B.Tech. ROBOTICS AND AUTOMATION ENGINEERING

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FOREWORD

Robotics and Automation Engineering has been one of the advanced inter-disciplinary programs that applies principles from Electrical, Electronics and Computer Science Engineering, physics in design, analysis, manufacturing of systems, which involves the associate process transfer and flow of energies from one form to another. Now, it is at the center of almost all technical advancements, covering health services to communications, transportation and most other infrastructure that we see around. Robotics and Automation Engineers of today are multidisciplinary in nature with knowledge deriving from other branches of engineering.

At VFSTR, the curriculum undergoes regular revisions to ensure local relevance with a global outlook. We believe in imparting a broad education which instills a sense of lifelong learning and leadership values in students, together with an appreciation of global issues. Additionally, we offer various overseas exchange programs to farther the global outreach of our Robotics and Automation Engineering degree. Robotics and Automation Engineers have huge employable opportunities in all service and manufacturing industries.

The new curriculum of R22 accomplishes multidisciplinary holistic education, continuous assessment along with honorable exit options if a student fails to complete the requirements to earn the degree within the stipulated period including the permissible spill over period.

R22 curriculum comprises of:

- *Revision in tune with National Education Policy 2020*
- *Honourable exit options*
- *Regular Degree along with Honours / Minor Degree*
- *Module wise course syllabus*

In R22 curriculum, every care has been taken to accommodate the knowledge and skill requirements of industry through software integrated practical sessions. While making the graduates work ready, it also enables them to be successful in competitive examinations like GATE and Engineering Services.

The Board of Studies of Robotics and Automation Engineering consists of eminent personalities from industry, and academia.

External BoS Members:

1. 1. Dr. D Benny Karunakar, Associate Professor, Department of Mechanical and Industrial Engineering, IIT Roorkee.
2. Dr. Jayabal K, Associate Professor, Department of Mechanical Engineering, IIITDM, Kancheepuram.
3. Mr. Subrata Karmakar, President-Head, Robotics and Discrete Automation Business, ABB India Ltd., Bengaluru, Karnataka.
4. Mr. Suroju Ramakrishna, Principal Consultant, Tech Mahindra, Pune.

I thank all the BoS and Academic Council Members for actively participating in designing this innovative curriculum.

Dr. L. Suvarna Raju
HoD, ME

VIGNAN'S
Foundation for Science, Technology & Research
(Deemed to be UNIVERSITY)
-Estd. u/s 3 of UGC Act 1956

VISION

To evolve into a Centre of Excellence in Science & Technology through creative and innovative practices in teaching – learning, towards promoting academic achievement and research excellence to produce internationally accepted, competitive and world class professionals who are psychologically strong & emotionally balanced, imbued with social consciousness & values.

MISSION

To provide high quality academic programmes, training activities, research facilities and opportunities supported by continuous industry – institute interaction aimed at promoting employability, entrepreneurship, leadership and research aptitude among students and contribute to the economic and technological development of the region, state and nation.

Department of
MECHANICIAL ENGINEERING
(ROBOTICS AND AUTOMATION ENGINEERING)

VISION of the department

To evolve as a Centre of Repute to produce globally accepted multi skilled Mechanical Engineering professionals who can contribute to society through innovation, leadership imbued with ethical values.

MISSION of the department

M_1: Offering state of the art curriculum with innovative practices in teaching learning to perceive career in Mechanical Engineering and aligned fields.

M_2: To facilitate advanced research laboratories and conductive research environment to make student industry ready and equip to carry out higher education towards research and consultancy.

M_3: Enhance Professional Skills, exposure to emerging technologies, and to solve societal problems through Industry Interaction programs.

B.Tech in ROBOTICS AND AUTOMATION ENGINEERING

Program Educational Objectives (PEOs)

PEO1: Be Employed and entrepreneur in the fields of Automation and allied sectors.

PEO2: Apply the emerging technologies like IoT, AI, ML techniques in the field of automation.

PEO3: Exhibit communication skills, team spirit, leadership qualities with lifelong learning skills by following code of ethics.

Program Specific Outcomes (PSOs)

PSO1: Expertise in modelling the robotic autonomous systems.

PSO2: Develop algorithms for motion planning and mapping of field and service robots.

PSO3: Analyze the sensor data through machine vision techniques.

Program Outcomes (POs)

The graduates of Mechanical Engineering will be able to:

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.

R22 B.Tech.
4 YEAR
DEGREE PROGRAMME

COURSE STRUCTURE - R22

I Year I Semester

Course Code	Course Title	L	T	P	C
22MT103	Linear Algebra and Ordinary Differential Equations	3	2	0	4
22PY102	Engineering Physics	2	0	2	3
22EE101	Basics of Electrical and Electronics Engineering	2	0	2	3
22RA101	IT Workshop and Robotic Engineering Products	1	0	4	3
22TP103	Programming in C	2	0	4	4
22EN102	English Proficiency and Communication Skills	0	0	2	1
22SA101	Physical Fitness, Sports & Games - I	0	0	3	1
22TP101	Constitution of India	0	2	0	1
Total		**10**	**4**	**17**	**20**
		31 Hrs			

I Year II Semester

Course Code	Course Title	L	T	P	C
22MT112	Partial Differential Equations and Vector Calculus	3	2	0	4
22CT103	Engineering Chemistry	2	0	2	3
22ME101	Engineering Graphics	2	0	2	3
22TP104	Basic Coding Competency	0	1	3	2
22EN104	Technical English Communication	2	0	2	3
22ME102	Engineering Mechanics	3	2	0	4
22SA103	Physical Fitness, Sports & Games - II	0	0	3	1
22SA102	Orientation Session	0	0	6	3
Total		**12**	**5**	**18**	**23**
		35 Hrs			

