implementation

**E-Procurement:** What is e-procurement, Drivers of e-procurement, Focus on estimating e-procurement cost, implementing e-procurement.

## 4. Books and Materials

### Text Books:

1. Dave Chaffey., E-Business and E-Commerce Management , strategy, Implementation and practice, 5<sup>th</sup> Edition, Prentice Hall,2011.

### Reference Books:

1. E-Commerce fundamentals and applications Hendry Chan, Raymond Lee, Tharam Dillon, Elizabeth - 215 - Chang, JohnWiley.
2. Whinston,Pearson., Frontiers of electronic commerce –Pearson Education, Kalakata,2015.
3. Bharat Bhaskar: Electronic Commerce,TataMc-Graw-Hill, New Delhi, 2003
4. E-Commerce — Business, Technology, Society, Kenneth C.Taudon, Carol Guyerico-Traver.



## Course Structure

### A8682 - Full Stack Development

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

The popularity of JavaScript has brought many advancements and changed the face of web development. Real-world applications are looking at the web design with push capabilities. The purpose of this course is to study the concepts of JAVASCRIPT, React JS and Node JS to build user interface web-based applications to meet real-world needs.

### Course Pre/co-requisites

A8604 - Web Technologies

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8682.1 Demonstrate the fundamentals of scripting languages & non - scripting languages and its differences.
- A8682.2 Use react concepts to design forms.
- A8682.3 Use different node.js modules to connect with database.
- A8682.4 Build web application using Node.js.

## 3. Course Syllabus

**Introduction:** Introduction to scripting language, motivation , applications; scripting languages vs non-scripting languages; overview of popular scripting languages-JavaScript, Perl, Python; environments - Node.js and react.js, java scripting language constructs.

**React JS:** JSX and its use case, DOM, Virtual DOM and its working, ES6, Difference between ES5 and ES6, NPM Modules, React Elements, Render Function, Redux ,ReactJS with Redux.

**React JS:** Components, Class Component, Props, Events, Forms, CSS, Hooks & Context API, Material UI.

**Node.JS:** Concepts-modules, packages, working with HTTP, streams and file systems,



events, REST API, ExpressJS.

**Node.JS:** Database connectivity-MySQL, create connection, create database, working with Database operations-create table, insert, select, update, delete, etc.s

## 4. Books and Materials

### Text Books:

1. Learning Node.js A Hands on Guide to Building Web Applications in JavaScript, Marc Wandschneider, Second Edition, Addison-Wesley.
2. React.js Book: Learning React JavaScript Library From Scratch, Greg Sidelnikov, Learning Curve, 2017.

### Reference Books:

1. Beginning Node.js, Basarat Ali Syed, Apress, 2004.
2. The Node Beginner Book: A Comprehensive Node.js Tutorial, Manuel Kiessling, Leanpub, 2011.
3. FullStack React: The Complete Guide to ReactJS and Friends, Anthony Accomazzo, Anthony Accomazzo, Nate Murray, Ari Lerner, Clay Allsopp, David Guttman, and Tyler McGinnis.
4. Learning React: Functional Web Development with React and Redux, Alex Banks & Eve Porcello, O'Reily.

**Course Structure****A8702 – Artificial Intelligence**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

This is an undergraduate course to acquire the ability to design intelligent solutions to problems in a variety of domains and business applications such as natural language Processing, text mining, and robotics, reasoning and problem-solving. AI will focus on problem solving, reasoning, planning and gaming. Through learning problem solving skills can be acquired. The course enables to choose data science domain to implement machine learning and deep learning applications.

**Course Pre/co-requisites**

A8508-Python Programming Laboratory

A8509-Discrete Mathematical Structures

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8702.1. Apply AI techniques to solve game playing theorem proving and machine learning.
- A8702.2. Apply the propositional logic to AI designs .
- A8702.3. Learn different playing and reinforcement learning techniques .
- A8702.4. Examine the role of searching strategies in AI environment.
- A8702.5. Analyse the constraint satisfaction problems for problem solving.

**3. Course Syllabus**

**Introduction:** Introduction to AI - Intelligent Agents, Problem-Solving Agents, Searching for Solutions - Breadth-first search, Depth-first search, Hill-climbing search, Simulated annealing search, Local Search in Continuous Spaces.

**Adversarial Search :** Games, Optimal decisions in games, The minimax algorithm, Alpha-Beta pruning, Defining Constraint Satisfaction Problems, Constraint Propagation, Backtracking search for CSPs, Knowledge-Based Agents, The wumpus world.

**Propositional Logic:** Inference and proofs, Proof by resolution, Horn clauses and definite clauses. First-Order Logic : Syntax and Semantics of First-Order Logic, Using First Order Logic, Knowledge Engineering in First-Order Logic. Inference in First-Order Logic: Propositional vs. First-Order Inference, Unification, Forward Chaining, Backward Chaining, Resolution.

**Planning:** Definition of Classical Planning, Algorithms for Planning with State Space Search, Planning ,Graphs, Analysis of Planning approaches, Hierarchical Planning.



**Reinforcement learning:** Introduction, passive Reinforcement learning, active Reinforcement learning, Generalization in reinforcement learning. **Robotics:** Introduction, Robot Hardware, Robot Perception, planning to move, moving Robotic Software Architectures.

## 4. Books and Materials

### Text Books:

1. Stuart J. Russel, Peter Norvig, Artificial Intelligence – A Modern Approach, 3rd Edition, Pearson Education, 2009.

### Reference Books:

1. E. Rich and K. Knight, Artificial Intelligence, 3rd Edition, Tata McGraw Hill, 2008.
2. Patrick Henry Winston, Artificial Intelligence, 3rd Edition, Pearson Education Private Limited, India, 2001.
3. George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, 6th Edition, Pearson, 2008.
4. Shivani Goel, Artificial Intelligence, 4th Edition, Pearson Education Private Limited, India, 2009.