Department Subject is extension of Basic sciences

COURSE STRUCTURE - R22

R22 B.Tech.
4 YEAR
DEGREE PROGRAMME

II Year I Semester

Course Code	Course Title	L	T	P	C
22ST202	Probability and Statistics	3	2	0	4
22CT201	Environmental Studies	1	1	0	1
22TP201	Data Structures	2	2	2	4
22MS201	Management Science	2	2	0	3
22RA201	Fundamentals of Robotics	2	2	2	4
22EE206	Electric Motors for Robotics	3	0	2	4
22EC204	Electronics for Automation	2	2	0	3
22SA201	Life Skills - I	0	0	2	1
Total		**15**	**11**	**8**	**24**
	NCC/ NSS/ SAC/ E-cell/ Student Mentoring/ Social activities/ Publication.	0	0	0	1
Total		**15**	**11**	**8**	**25**
		34 Hrs			

II Year II Semester

Course Code	Course Title	L	T	P	C
22TP203	Advanced Coding Competency	0	0	2	1
22TP204	Professional Communication	0	0	2	1
22RA202	Mobile Robotics	3	0	2	4
22RA203	Robot Mechanisms	2	2	2	4
22RA204	ROS Programming	1	2	2	3
	Department Elective - 1	2	2	0	3
	Open Elective - 1	2	2	0	3
22SA202	Life Skills - II	0	0	2	1
Total		**10**	**8**	**12**	**20**
	Minor / Honors - 1	3	2	0	**4**
Total		**13**	**10**	**12**	**24**
		35 Hrs			

R22 B.Tech.
4 YEAR
DEGREE PROGRAMME

COURSE STRUCTURE - R22

III Year I Semester

Course Code	Course Title	L	T	P	C
22TP301	Soft Skills Lab	0	0	2	1
22RA302	Planning and Navigation	2	2	2	4
22EE304	Power Electronics	3	0	2	4
22RA301	Automation in Manufacturing	2	2	2	4
22ME307	Industry Interface course (Modular course)	1	0	0	1
	Department Elective - 2	2	2	0	3
	Open Elective - 2	2	2	0	3
22ME304	Inter-Disciplinary Project - Phase I	0	0	2	0
Total		**12**	**8**	**10**	**20**
	NCC/ NSS/ SAC/ E-cell/ Student Mentoring/ Social activities/ Publication.	**0**	**0**	**0**	**1**
	Minor / Honours - 2	3	2	0	4
Total		**15**	**10**	**10**	**25**
		35 Hrs			

III Year II Semester

Course Code	Course Title	L	T	P	C
22TP302	Quantitative Aptitude and Logical Reasoning	1	2	0	2
22RA305	Data Science for Engineers	2	2	2	4
22RA306	Robot perception	2	2	0	3
	Department Elective - 3	2	2	0	3
	Department Elective - 4	2	2	0	3
	Open Elective - 3	2	2	0	3
22ME307	Inter-Disciplinary Project - Phase II	0	0	2	2
Total		**11**	**12**	**4**	**20**
	Minor / Honors - 3	3	2	0	4
Total		**14**	**14**	**4**	**24**
		32 Hrs			

COURSE STRUCTURE - R22

R22 B.Tech.
4 YEAR
DEGREE PROGRAMME

IV Year I Semester

Course Code	Course Title	L	T	P	C
22RA401	Artificial Intelligence for Robotics	2	2	2	4
22RA402	Industry 5.0	3	2	0	4
	Department Elective – 5	2	2	0	3
	Department Elective – 6	2	2	0	3
	Department Elective – 7	2	2	0	3
	Department Elective – 8	2	2	0	3
Total		**13**	**12**	**2**	**20**
	Minor / Honors - 4	3	2	0	4
Total		**16**	**14**	**2**	**24**
		32 Hrs			

IV Year II Semester

Course Code	Course Title	L	T	P	C
22RA403	Internship / Project Work	0	2	22	12
Total		**0**	**2**	**22**	**12**
	Minor / Honors - 5	3	2	0	4
Total		**3**	**4**	**22**	**16**
		29 Hrs			

for interaction between Guide and students

R22 B.Tech. 4 YEAR DEGREE PROGRAMME

COURSE STRUCTURE - R22

Department Electives

Course Code	Course Title	L	T	P	C
22ME801	3D Printing and Design	2	2	0	3
22ME804	Asset Management	2	2	0	3
22ME805	Automation and Advanced Manufacturing Processes	2	2	0	3
22ME806	Biomechanics	2	2	0	3
22ME807	Ceramics, Polymers and Smart Materials	2	2	0	3
22ME808	Composite Materials	2	2	0	3
22ME811	Computational Multibody Dynamics	2	2	0	3
22ME813	Design and Fabrication of Composite Materials	2	2	0	3
22ME814	Design of Smart Actuators	2	2	0	3
22ME815	Digital Manufacturing	2	2	0	3
22ME816	Electronics and Aerospace Materials	2	2	0	3
22ME818	Environmental Degradation and Bio Materials	2	2	0	3
22ME819	Failure Analysis	2	2	0	3
22ME821	Industrial Economics	2	2	0	3
22ME822	Industrial Engineering and Estimating & Costing	2	2	0	3
22ME823	Industrial Engineering and Production Management	2	2	0	3
22ME824	IOT and Smart Manufacturing	2	2	0	3
22RA802	Legged Robots	2	2	0	3
22ME826	Metrology and Surface Engineering	2	2	0	3
22ME827	Modelling and Simulation of Manufacturing Systems	2	2	0	3
22ME828	Nano material synthesis and Characterization Techniques	2	2	0	3
22ME830	Product Design for Manufacturing	2	2	0	3
22RA803	RPA in Industry	2	2	0	3
22ME832	Special Casting and Welding Technologies	2	2	0	3
22ME833	Tribology	2	2	0	3
22ME834	Value Engineering	2	2	0	3

Honors - Product Design

Course Code	Course Title	L	T	P	C
22RA951	Computer Aided Design and Manufacturing	3	2	0	4
22RA952	Design of Machine Members	3	2	0	4
22RA953	Finite Element Methods	3	2	0	4
22RA954	Mechanics of Materials	3	2	0	4
22RA955	Product Life Cycle Management	3	2	0	4

I

YEAR

B.Tech.

ROBOTICS AND AUTOMATION ENGINEERING

COURSE CONTENTS

I SEM & II SEM

I SEMESTER

22MT103	-	Linear Algebra and Ordinary Differential Equations
22PY102	-	Engineering Physics
22EE101	-	Basics of Electrical and Electronics Engineering
22RA101	-	IT Workshop and Robotic Engineering Products
22TP103	-	Programming in C
22EN102	-	English Proficiency and Communication Skills
22SA101	-	Physical Fitness, Sports and Games – I
22TP101	-	Constitution of India

II SEMESTER

22MT112	-	Partial Differential Equations and Vector Calculus
22CT103	-	Engineering Chemistry
22ME101	-	Engineering Graphics
22TP104	-	Basic Coding Competency
22EN104	-	Technical English Communication
22ME102	-	Engineering Mechanics
22SA103	-	Physical Fitness, Sports and Games – II
22SA102	-	Orientation Session

22MT103 LINEAR ALGEBRA AND ORDINARY DIFFERENTIAL EQUATIONS

Source: https://www.amazon.com/Differential-Equations/dp/B01H30X2JA

Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Basics of matrices, Differentiation and Integration.

COURSE DESCRIPTION AND OBJECTIVES:

The goal of this course is to build a grasp of the principles of mathematics through matrices, differential equations and applications that serves as an essential tool in several engineering applications.

MODULE-1

UNIT-1 **12L+8T+0P=20 Hours**

MATRICES:

Definition of matrix; Types of matrices; Algebra of matrices, adjoint of a matrix, inverse of a matrix through adjoint and elementary row operations, Rank of a matrix, Echelon form, Normal form. Eigen values and Eigen vectors (up to 3 x 3 matrices only) and properties (without proofs).

UNIT-2 **12L+8T+0P=20 Hours**

APPLICATIONS OF MATRICES:

Consistency of system of linear equations, Solution of system of linear equations having unique solution and involving not more than three variables by Gauss elimination method and Gauss Jordan method. Cayley-Hamilton theorem (without proof), Power of a matrix, Inverse of a matrix. Strength of materials and strength of beams using Eigen value and Eigen vectors.

PRACTICES:

- Compute inverse of a matrix if exists.
- Explain with suitable examples how rank of matrix is independent of the elementary operations.
- Explain with suitable examples how rank of matrix is unique.
- Discuss with suitable examples when eigen values and eigen vectors are possible for a matrix.
- Discuss the possibility of solution of a system of equations.
- Discuss when inverse and power of a matrix exist using Cayley-Hamilton theorem.

MODULE-2

UNIT-1 **12L+8T+0P=20 Hours**

ORDINARY DIFFERENTIAL EQUATIONS (ODE):

First Order Differential Equations: Introduction to ODE, variable separable method, homogenous and non-homogenous differential equations, linear differential equations, Bernoulli's equations.

Second Order Differential Equations: Linear differential equations with constant coefficients with RHS of the form eax, xn, sin(ax) or cos(ax).

SKILLS:

- ✓ *Find rank of a matrix using different methods.*
- ✓ *Compute the eigen values and eigen vectors of a matrix.*
- ✓ *Find analytical solution of a differential equation using appropriate method.*
- ✓ *Demonstrate any one numerical method to solve differential equation*

UNIT-2 **12L+8T+0P=20 Hours**

APPLICATIONS OF ODE:

Applications of ODE: Newton's law of cooling, Law of natural growth and decay, LR Circuit.

PRACTICES:

- Check the order and degree of an ODE.
- Find solution for any four ordinary differential equations by applying suitable method.
- Find numerical solution for any four ordinary differential equations by applying suitable method.
- Discuss some applications of ODE.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the concepts of rank, eigen values and eigenvectors of a matrix and finding inverse of a matrix and powers of a matrix.	Apply	1	1, 2, 9, 10, 12
2	Apply differential equations in real life problems.	Apply	2	1, 2, 9, 10, 12
3	Analyse the solution of a system of linear equations and find it.	Analyze	1	1, 2, 9, 10, 12
4	Inspect the analytical method for solving differential equations and applications.	Analyze	2	1, 2, 9, 10, 12

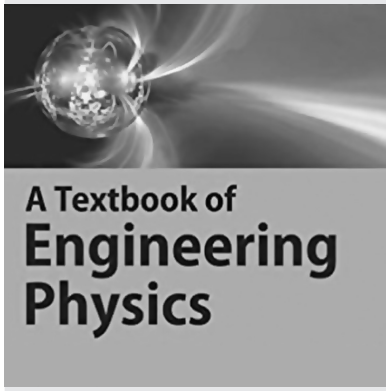
TEXT BOOKS:

1. N. P. Bali, K. L. Sai Prasad, "A Textbook of Engineering Mathematics I, II, III", 2nd Edition Universal Science Press, New Delhi, 2018.
2. B. S. Grewal,"Higher Engineering Mathematics", 44 Edition, Khanna Publishers, 2018.

REFERENCE BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley & Sons, Inc, 2015.
2. H. K. Dass and Er. RajanishVerma, "Higher Engineering Mathematics", 3rd revised edition, S. Chand & Co., 2015.
3. B. V. Ramana, "Advanced Engineering Mathematics", TMH Publishers, 2020.
4. T. K.V. Iyengar et al, "Engineering Mathematics, I, II, III", S. Chand & Co., New Delhi,2018.