## Course Structure

### A8781- Computer Organization and Architecture

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
2	0	0	30	0	0	3	40	60	100

## 1. Course Description

### Course Overview

This course is designed to understand the concepts and functionalities of computer system among the various components such as registers, control unit and memory units. The course provides in-depth knowledge of internal working, structuring, and implementation of a computer system, the way the system is structured so that all those catalogued tools can be used properly. In addition, this course helps to construct the circuits to the corresponding operations and also discusses the multiprocessing. It is a fundamental course and provides the concepts and terminology required for advanced courses.

### Course Pre/co-requisites

A8402 - Digital Electronics

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8781.1. Identify various functional aspects of computer hardware.
- A8781.2. Choose various instructions and addressing modes to execute an instruction.
- A8781.3. Make use of integer and floating point algorithms to perform arithmetic operations on data.
- A8781.4. Design control unit and memory for a computer system.
- A8781.5. Examine the performance of a system using pipelining and multiprocessors.

## 3. Course Syllabus

**Introduction and Micro operations:** Computer functional units, Von – Neumann Architecture, Harvard architecture. Register transfer, Bus and memory transfer, arithmetic micro operations, logic micro operations, shift micro operations, arithmetic logic and shift unit. Data Representation – Fixed point and Floating point.

**Instructions and Addressing Modes:** Computer Instructions, Instruction Cycle, Register reference instructions, Memory reference instructions, Input-output and Interrupt. Stack organization, instruction formats, addressing modes, data transfer and manipulation, Inter-



rupt Handling and types.

**Computer Arithmetic:** Introduction, Addition, Subtraction and Multiplication algorithms on signed magnitude and two's complement data, Division Algorithms, Floating point arithmetic operations.

**Control Unit and Memory Organization:**Control memory, address sequencing, micro program example and design of control unit. Memory Hierarchy, Main Memory – RAM and ROM chips, Cache Memory – Introduction, Cache Mapping Techniques.

**Pipelining and Multiprocessors:** Parallel processing, Arithmetic Pipeline, Instruction pipeline and RISC pipeline. Multiprocessors- characteristics of multiprocessors, Interconnection structures, Interprocessor arbitration.

## 4. Books and Materials

### Text Books:

1. M. Moris Mano., Computer System Architecture,3<sup>rd</sup> Edition, Pearson Publication, India, 2006.
2. Stallings William., Computer Organization and Architecture,9<sup>th</sup> Edition, Pearson Education India, 2012.

### Reference Books:

1. Carl Hamacher, ZvonksVranesic, SafeaZaky., Computer Organization,5<sup>th</sup> Edition, McGraw-Hill, New Delhi, India, 2002.



## Course Structure

### A8851 - Data Science for Engineers

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

Data Science for Engineers course aims to equip engineering students with the essential knowledge and practical skills required to excel in the dynamic field of data science, emphasizing their ability to proficiently query and analyze diverse datasets. Through this course, students will gain a comprehensive understanding of the intricacies involved in handling heterogeneous data, learning how to effectively preprocess and visualize it. By exploring the methodologies and tools employed in data science, students will not only grasp the theoretical foundations but also engage in hands-on applications. Ultimately, upon completing this course, students will emerge with a well-rounded skill set that encompasses data querying and analytics, data preprocessing and visualization, and a solid foundation in data science methodologies and tools. This comprehensive preparation equips them to navigate the complex landscape of data science effectively and contribute meaningfully to data-driven decision-making processes.

### Course Pre/co-requisites

A8005- Computer Oriented Statistical Methods

A8514- Database Management Systems

A8804- Data Analytics

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8851.1 Identify the various requirements for data science process.
- A8851.2 Choose an appropriate database required for processing data.
- A8851.3 Demonstrate the data science methodology and text mining approaches.
- A8851.4 Make use of data science tools to visualize the insights of data.
- A8851.5 Apply various data visualization techniques using Tableau over Google Sheets.

## 3. Course Syllabus

**Importance of Data Science:** Need for Data Science, what is Data Science? Data Science Process, Business Intelligence and Data Science, Prerequisites for a Data Scientist, Components of Data Science, Tools and Skills needed. Statistics and Probability- Data Types, Variable Types, Statistics, Sampling Techniques and Probability, Information Gain and Entropy, Probability Theory, Probability Types, Probability Distribution Functions, Bayes' Theorem, Inferential Statistics.



**Databases for Data Science:** SQL – Tool for Data Science, Basic Statistics with SQL, Data Munging with SQL, Filtering, Joins, and Aggregation, Window Functions and Ordered Data, Preparing Data for Analytics Tool, Advanced NoSQL for Data Science- Why NoSQL, Document Databases for Data Science, Wide-Column Databases for Data Science, Graph Databases for Data Science.

**Data Science Methodology:** Analytics for Data Science, Examples of Data Analytics, Data Analytics Life Cycle- Data Discovery, Data Preparation, Model Planning, Model Building, Communicate Results, Operationalization. Data Analytics and Text Mining- Text Mining, Major Text Mining Areas, Text Analytics, Major Components of NLP, Stages of NLP, Statistical Processing of Natural Language, Applications of NLP.

**Data Science Tools-I:** Python Libraries: DataFrame Manipulation with pandas and NumPy, Data Wrangling: Clean, Transform, Merge, Reshape, Exploration Data Analysis with Python, Time Series Data, clustering with Python, Plotting and Visualization, ARCH and GARCH, Dimensionality Reduction.