22PY102 ENGINEERING PHYSICS (AME, MECH, CIVIL, TT, PE, CHEM)



Source: https://arcus-www.amazon.in/Textbook-Engineering-Physics-M-Avadhanulu/dp/9352833996

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Atomic structure, Electronic transitions, Bonding in solids and Wave optics.

COURSE DESCRIPTION AND OBJECTIVES:

The course is aimed at realizing the concept of waves in understanding the applications of ultrasonics and quantum optics in lasers. It imparts knowledge on distinguishing crystal structures and synthesis of nanomaterials and their characterization.

MODULE – 1

UNIT-1 **8L+0T+8P=16 Hours**

WAVES AND OSCILLATIONS:

Waves & Oscillation: Simple harmonic motion & Free oscillations - Equation of motion -Energy expressions; Damped Oscillations - Differential equation - different cases of damping - logarithmic decrement - relaxation time - quality factor; Forced Oscillations - Difference between free and forced oscillations - equation of motion - expression for amplitude and phase; Resonance and its examples

Ultrasonics: Introduction – properties of ultrasonic waves - Production of ultrasonic waves by Piezoelectric Method-Determination of velocity of ultrasonic waves in liquids -Interferometer method - NDT - Ultrasonic testing & X-ray radiography.

UNIT-2 **8L+0T+8P=16 Hours**

LASERS AND OPTICAL FIBERS:

Lasers: Introduction to Laser - population inversion and pumping methods - CO2 laser - Laser applications in industry and scientific research; Holography - construction of hologram - reconstruction of image and applications.

Fibre Optics: Introduction – Classification - Step and Graded index fibres - Acceptance Angle - Numerical aperture - Fibre optic sensors and types of sensors.

PRACTICES:

- Melde's experiment- Determination of frequency of a given tuning fork
- Ultrasonic Interferometer-Determination of the velocity of ultrasonic waves in liquids
- Semiconductor laser- Determination of wavelength
- Optical fibre- Determination of Numerical Aperture and Acceptance angle

MODULE-2

UNIT-1 **8L+0T+8P=16 Hours**

CRYSTAL PHYSICS:

Fundamental terms of crystal Physics - Lattice parameters - Crystal Systems-Packing factor for SC, BCC and FCC - Miller Indices - Important planes of cubic crystal system - Distance of separation between successive (h k l) planes - X-ray diffraction – Bragg's law - Defects in solids - Point defects - Line defects - Edge & Screw dislocations.

SKILLS:

- ✓ *To apply Ultrasonic waves in non-destructive testing.*
- ✓ *To compute the power of the laser and the signal carrying capacity of optical fiber.*
- ✓ *To distinguish various crystals and the orientation of crystal planes.*
- ✓ *To demonstrate the synthesis and characterization of nanoparticles in view of their application.*

UNIT-2 **8L+0T+8P=16 Hours**

NANOMATERIALS AND THEIR CHARACTERIZATION:

Introduction to nanoscience and technology-surface area to volume ratio & quantum confinement; Synthesis of nanomaterials Top-down & Bottom-up approach, Ball milling- Sol-Gel method; Applications of nanotechnology in various fields; X-Ray Diffraction -Bragg's law - Powder method - Electron microscopy-(SEM &TEM); Atomic force microscopy (AFM).

PRACTICES:

- Semiconductor- Determination of Bandgap.
- Diffraction grating- Determination of wavelength of a given light source.
- Photoelectric effect- Determination of Planks constant.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the knowledge of mechanical and sound waves from the perspective of engineering applications.	Apply	1	1, 2, 3, 4 , 9, 10
2	Analyze the wavelengths of lasers for relevant diverse applications and foster the knowledge to realize fiber optic sensors.	Analyze	1	1, 2, 5, 9, 10
3	Apply the knowledge of crystal geometry to distinguish solids.	Apply	2	1, 2, 3, 4, 5, 9, 10
4	Compute the dimensions of nano particles to the physical and chemical aspects of nanomaterials.	Evaluate	2	1, 2, 3, 4, 9, 10

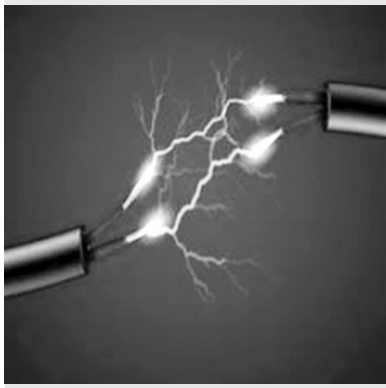
TEXT BOOKS:

1. S.O. Pillai, "Solid State Physics", New age International publishers, 8th edition, 2018.
2. H.P. Myers, "Introduction to Solid State Physics", Taylor & Francis, 2009.
3. V. Rajendran, "Engineering Physics", Tata Mc-Graw Hill Publications, 2016.

REFERENCE BOOKS:

1. D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", 6th edition, John Wiley and Sons, New York, 2001.
2. Charles Kittel, "Introduction to Solid State Physics", 7th edition, Wiley, Delhi, 2007.
3. Donald A. Neamen, "Semiconductor Physics and Devices: Basic Principle", 4th edition, McGraw-Hill, New York, 2012.
4. N.W. Ashcroft and N.D. Mermin, "Solid State Physics", International student edition, Brooks Cole, 2008.

22EE101 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING



Source: https://vita.vision.org.in/emerging-technologies-in-electrical-engineering/

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Electrostatics and Electromagnetism.

COURSE DESCRIPTION AND OBJECTIVES:

This course provides an insight into the functioning of basic electrical components like resistor, inductor and capacitor. It deals with the constructional and operational details of AC machines. It also deals with the basic electronic components like P-N junction diode, Zener diode, Transistor and their characteristics.

MODULE–1

UNIT-1 **8L+0T+8P=16 Hours**

FUNDAMENTALS OF ELECTRIC CIRCUITS:

DC Circuits: Concept of network, Active and passive elements, Voltage and current sources, Concept of linearity and linear network, Unilateral and bilateral elements, R, L and C as linear elements, Ohm's Law, Kirchhoff's Laws, Application to simple series, Parallel circuits, Mesh and nodal analysis of resistive circuits with DC source.

AC circuits: Generation of AC voltage, Frequency, Average value, R.M.S. value, Form factor, Peak factor for sinusoidal only.

UNIT-2 **8L+0T+8P=16 Hours**

Semiconductor Devices: Classification of semiconductors, P-N junction diode -operation and its characteristics, Half wave rectifier - operation, efficiency; Full wave rectifiers -types, operation, efficiency; Zener diode and its characteristics, Zener diode as Voltage regulator. Bi polar junction transistor-operation, types (NPN & PNP)

PRACTICES:

- Verification of Ohm's law.
- Verification of Kirchhoff's current law.
- Verification of Kirchhoff's voltage law.
- Determination of R.M.S. Values of sinusoidal waveform.
- Verification of PN junction diode characteristics under both forward and reverse bias.
- Verification of Zener diode characteristics under reverse bias.

MODULE–2

UNIT-1 **8L+0T+8P=16 Hours**

Analysis of AC Circuits: Analysis of single- phase ac circuits consisting of R, L, C, RL, RC (series and parallel) (simple numerical problems). Introduction to three phase system, Relation between phase and line quantities of voltages and currents in star and delta connected systems (Elementary treatment only).

UNIT-2 **8L+0T+8P=16 Hours**

AC MACHINES:

Electromagnetism: Concepts of Magneto motive force, Reluctance, Flux and flux density, Concept of self-inductance and mutual inductance, Coefficient of coupling .

SKILLS:

- ✓ *Distinguish between linear and nonlinear elements by looking at VI characteristics.*
- ✓ *Develop a simple loop generator.*
- ✓ *Design a voltage regulator using Zener diode.*
- ✓ *Design a half wave rectifier using PN junction diode.*
- ✓ *Design a full wave rectifier using PN junction diodes.*

Static AC Machine: Principle of operation of single phase transformer, Constructional features, EMF equation (simple numerical problems).

Rotating AC Machine Principle of operation of three phase induction motor, Slip ring and squirrel cage motors, Torque equation; Constructional details of synchronous machine.

PRACTICES:

- Transformation ratio of a single phase transformer at different loads.
- Measurement of Energy in single phase resistive load circuit.
- Measurement of Power in single phase resistive load circuit.
- Determination of impedance in complex AC circuits.
- Verification of line and phase quantities in a balanced three phase system.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze the resistive circuits with independent sources and find its solution.	Analyze	1, 2	1, 2, 6, 9
2	Solve the AC (single and three phase) and DC circuits using different methods.	Apply	1, 2	1, 2, 9, 12
3	Apply the concepts of electromagnetism for its applications.	Apply	2	1, 2, 3, 9, 12
4	Examine the different electrical equipment.	Evaluate	2	1, 2, 9, 12
5	Acquire the knowledge of semiconductor devices to create circuits.	Create	1	1, 2, 3, 9, 12

TEXT BOOKS:

1. V. K. Mehta, “Principles of Electrical Engineering and Electronics”, S.Chand& Co., Publications, New Delhi, 2019.
2. D.P. Kothari, “Basic Electrical and Electronics Engineering”, TMH, New Delhi, 2017.

REFERENCE BOOKS:

1. Millman and Halkias, “Electronic Devices and Circuits”, Mc Graw Hill, 2006.
2. A.K. Thereja and B.L.Thereja, “Electrical Technology”, Vol.–II, S. Chand & Co., Publications, 2020.
3. U. Bakshi and A. Bakshi, “Basic Electrical Engineering”, 1st edition, Technical Publications, Pune, Nov 2020.

22RA101 IT WORKSHOP AND ROBOTIC ENGINEERING PRODUCTS

Hours Per Week :

L	T	P	C
1	0	4	3

PREREQUISITE KNOWLEDGE: Basics idea of home appliances & computer.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with different Mechanical trades and IT tools. The objective of this course is to develop models using Carpentry, Fitting, Tin smithy, House wiring and giving hands on practice on assembling and disassembling, productivity tools like word processors, spreadsheets and presentations.

MODULE-1

UNIT-1 **3L+0T+12P=15 Hours**

COMPUTER HARDWARE & TOOLS FOR REPORT WRITING AND PRESENTATION:

Computer Hardware: Peripherals of a computer, components in a CPU and its functions, block diagram of the CPU.

Tools for Report writing and Presentation: Overview and Installation of Microsoft Word, Excel and PowerPoint Presentation.

UNIT-2 **5L+0T+20P=25 Hours**

Computer Hardware: Disassemble and Assemble the PC back to working condition.

Tools for Report writing and Presentation: Creating project, Creating a Newsletter using Microsoft Word; Creating a Scheduler, Calculating GPA, Performance Analysis, Conditional Formatting, Charts and Pivot Tables using MS Excel; Power Point utilities and tools, Master Layouts, Design Templates, Background and textures using Power Point Presentation.

PRACTICES:

- Troubleshooting of a computer hardware.
- Assembly and disassembly of a computer.
- Creation of projects and newsletter using MS Word.
- Spreadsheet basics, modifying worksheets, formatting cells, formulas and functions, sorting and filtering, charts using MS Excel.
- Power point screen, working with slides, add content, work with text, working with tables, graphics, slide animation, reordering slides, adding sound to a presentation using MS PPT.