**Data Science Tools-II:** Tableau- Introduction to Data Visualization and Tableau, Dimensions and Measures, Cleaning and Structuring Messy Data Descriptive Statistics, Basic Charts, Joins and blends, Filtering data, Row-level calculations, Aggregate-level calculations, Level of detail calculations, Custom Table Calculations, Dashboard Design & Principles, Special Chart Types, Integrate Tableau with Google Sheets.

## 4. Books and Materials

### Text Books:

1. Sanjeev Wagh, Manisha Bhende, Anuradha Thakare, Fundamentals of Data Science, 1<sup>st</sup> Edition, CRC Press, India, 2022.
2. Wes McKinney., Python for Data Analysis, 1<sup>st</sup> Edition, O'Reilly Publications, 2015.
3. Joshua N. Milligan, Learning Tableau 2019, Packt Publications, 2019.

### Reference Books:

1. Avrim Blum, John Hopcroft, Ravindran Kannan., Foundations of Data Science, 1<sup>st</sup> Edition, Cambridge University Press, 2020.
2. Ani Adhikari and John DeNero, Computational and Inferential Thinking: The Foundations of Data Science, GitBook, 2019.



## Course Structure

### A8081 - Mathematical Programming

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

This course provides mathematical knowledge required to analyze problems encountered in engineering. In this course, the students are acquainted with the Linear programming problem, Formulation and Graphical solution of Linear programming problem, Simplex method, Big -M method, Two-phase simplex method, Dual simplex method, Degeneracy in simplex and unbounded solutions, Transportation problem, Assignment model, Replacement models and Sequencing models. In addition, this course can be applied in many areas of engineering such as computer graphics, cryptography.

### Course Pre/co-requisites

This course has no specific prerequisite and co requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8081.1. Identify LPP and express in mathematical form to solve by graphical or simplex method.
- A8081.2. Apply artificial variable techniques to obtain the optimal solution of an LPP.
- A8081.3. Interpret various methods under transportation model to get optimal results.
- A8081.4. Solve travelling salesmen problem using Hungarian method.
- A8081.5. Develop various replacement and sequencing models to arrive at an optimal decision.

## 3. Course Syllabus

**Introduction to Operations Research:** Basic definition, scope, objectives, phases, models and limitations of Operations Research. Linear Programming Problem, Formulation and Graphical solution of Linear Programming Problem, Simplex method.

**Artificial Variables Techniques:** Big -M method, Two-phase simplex method, Duality in simplex method, Dual simplex method, degeneracy in simplex and unbound solutions.

**Transportation problem:** Formulation, solution, unbalanced Transportation problem. Finding initial basic feasible solutions, North-West corner rule, lowest cost entry method and Vogel's approximation method. Optimality test- MODI method, degeneracy in transportation, restricted transportation problem, conditional transportation problem.



**Assignment Model:** Formulation, Hungarian method for optimal solution, solving unbalanced problem, restricted assignment, conditional assignment problems, crew assignment problems, Travelling salesman problem, Transportation problem as assignment problem.

**Replacement Models and Sequencing Models:** Replacement Models: Replacement of Items that Deteriorate whose maintenance costs increase with time without change in the money value, Replacement of items that fail suddenly, individual replacement policy, group replacement policy. Sequencing Models: Solution of Sequencing Problem, Processing  $n$  Jobs through two machines, Processing  $n$  Jobs through three machines, Processing two Jobs through  $m$  machines, Processing  $n$  Jobs through  $m$  Machines.

## 4. Books and Materials

### Text Books:

1. Sharma S. D. Operation Research, Tata McGraw Hill, New Delhi, 2009.
2. Panneerselvam R. Operations Research, 2<sup>nd</sup> Edition, Prentice Hall of India, India, 2008.

### Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9<sup>th</sup> Edition, John Wiley & Sons, 2006
2. Sharma J. K. Operations Research – Theory and Applications, 5<sup>th</sup> Edition, Macmillan India Ltd, India, 2007.

**Course Structure****A8082 - Transform Calculus**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

This course provides mathematical knowledge required to analyze problems encountered in engineering. In this course, the students are acquainted with the Series Solutions of Second Order Ordinary Differential Equations, Fourier Series, Fourier Transforms, Z-Transforms and Applications of Transforms to Integral equations. In addition, this course can be applied in many areas of engineering such as computer graphics, cryptography, wireless communication, signal processing, robotics and animation.

**Course Pre/co-requisites**

A8002 - Ordinary Differential Equations and Vector Calculus.

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8082.1. Formulate series solutions of ordinary differential equations.
- A8082.2. Develop Fourier series for different types of functions.
- A8082.3. Apply Fourier Transform to connect the time and frequency domain.
- A8082.4. Analyze Z-transform and discrete signals to solve equations.
- A8082.5. Apply Laplace transforms to solve integral equations.

**3. Course Syllabus**

**Series Solutions of Second Order Ordinary Differential Equations:** Classification of Singularities, Series Solutions to Differential Equations around zero, Frobenius Method around zero.

**Fourier Series:** Euler's formulae, Dirichlet's conditions, Fourier series for functions having period  $2\pi$ , Fourier series for even and odd functions, Half range Fourier sine and cosine series.

**Fourier Transforms:** Fourier integrals, Fourier sine and cosine integrals, Fourier transforms, Fourier sine and cosine transforms, Inverse Fourier transforms, Finite Fourier transforms.

**Z-Transforms:** Definition, Some standard Z-transforms, Damping rule, Shifting rule, Multiplication by  $n$ , Initial and final value theorems. Inverse Z-transforms using partial fractions, Convolution theorem, Solution of difference equations by Z - transforms.

**Applications of Transforms to Integral equations:** Integral equations, Abel's Integral equations, Integral equation of convolution type, Integro differential equations, Applications



of Transforms to Integral equations.

## 4. Books and Materials

### Text Books:

1. Grewal, B.S. Higher Engineering Mathematics, 43<sup>rd</sup> Edition, Khanna Publications, 2015.
2. Jain, R.K. and Iyengar, S.R.K. Advanced Engineering Mathematics, Narosa Publishing House, 2015.

### Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9<sup>th</sup> Edition, John Wiley & Sons, 2006
2. Ramana, B.V. Higher Engineering Mathematics, 23<sup>rd</sup> Reprint, Tata Mc-GrawHill Education Private Limited, New Delhi, 2015.

**Course Structure****A8083 - Numerical Techniques**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

This course offers more advanced topics of mathematics required to analyze the problems in engineering. Topics to be covered in this course include: Solution of algebraic and transcendental equations, system of linear equations, Interpolation, Numerical differentiation and integration, curve fitting, Numerical solutions of ordinary and partial differential equations. The mathematical skills derived from this course provides necessary base to analytical and theoretical concepts occurring in the program.

**Course Pre/co-requisites**

This course has no specific prerequisite and co-requisite.

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8083.1 Apply numerical methods to obtain approximate solutions of algebraic and transcendental equations
- A8083.2 Make use of interpolation techniques to find approximate values and derivatives of the function at intermediate points
- A8083.3 Compute an approximate value of a definite integral using numerical integration
- A8083.4. Construct curve of best fit for the experimental data using method of least squares
- A8083.5. Select an appropriate numerical method to solve ordinary and partial differential equations.

**3. Course Syllabus**

**Solution of Algebraic, Transcendental Equations and System of Linear Equations:** Bisection method, Regula-falsi method, Iteration method, Newton - Raphson method. Iterative methods of solution of system of equations: Jacobi's iteration method, Gauss-Seidel iteration method.

**Interpolation:** Finite differences: Forward, Backward and Central differences, Other difference operators and relations between them, Differences of a polynomial, Missing terms, Newton's interpolation formulae, Interpolation with unequal intervals: Lagrange's interpolation formula.

**Numerical Differentiation, Integration and Curve fitting:** Numerical differentiation: Derivatives using Newton's interpolation formulae. Numerical integration: Newton-Cote quadrature formula, Trapezoidal rule, Simpson's one-third rule, Simpson's three-eighth



rule. Curve Fitting: Method of least squares, Fitting a straight line, Second degree parabola and Non-linear curves of the form  $y = ae^{bx}$ ,  $y = ab^x$ ,  $y = ax^b$  by the method of least squares

**Numerical Solution of Ordinary Differential Equations of First Order:** Taylor's series method, Picard's method, Euler's and modified Euler's Method, Runge-Kutta method of fourth order, Predictor and Corrector methods: Milne's method, Adams-Bashforth-Moulton method.

**Numerical Solution of Partial Differential Equations:** Finite difference approximations to partial derivatives, Elliptic equations: Solution of Laplace equation by Liebmann's iteration process, Parabolic equations: Solution of one dimensional Heat equation by Schmidt explicit method and Crank-Nicolson implicit method.

## 4. Books and Materials

### Text Books:

1. S.S. Sastry, Introductory Methods of Numerical Analysis, 5<sup>th</sup> Edition, PHI Learning Pvt. Ltd, New Delhi, 2012.
2. M.K. Jain, S.R.K Iyengar and R.K.Jain, Numerical Methods for Scientific and Engineering Computation, 5<sup>rd</sup> Edition, New Age International Publishers, New Delhi, 2007.

### Reference Books:

1. Grewal, B.S., Higher Engineering Mathematics, 43<sup>rd</sup> Edition, Khanna Publishers, New Delhi, 2014.
2. Ramana, B.V. Higher Engineering Mathematics, 23<sup>rd</sup> Reprint, Tata McGraw Hill Education (India) Pvt Ltd, New Delhi, 2015.
3. T.K.V. Iyengar, B. Krishna Gandhi & Others, Numerical Methods, 2<sup>nd</sup> Revised Edition, S Chand & Company Ltd, New Delhi, 2013.

**Course Structure****A8084 - Entrepreneurship Development**

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

**1. Course Description****Course Overview**

This course aims to provide students with an understanding of the nature of enterprise and entrepreneurship and introduces the role of the entrepreneur, will inculcate the knowledge of government supporting programs like financial assistance by public sector banks. Apart from this, students learn about the women entrepreneurs and success stories of women entrepreneurs, gain the knowledge of project management and profitability appraisal, focus on importance of training the new entrepreneurs as well as existing entrepreneurs.

**Course Pre/co-requisites**

The course has no specific prerequisite and co requisite.

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8084.1 Identify the role, characteristics, qualities and functions of entrepreneur.
- A8084.2 Interpret various Institutional supports for setting up a business enterprise.
- A8084.3 Illustrate role, importance and functions of women entrepreneur.
- A8084.4 Infer the concept of Project Management and steps in Project development.
- A8084.5 Indicate training programs and different training institutions to impart training.

**3. Course Syllabus**

**Entrepreneurship:** Importance and role of entrepreneurship, Qualities of an entrepreneur, Functions of entrepreneur, Theories of entrepreneurship, Stimulants of entrepreneurship and Barriers to entrepreneurship, Ethics and Social Responsibility, Role of entrepreneur in economic development.

**Institutional Support:** Role of Government: Role of IDBI, SIDBI, SIDO, NIESBUD, DIC, Entrepreneurship Development Institute, T-Hub (Telangana Hub).

**Women Entrepreneurship:** Role & Importance, Functions of women entrepreneur, Profile of Indian Women Entrepreneur, Problems of Women Entrepreneurs, Women Entrepreneurship Development in India and in Foreign Countries.