MODULE-2

UNIT-1 **3L+0T+12P=15 Hours**

ENGINEERING MATERIALS & TRADES:

Engineering Materials: Introduction, Classification, Ferrous & non-ferrous metals and alloys.

Trades: Introduction and Materials used in Carpentry, Fitting, Tin smithy and House Wiring. Cutting Tools, Holding Tools, Marking Tools used and types of joints made in Carpentry, Fitting, Tin smithy and House wiring.

source: https://www.itprotoday.com/windows-and-user-productivity/10-tools-providing-247-it-support-remote-workers

SKILLS:

- ✓ *Understand the concepts of making various wooden joints for house hold purpose.*
- ✓ *Design and develop various sheet metal products.*
- ✓ *Analyse the functioning & troubleshoots of household appliances.*
- ✓ *Create products by using different trades for Industrial applications.*

UNIT-2 **5L+0T+20P=25 Hours**

INDUSTRIAL AND DOMESTIC ROBOTS:

Working Principle of Industrial and Domestic Robots: Working principle of Articulated Robot, Components; Working principle of Scara Robot-Parts and applications, Working principle of Flexi-pickers and its components, Working principle of Robot Vacuum Cleaner - Parts and applications.

PRACTICES:

- Fabrication of T-lap joint using carpentry tools.
- Fabrication of V-fit using fitting tools.
- Fabrication of truncated cylinder using tin smith tools.
- Performance of 1 lamp controlled by one way switch using house wiring.
- Performance of 2 lamp controlled by one way switch using house wiring.
- Demonstration of modelling & functioning of Articulated Robot.
- Demonstration of modelling & functioning of Scara Robot.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Assemble and disassemble of a computer.	Apply	1	1, 2
2	Create documents, spread sheets and presentations using MS Tools.	Apply	1	1, 2, 5, 6, 12
3	Fabricate different models using workshop trades.	Apply	2	1, 2 5
4	Develop methodology for fabrication as per specifications of the product.	Analyze	2	1, 3, 8, 9,10
5	Analyse the functioning of Industrial and Domestic Robots.	Analyze	2	1, 6, 7

TEXT BOOKS:

1. Peter Norton, “Introduction to Computers”, Tata Mc Graw Hill Publishers, 7th Edition, 2017.
2. Felix W “Basic Workshop Technology: Manufacturing Process”, 1st Edition, 2019.

REFERENCE BOOKS:

1. K.V.N.Pakirappa, “Workshop Technology”, Radiant Publishing House, 5th Edition, 2011.
2. Segun R. Bello, “Workshop Technology & Practice”, Createspace Independent Publication, 1st Edition, 2012.
3. Nicolas Odrey, Mitchell Weiss, Mikell Groover, Roger Nagel, Ashish Dutta, “Industrial Robotics -Technology, Programming and Applications”, McGraw Hill Publications, 2nd Edition, 2017.

22TP103 PROGRAMMING IN C

Source: Techgig.com

Hours Per Week :

L	T	P	C
2	0	4	4

PREREQUISITE KNOWLEDGE: Fundamentals of Problem Solving.

COURSE DESCRIPTION AND OBJECTIVES:

This course is aimed to impart knowledge on basic concepts of C programming language and problem solving through programming. It covers basic structure of C program, data types, operators, decision making statements, loops, functions, strings, pointers, and also file manipulations. At the end of this course, students will be able to design, implement, test and debug complex problems using features of C.

MODULE- 1

UNIT-1 **8L+0T+16P=24 Hours**

INTRODUCTION TO ALGORITHMS AND PROGRAMMING LANGUAGES:

Introduction to Algorithms: Basics of algorithms; Flow charts; Generations of programming languages. Introduction to C: Structure of a C program - pre-processor statement, inline comments, variable declaration statements, executable statements; C Tokens - C character set, identifiers and keywords, type qualifiers, type modifiers, variables, constants, punctuations and operators.

Data Types and Operators: Basic data types; Storage classes; Scope of a variable; Formatted I/O; Reading and writing characters; Operators - assignment, arithmetic, relational, logical, bitwise, ternary, address, indirection, sizeof, dot, arrow, parentheses operators; Expressions - operator precedence, associative rules.

Control Statements: Introduction to category of control statements; Conditional branching statements - if, if– else, nested-if, if – else ladder, switch case; Iterative statements - for, while, do - while, nested loops; Jump statements - break, jump, goto and continue.

UNIT-2 **8L+0T+16P=24 Hours**

ARRAYS & STRINGS:

Arrays: Introduction; Types of arrays; Single dimensional array - declaration, initialization, usage, reading, writing, accessing, memory representation, operations; Multidimensional arrays.

Strings: Character array, Reading string from the standard input device, Displaying strings on the standard output device, Importance of terminating a string, Standard string library functions.

PRACTICES:

QUESTIONS ON DATA HANDLING – LEVEL 1:

- Write a program to accept a character as input from the user and print it.
- Write a program to accept a number as input from the user and print it.
- Write a program to accept a float value from the user and print it.
- Write a program to accept a message as input from the user and print it.
- Write a program to accept a message from the user as input and print it in 3 different lines.
- Write a program to accept 2 numbers from the user as input and print their sum.
- Write a program to accept 2 numbers from the user as input and print their product.
- Write a program to accept a number as input from the user which denotes the temperature in Celsius, convert it to Fahrenheit reading and print it.

SKILLS:

- ✓ *Analysis of the problem to be solved.*
- ✓ *Select static or dynamic data structures for a given problem and manipulation of data items.*
- ✓ *Application of various file operations effectively in solving real world problems.*
- ✓ *Develop C programs that are understandable, debuggable, maintainable and more likely to work correctly in the first attempt.*

- Write a program to accept a number as input from the user which denotes the radius and print the area of the circle.
- Write a program to accept a character as input from the user and print it's corresponding ASCII value.