**Project Management:** Concept of project and classification of project, Project life cycle identification, Project formulation, Project report, Project evaluation- profitability appraisal, social cost benefit analysis, feasibility analysis, financial analysis and project financ-



ing, Project implementation, Project completion.

**Entrepreneur Training:** Designing appropriate training programmes to inculcate Entrepreneurial Spirit, significance of entrepreneurial training, Feedback and Performance of Trainees, NSIC, Pradhan Mantri Kaushal Vikas Yojana (PMKVY), Telangana Academy for Skill and Knowledge (TASK).

## 4. Books and Materials

### Text Books:

1. Robert Hisrich, Michael P. Peter, Dean A. Shepherd (2010), Entrepreneurship, Tata McGraw Hill, New Delhi

### Reference Books:

1. Bholanath Datta (2009), Entrepreneurship, Excel publications, India.
2. David H Holt (2010), Entrepreneurship, Prentice hall of India, New Delhi, India



### Course Structure

#### A8085 - Logistics and Supply Chain Management

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

The LSCM deals with effective management, organizing and monitoring of storage and distribution of goods. It imparts knowledge on the various functions of logistics management. It educate on designing of the supply chain network. it gives clarify the significance of establishing global supply chain. Also it will highlight the role of information technology in supply chain. The aim is to manage the entire order cycle in the most efficient way so that it enhances business development and ensures sustainability and customer satisfaction.

### Course Pre/co-requisites

This course has no specific prerequisite and co requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8085.1. Understand the cyclical perspective of logistics and supply chain process.
- A8085.2. Learn about the distribution, transportation, warehousing related issues and challenges in supply chain.
- A8085.3. Appreciate the significance of network design in the supply chain.
- A8085.4. Gain knowledge of various models/tools of measuring the Supply Chain Performance.
- A8085.5. Appreciate the role of coordination and technology in supply chain management.

## 3. Course Syllabus

**Understanding Supply Chain:** Objectives of a Supply Chain, Importance, Stages of Supply Chain, Value Chain Process, Cycle View of Supply Chain Process, Key Issues in SCM, Logistics & SCM, Supply Chain Drivers and Obstacles, Supply Chain Strategies, Strategic Fit, Best Practices in SCM, Obstacles of Streamlined SCM, Green Supply Chain Management, Supply Chain Sustainability – case study.

**Logistics:** Evolution, Objectives, Components and Functions of Logistics Management, Difference between Logistics and Supply Chain, Distribution related Issues and Challenges. Gaining Competitive Advantage through Logistics Management. **TRANSPORTATION:** Functions, Costs, and Mode of Transportation Network and Decision, Models, Containerization, Cross Docking, Reverse Logistics. **Outsourcing:** Nature and Concept, Strategic Decision to Outsourcing, Third-party Logistics (3PL), Fourth-party Logistics (4PL) - case study.



**Designing the Supply Chain Network:** Designing the Distribution Network ,Role of Distribution, Factors Influencing Distribution, Design Options, e-Business and its Impact, Distribution Networks in Practice, Network Design in the Supply Chain, Role of Network, Factors Affecting the Network Design Decisions ,Modeling for Supply Chain - case study.

**Supply Chain Performance:** Bullwhip Effect and Reduction, Performance Measurement: Dimension, Tools of Performance Measurement, SCOR Model. Demand Chain Management, Global Supply Chain, Challenges in Establishing Global Supply Chain, Factors that influence Designing Global Supply Chain Network-case study.

**Coordination in a Supply Chain:** Importance of Coordination, Lack of Supply Chain Coordination and the Bull whip Effect, Obstacles to Coordination, Managerial Levels, Building Partnerships and Trust, Continuous Replenishment and Vendor Managed Inventories, Collaborative Planning, Forecasting and Replenishment. Role of Information Technology in Supply Chain, Supply Chain 4.0.-Case study.

## 4. Books and Materials

### Text Books:

1. David B. Grant, Chee Yew Wong, Sustainable Logistics and Supply Chain Management: Principles and Practices for Sustainable Operations and Management, Kindle Edition
2. Fundamentals of Logistics Management (The Irwin/Mcgraw-Hill Series in Marketing), Douglas Lambert, James R Stock, LisaM. Ellram, McGrawhill/Irwin, First Edition, 1998.
3. Vinod V. Sople (2009) Logistic Management (2nd Edn.), Pearson Limited.

### Reference Books:

1. IMT Ghaziabad, Advanced Supply Chain Management Sage Publications, 2021.
2. Rajat K. Basiya, Integrated Supply Chain Management, Sage Publications, 2020.
3. K Sridhara Bhat, Logistics & Supply Chain Management, HPH,1e,2017.
4. Chopra, Sunil, Meindl, Peter and Kalra, D.V., Supply Chain Management: Strategy, Planning and Operation, Pearson Education,6e,2016.
5. Altekar, Rahul V, Supply Chain Management: Concepts and Cases, PHILearning,1e,2005.
6. Ballou, R.H. Business Logistics Management.Pearson Education,5e, 2014.
7. Coyle, Bardi, Langley, The Management of Business Logistics–A Supply Chain Perspective, Thomson Press,7e,2003.



## Course Structure

### A8086 - Management Science

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

In this course, students will learn the fundamental concepts and contributions of Management. It also explains Inventory control techniques, Human Resource Practices, Quality control techniques and Project Management which plays a vital role in the organization.

### Course Pre/co-requisites

The course has no specific prerequisite and co requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8086.1 Explain and infer the concepts and aspects of management.
- A8086.2 Analyze the contributions of management, organizational structures, plant layouts, work study tools for enhancement of productivity in an organization
- A8086.3 Apply the project management techniques to decide the optimum time and cost for completion of a project.
- A8086.4 Apply statistical quality control & Inventory control techniques to manage and control products and materials.
- A8086.5 Use Human resource management techniques for better people management.

## 3. Course Syllabus

**Introduction:** Management - Definition, Nature, Importance of management, Functions of Management- Taylor's scientific management theory, Fayol's principles of management, Contribution of Elton mayo, Maslow, Herzberg, Douglas MC Gregor. Basic concepts of Organisation Authority, Responsibility, Delegation of Authority, Span of control, Departmentation and Decentralization - Organisation structures (Line organization, Line and staff organization, Functional organization, Committee organization, Matrix organization).

**Operations Management:** Plant location, Factors influencing location, Principles and types of plant layouts - Methods of production (job, batch and mass production), Work study - Basic procedure involved in method study and Work measurement.

**Quality Control and Materials Management:** : Statistical quality control - Meaning- Variables and attributes - X chart, R Chart, C Chart, P Chart, (simple Problems) Acceptance sampling, Sampling plans, Deming's contribution to quality. Materials management - objectives, Need for inventory control, Purchase procedure, Store records, EOQ, ABC analysis, Stock levels.



**Human Resource Management (HRM):** Concepts of HRM, Basic functions of HR manager: Man power planning, Recruitment, Selection, Training and development, Placement, Wage and salary administration, Promotion, Transfers, Separation, performance appraisal, Job evaluation and Merit rating.

**Project Management:** Early techniques in project management - Network analysis: Programme evaluation and review technique (PERT), Critical path method (CPM), Identifying critical path, Probability of completing project within given time, Project cost analysis, project crashing (simple problems)..

## 4. Books and Materials

### Text Books:

1. Koontz & weihrich - Essentials of management, TMH, 8th edition, 2010
2. O.P. Khana, Industrial engineering and Management, Dhanpat rai publication

### Reference Books:

1. Dr.A.R.Aryasri, Management Science, TMH, 4th edition, 2009.
2. Stoner, Freeman, Gilbert, Management, 6th edition Pearson education, New Delhi, 2004
3. L.S.Srinath, PERT & CPM, 3rd edition East-West press pvt. ltd.-New Delhi.



## Course Structure

### A8087 - Human Resource Management

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

This course is intended to disseminate the concepts of Human resource management, functions of Human resource management from human resource planning to employee relations aspects that helps in effective functioning of an organization.

### Course Pre/co-requisites

This course has no specific prerequisite and co requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8087.1. Identify the functions of Human Resource Management.
- A8087.2. Illustrate the process of Recruitment and selection.
- A8087.3. Analyse the needs and methods of training.
- A8087.4. Appraise the functional relationship with performance compensation and employee welfare.
- A8087.5. Examine the significance of employee relations.

## 3. Course Syllabus

**Introduction to HRM:** Objectives and Functions of HRM, Challenges of HRM, Line Managers. HR Roles and responsibilities, Workforce and demographic trends, New Approaches to organizing HR, HR Scorecard - Human Resource Information System (HRIS).

**Recruitment and Selection:** Job Design, Job Analysis, Process and methods of data collection, Job descriptions and Job specification, Job enlargement, Job enrichment and Job rotation. Human Resource Planning, Recruitment, Sources of Recruitment, Recruitment on Diverse Work Force, e-Recruitment and Selection Process, Employee Testing and Selection, Basic Types of Interviews, Errors in Interviews.

**Training and Development:** Definition, Training vs. Development, Importance of Training and Development, Process of Training, Methods of Training and Management development programmes. **PERFORMANCE APPRAISAL:** Concepts of Performance Management, Process of Performance Management, Performance Appraisal, Techniques of Performance Appraisal, Errors in Performance Appraisal, Career Management.

**Compensation:** Objectives of compensation, Factors influencing on compensation, concept of job evaluation and techniques of job evaluation. **EMPLOYEE WELFARE:** Concept of employee welfare, performance-based pay benefits, provisions of employee's compensation



act and implications of employee welfare on productivity.

**Employee Relations:** Employee Associations, Grievances: Grievances Handling Procedure, Employee Separation, Downsizing, Work-Life Integration - Hybrid work culture, contemporary developments in HR practices. Stress Management, talent mobility, Prevention of sexual harassment (POSH) at workplace.

## 4. Books and Materials

### Text Books:

1. Gary Dessler, BijuVarkkey, Human Resource Management, 4th edition, Pearson Publication, 2017.
2. P. Subba Rao, Essentials of Human Resource Management, Himalaya Publishing, 6e, 2021.

### Reference Books:

1. Biswajeet Pattanayak, Human Resource Management, 6e, PHI Learning Pvt. Ltd, 2020.
2. Mamoria and Mamoria, Personnel Management, Himalaya Publications, 2006

**Course Structure****A8088 – Organizational Behavior**

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	45	0	3	40	60	100

**1. Course Description****Course Overview**

The course focuses upon translation of organizational behaviour theory to practices that result in organizational effectiveness, efficiency, and human resource development. The primary goal of this course is to prepare students for advanced leadership roles in modern organization.

**Course Pre/co-requisites**

This course has no specific prerequisite and co-requisite.

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8088.1. Analyse the Concepts and models of Organizational Behaviour and Contemporary challenges.
- A8088.2. Analyse the relevance of planning and decision making process for the development of the organisation.
- A8088.3. Identify various organisation design and control technique for better performance of the company.
- A8088.4. Examine the relevance of Individual and group behaviour in an organization and the role of Culture and dynamics
- A8088.5. Apply the theories of leadership and motivation to lead people to attain the organisation goals.

**3. Course Syllabus**

**Behavioural Concepts:** Nature and Concepts of Organizational Behaviour, Models of Organizational Behaviour, Relationship with Other Fields, Contemporary challenges. Learning: Nature and Significance of Learning, Process of Learning, Theories of Learning.