QUESTIONS ON CONTROL STATEMENTS - LOOPING – LEVEL 1:

- Write a C program to print all the characters from a to z once.
- Write a C program to print all the characters from Z to A once.
- Write a C program to print all the characters from A to Z 3 times.
- Write a C program to print the first N natural numbers, where N is given as input by the user.
- Write a C program to print the first N natural numbers and their sum, where N is given as input by the user.
- Write a C program to print all the odd numbers between 1 and N where N is given as input by the user.
- Write a C program to print all the even numbers between I and N where N is given as input by the user.
- Write a C program to print the squares of the first N natural numbers between 1 and N, where N is given as input by the user.
- Write a C program to print the cubes of the first N natural numbers between 1 and N, where N is given as input by the user.
- Write a C program to print the squares of every 5th number starting from 1 to N, where N is given as input by the user.

QUESTIONS ON CONTROL STATEMENTS – DECISION MAKING – LEVEL 1:

- Write a program to accept two numbers as input check if they are equal.
- Write a program to accept two characters as input and check if they are equal.
- Write a program to accept two numbers as input and print the greater of the 2 numbers.
- Write a program to accept two numbers as input and print the lesser of the 2 numbers.
- Write a program to accept 3 numbers as input and print the maximum of the 3.
- Write a program to accept 3 numbers as input and print the minimum of the 3.
- Write a program to accept a number as input and print EVEN if it is an even number and ODD if it is an odd number.
- Write a program to accept a number as input and check if it is divisible by 3. If it is divisible by 3 print YES else print NO.
- Write a program to accept a number as input and check if it is divisible by both 3 & 5. If it is divisible print YES else print NO.
- Write a program to accept a number as input and check if it is positive, negative or zero.

QUESTIONS ON PATTERNS – LEVEL 1:

- Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.

  *****

  *****

  *****

  *****

  *****

- Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.

  *****

  * *

  * *

  * *

  *****

- Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.
  *
  **
  ***
  ****
  *****
- Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.
  *
  **
  ***
  ****
  *****
- Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.
  1
  12
  123
  1234
  12345
- Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.
  1
  22
  333
  4444
  55555
- Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.
  54321
  4321
  321
  21
  1
- Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.
  12345
  2345
  345
  45
  5
- Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.
  A
  AB
  ABC
  ABCD
  ABCDE

- Write a program to accept a number N as input from the user and print the following pattern. Sample N = 5.

  A

  BC

  DEF

  GHIJ

  KLMNO

QUESTIONS ON NUMBER CRUNCHING – LEVEL 1:

- Write a program to accept a number as input and print the number of digits in the number.
- Write a program to accept a number as input print the sum of its digits.
- Write a program to accept a number as input, reverse the number and print it.
- Write a program to accept a number and digit as input and find the number of occurrences of the digit in the number.
- Write a program to accept a number as input and check if it is an Armstrong number.
- Write a program to accept a number as input and check if it is an Adam number.
- Write a program to accept a number as input and check if is a prime number.
- Write a program to accept 2 numbers as input and check if they are amicable or not.
- Write a program to accept a number as input and check if it is a power of 2.
- Write a program to accept 2 numbers as input and find their LCM.

QUESTIONS ON ARRAYS – LEVEL 1:

- Print the contents of an array from the left to the right.
- Print the contents of an array from the right to the left.
- Find the sum of the elements of an array.
- Find the maximum element in an unsorted array.
- Find the minimum element in an unsorted array.
- Find the average of the elements in an unsorted array.
- Count the number of 0s and 1s in an array having 0s and 1s in random order.
- Count the number of elements in an array whose elements are lesser than a key element in an unsorted array.
- Print all the elements in an array whose values are lesser than a key element in an unsorted array.
- Find the repeated elements in a sorted array.

QUESTIONS NUMBER CRUNCHING – LEVEL 2:

- Write a program to accept a number as input and print the product of its digits.
- Write a program to accept a number as input and check if it is a palindrome.
- Write a program to accept a number as input and print the frequency of occurrence of each digit.
- Write a program to accept a number as input and print its factors.
- Write a program to accept a number as input and print its prime factors.
- Write a program to accept a number as input and check if it is a perfect square of not.
- Write a program to accept 2 numbers as input and check if they are betrothed numbers or not.
- Write a program to accept 2 numbers as input and print their HCF.
- Write a program to accept a number as input and check if is a strong number.
- Write a program to generate prime numbers between two intervals given as input.

QUESTIONS ON ARRAYS – LEVEL 2:

- Find the sum of the maximum and minimum numbers of an unsorted array.
- Replace every element in an array with the sum of its every other element.
- Replace every element in an array with the sum of its right side elements.
- Replace every element in an array with the sum of its left side elements.
- Reverse the elements of an array (in place replacement).

- Reverse the first half of an array.
- Reverse the second half of an array.
- Write a program to find the second largest element in an unsorted array.
- Write a program to find the second smallest element in an unsorted array.
- Write a program to print the number of odd and even numbers in an unsorted array.

QUESTIONS ON STRINGS – LEVEL 1:

- Write a program to accept a string as input and print it.
- Write a program to accept a string as input and count the number of vowels in it.
- Write a program to accept a string as input and count the number of consonants in it.
- Write a program to accept a string as input and print its length.
- Write a program to accept a string as input and print the reversed string.
- Write a program to accept 2 strings as input and check if they are the same.
- Write a program to accept a string as input and copy the contents into a second string and print the second string.
- Write a program to accept 2 strings as input and concatenate them into a third string and print the third string.
- Write a program to accept a string as input and check if it is a palindrome.
- Write a program to accept two strings as input and check if the second string is a substring of the first.