**Planning and Decision Making:** Planning and Goal Setting, Organizational Planning, Vision, Mission and Goals, Types of Plans, Steps in Planning Process, Approaches to Planning, Planning in Dynamic Environment. Decision-making Process, Types of Decisions, Decision Making Styles, Vroom's Participative Decision-making Model.



**Organizing and Controlling:** Organizational Structure, Principles of Organizing, Authority, Power and Influence, Designing Organizational Structure. Mechanistic and Organic Structures, Contemporary Organizational Design and its Challenges. Controlling: The Control Process, Controlling for Organizational Performance, Types of Control, Financial Controls, Balanced Scorecard, Bench Marking, Contemporary issues in Controlling.

**Organizational Behavior:** Individual and Group Behavior: Importance of Organizational Behavior, Culture and Dynamics of Diversity, Personality Theories, Perception, Formation of Group Behavior, Classification of Groups, Group Properties, Group Cohesiveness, Building Teams.

**Leadership and Motivation:** Leadership Traits, Leadership Styles, Leadership Theories, Power and Politics. Motivation: Approaches to Motivation, Maslow's Needs Hierarchy Theory, Two-factor Theory of Motivation, McGregor's Theory, ERG theory, McClelland's Needs Theory, Valance Theory.

## 4. Books and Materials

### Text Books:

1. K. Aswathappa, Organisational Behaviour, Himalaya Publications, 8e, 2021
2. Harold Koontz, Heinz Weihrich, Mark V Cannice, Essentials of Management, Tata McGraw Hill Education, 11e, 2020.
3. Stephen P. Robbins, Timothy A. Judge, Neharika Vohra, Organizational Behaviour, Pearson Education, 18e, 2018.

### Reference Books:

1. Luthans Fred, "Organizational Behaviour", Tata McGraw Hill.
2. Rao V S P., "Organizational Behaviour", Excel Books.
3. Chandrani Singh, Aditi Ktri, Principles and Practices of Management and Organizational Behaviour, Sage Publications, 1e,2016.
4. Afsaneh Nahavandi, Robert B. Denhardt, Janet V. Denhardt, Maris P. Aristigueta, Organizational Behaviour, Sage Publications, 1e, 2015.

**Course Structure****A8089 – Intellectual Property Rights**

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	45	0	3	40	60	100

**1. Course Description****Course Overview**

This Course deals with the types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights. It analyzes and evaluates the procedures involved in submission of application for the grant of intellectual property rights. It also deals with the significance of intellectual property of a business enterprise.

**Course Pre/co-requisites**

This course has no specific prerequisite and co-requisite.

**2. Course Outcomes (COs)**

After the completion of the course, the student will be able to:

- A8089.1. Identify the different types of intellectual property, agencies and treaties that protect intellectual property rights
- A8089.2. Classify the protectable matter of intellectual property rights.
- A8089.3. Analyze and evaluate the procedures involved in submission of application for the grant of intellectual property rights
- A8089.4. Interpret Trade secret law, liability for misappropriations of trade secrets, protection for submission, and trade secret litigation

**3. Course Syllabus**

**Introduction to Intellectual Property:** Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights.

**Trade Marks:** Purpose and function of trademarks, Trade mark rights, protectable matter, selecting and evaluating trademarks, trade mark registration process.

**Law of Copy Rights:** Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law.



**Law of Patents:** Foundation of patent law, patent searching process, ownership rights and transfer.

**Trade Secrets:** Trade secret law, determination of trade secrets status, liability for misappropriations of trade secrets, protection for submission, and trade secret litigation. Unfair Competition: Misappropriation right of publicity, false advertising.

## 4. Books and Materials

### Text Books:

1. R.S.Nagarajan, a Textbook on Professional Ethics and Human Values, New Age Publishers – 2006. Deborah.
2. Neeraj Pandey, Khushdeep Dharni- 2014, Intellectual property rights, PHI, India.

### Reference Books:

1. Prabudda ganguli (2003), Intellectual property right, Tata McGraw Hill Publishing company ltd., India.
2. P.N. Cheremisinoff, R.P. Ouellette and R.M. Bartholomew, Biotechnology Applications and Research, Technomic Publishing Co., Inc. USA, 1985
3. P. Narayanan; Law of Copyright and Industrial Designs; Eastern law House, Delhi, 2010



## Course Structure

### A8090 - Professional Practice, Law and Ethics

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

This course makes students to understand the types of roles they are expected to play in the society as practitioners of an engineering profession. It develops ideas of the legal and practical aspects of their profession. Students will learn importance of professional practice, Law and Ethics in their personal lives and professional careers and the rights and responsibilities as an employee and team leader.

### Course Pre/co-requisites

This course has no specific prerequisite and co requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8090.1. Apply the concepts of professional practice, Law and Ethics in their personal lives and professional careers.
- A8090.2. Analyze Arbitration, Conciliation and Alternative Dispute Resolution system
- A8090.3. Interpret Law relating to Intellectual property
- A8090.4. Apply the rights and responsibilities as an employee, team member in any organization as a global citizen.

## 3. Course Syllabus

**Professional Practice and Ethics:** Definition of Ethics, Professional Ethics - Engineering Ethics, Personal Ethics; Code of Ethics - Profession, Professionalism, Professional Responsibility, Conflict of Interest, Gift Vs Bribery, Environmental breaches, Negligence, Deficiencies in state-of-the-art; Vigil Mechanism, Whistle blowing, protected disclosures. Introduction to GST- Various Roles of Various Stake holders.

**Law of Contract:** Nature of Contract and Essential elements of valid contract, Offer and Acceptance, Consideration, Capacity to contract and Free Consent, Legality of Object. Unlawful and illegal agreements, Contingent Contracts, Performance and discharge of Contracts, Remedies for breach of contract. Contracts-II: Indemnity and guarantee, Contract of Agency, Sale of goods Act -1930: General Principles, Conditions & Warranties, Performance of Contract of Sale.

**Arbitration, Conciliation and ADR (Alternative Dispute Resolution) system:** Arbitration – meaning, scope and types – distinction between laws of 1940 and 1996; UNCITRAL model law – Arbitration and expert determination; Extent of judicial intervention;



International commercial arbitration; Arbitration agreements – essential and kinds, validity, reference and interim measures by court; Arbitration tribunal – appointment, challenge, jurisdiction of arbitral tribunal, powers, grounds of challenge, procedure and court assistance; Distinction between conciliation, negotiation, mediation and arbitration, confidentiality, resort to judicial proceedings, costs; Dispute Resolution Boards; Lok Adalats.

**Engagement of Labour and Labour & other construction-related Laws:** Role of Labour in Civil Engineering; Methods of engaging labour- on rolls, labour sub-contract, piece rate work; Industrial Disputes Act, 1947; Collective bargaining; Industrial Employment (Standing Orders) Act, 1946; Workmen’s Compensation Act, 1923; Building & Other - Construction Workers (regulation of employment and conditions of service) Act (1996) and Rules (1998); RERA Act 2017, NBC 2017.

**Law relating to Intellectual property:** Introduction – meaning of intellectual property, main forms of IP, Copyright, Trademarks, Patents and Designs, Secrets; Law relating to Copyright in India including Historical evolution of Copy Rights Act, 1957, Meaning of copyright – computer programs, Ownership of copyrights and assignment, Criteria of infringement, Piracy in Internet – Remedies and procedures in India; Law relating to Patents under Patents Act, 1970.

## 4. Books and Materials

### Text Books:

1. R. Subramanian - Professional Ethics, Oxford University Press, 2015.
2. Ravinder Kaur - Legal Aspects of Business, 4th edition, Cengage Learning, 2016.

### Reference Books:

1. RERA Act, 2017.
2. Wadhwa - Intellectual Property Rights, Universal Law Publishing Co.,2004.
3. T. Ramappa - Intellectual Property Rights Law in India, Asia Law House,2010.
4. O.P. Malhotra - Law of Industrial Disputes, N.M. Tripathi Publishers.



## Course Structure

### A8091 - National Cadet Corps(NCC)

Hours Per Week			Hours Per Semester			Credits	Assessment Marks		
L	T	P	L	T	P	C	CIE	SEE	Total
3	0	0	45	0	0	3	40	60	100

## 1. Course Description

### Course Overview

National Cadet Corps, is a unique course designed for youth in India that aims to develop character, discipline, leadership, secular outlook, spirit of adventure, and ideals of selfless service among young citizens. Through this course students learn about the national integration and its importance. They understand the concept of self-awareness and emotional intelligence, critical & creative thinking, decision making & problem solving and importance of Social service. This course also explores the security challenges & role of cadets in border areas. Students acquire the knowledge about various wars and their heroes.

### Course Pre/co-requisites

This course has no specific prerequisite and co requisite.

## 2. Course Outcomes (COs)

After the completion of the course, the student will be able to:

- A8091.1. Acquire knowledge of the history of NCC, its organization, and incentives of NCC for their career prospects and duties & conduct of ncc cadets.
- A8091.2. Imbibe good leadership traits and apply them in practical life and appreciate the visible outcome of leadership and motivation.
- A8091.3. Develop a sense of responsibility, smartness in appearance and improve self-confidence, inculcate importance of empathizing with others, improve their deep-thinking ability and apply ideas and be able to face problems in a constructive manner with solutions.
- A8091.4. Learn about the various natural resources, their utilization and practice method of conservation of these resources in daily life.
- A8091.5. Appreciate value of physical and mental health in daily life and spread awareness about treatment and care of wounds in their society.
- A8091.6. Understand individual responsibilities & role in meetings the security challenges on Border/Coastal areas.

## 3. Course Syllabus

**Introduction to NCC and National Integration:** Introduction of NCC, History, Aims, Objective of NCC & NCC as Organization, Duties of NCC Cadet. **National Integration:** Importance & Necessity, Factors Affecting National Integration, Unity in Diversity & Role of NCC in Nation Building.

**Personality Development & Leadership:** Intra & Interpersonal skills - Self-Awareness- & Analysis, Empathy, Critical & creative thinking, Decision making and problem solv-



ing. levels of Creativity, Characteristics of creative person. Leadership capsule., Important Leadership traits, Indicators of leadership and evaluation., Motivation- Meaning & concept, Types of motivation. Factors affecting motivation., Ethics and Honor codes.

**Social Service & Community Development:** Basics of social service and its need, Types of social service activities, Objectives of rural development programs and its importance, NGO's and their contribution in social welfare, contribution of youth and NCC in Social welfare. Protection of Children & Women Safety., Road/Rail Safety., New Government Initiatives., Cyber and mobile Security Awareness.

**Environmental Awareness and Conservation:** Natural Resources, Conservation and Management, Water Conservation, Waste Management, Energy Conservation. Adventure Environmental Awareness and Conservation. Health & Hygiene: Hygiene & Sanitation (Hygiene- Personal & Social Hygiene)., First Aid in common medical emergencies. Treatment & Care of Wounds.

**Border & Coastal Areas:** History, Geography & Topography of Border/ Coastal Areas. Security Setup and Border/Coastal management in the area., Security Challenges & Role of cadets in Border management.

## 4. Books and Materials

### Text Books:

1. R. K. Gupta, "Hand book of NCC Cadets for A, B & C Certificate Examinations", R-1992, 23rd Edition. Ramesh Publishing House, New Delhi (2023).