QUESTIONS ON STRINGS – LEVEL 2:

- Implement the string length function.
- Implement the string copy function.
- Implement the string concatenate function.
- Implement the string compare function.
- Implement the vowel count function.
- Implement the consonant count function.
- Implement the count words function.
- Implement the string reverse function.
- Implement the strstr function.
- Complete the code snippet to implement the is Palindrome function that checks if a given string is a palindrome. You will need to use the 3 functions string Copy, str Reverse and string Compare functions provided to accomplish this.

MODULE-2

UNIT-1 **8L+0T+16P=24 Hours**

FUNCTIONS & POINTERS:

User-defined functions: Function declaration - definition, header of a function, body of a function, function invocation; Call by value; Call by address; Passing arrays to functions; Command line arguments; Recursion; Library Functions.

Pointers: Declaration, Initialization, Multiple indirection, Pointer arithmetic, Relationship between arrays and pointers, Scaling up - array of arrays, array of pointers, pointer to a pointer and pointer to an array; Dynamic memory allocation functions.

UNIT-2 **8L+0T+16P=24 Hours**

STRUCTURES, UNIONS & FILES:

Structures: Defining a structure, Declaring structure variable, Operations on structures, Pointers to structure - declaring pointer to a structure, accessing structure members using pointer; Array of structures, Nested structures, Passing structures to functions - passing each member of a structure as a separate argument, passing structure variable by value, passing structure variable by reference/ address; Typedef and structures.

Unions: Defining a union - declaring union variable, operations on union; Pointers to union - declaring pointer to a union, accessing union members using pointer; Array of union, Nested union, Typedef and union, Enumerations, Bit-fields.

Files: Introduction to files, Streams, I/O using streams – opening a stream, closing stream; Character input, Character output, File position indicator, End of file and errors, Line input and line output, Formatted I/O, Block input and output, File type, Files and command line arguments.

PRACTICES:

QUESTIONS ON STRINGS – LEVEL 3:

- Write a program to swap two given strings and print the swapped strings.
- Write a program to swap two given words of the given sentence and print the altered string.
- Return the maximum occurring character in the string.
- Write a program to print the character in the string with the count where count is the occurrence of the character.
- Write a program to print the duplicate characters in the given string.
- Write a program to remove the duplicate characters in the given string.
- Write a program to remove the vowels from a given string.
- Write a program to rotate a given string N number of times.
- Write a program to check if 2 strings are rotations of each other.
- Write a program to remove the characters from the first string that are present in the second string.

QUESTIONS ON 2D ARRAYS – LEVEL 1:

- Print the contents of a 2D array row-wise.
- Print the contents of a 2D array column-wise.
- Print the contents of a 2D array in a zig-zag order.
- Print the contents of a 2D array diagonal-wise.
- Print the contents of a 2D array right-diagonal order.
- Print the contents of a 2D array left-diagonal order.
- Print the contents of a 2D array in the upper triangular order – left top to right bottom.
- Print the contents of a 2D array in the lower triangular order.
- Find and print the maximum element along with its position in a matrix.
- Find and print the minimum element along with its position in a matrix.

QUESTIONS ON 2D ARRAYS – LEVEL 2:

- Find and print the maximum element of each row of a matrix.
- Find and print the minimum elements of each row of a matrix.
- Find and print the maximum element of each column of a matrix.
- Find and print the minimum element of each column of a matrix.
- Find the lowest value in the upper triangle area and the largest value in the lower triangular area of a matrix and print their product.
- Find the sum of the elements of each row and each column of a matrix and print the minimum row sum and maximum sum column.
- Write a program to find the row with the maximum number of 1’s in a matrix consisting of only 0’s and 1’s.
- Write a program to print the quotient and remainder on dividing sum of left-top to right-bottom diagonal by sum of right-top to left-bottom diagonal.
- Write a program to print the absolute difference of the sum of major diagonal elements and the sum of minor diagonals of the given matrix.
- Write a program to search a given element in a row-wise and column-wise sorted 2D array.

QUESTIONS ON 2D ARRAYS – LEVEL 3:

- Write a program to find the Kth smallest element in the given matrix.
- Write a program to find the Kth largest element in the given matrix.
- Write a program to check whether the given two two-dimensional array of same dimensions are equal or not.
- Write a program to add the given two two-dimensional array of same dimensions.
- Write a program to subtract the given two two-dimensional array of same dimensions.
- Write a program to multiply the given two two-dimensional array of same dimensions.
- Write a program to sort each row of a matrix.
- Write a program to find the sum of the elements in 'Z' sequence of the given 2D array.
- Write a program to print the unique rows of the given two-dimensional array consisting of only 0's and 1's.
- Write a program to print the unique columns of the given two-dimensional array consisting of only 0's and 1's.

QUESTIONS ON FILES, STRUCTURES & UNIONS:

- Write a C program to create a struct, named Student, representing the student's details as follows: first_name, last_name, Age and standard.

  Example

  Read student data

  john

  carmack

  15

  10

  Display the data in the following format

  First Name: john

  Last Name: carmack

  Age: 15

  Standard: 10

- Declare a structure POINT. Input the coordinates of point variable and write a C program to determine the quadrant in which it lies. The following table can be used to determine the quadrant.

Quadrant	X	Y
1	Positive	Positive
2	Negative	Positive
3	Negative	Negative
4	Positive	Negative

  Example

  Input the values for X and Y coordinate: 7 9

  The coordinate point (7,9) lies in the First quadrant.

- Bob and Alice both are friends. Bob asked Alice how to store the information of the books using Structures. Then Alice written a c program to store the information of books using book structure by taking different attributes like book_name, author, book_id, price. Write a C program to read and display the attributes of the books using structures.

  Sample Input:

  Enter number of books: 1

  Enter the book name: c Programming

  Enter the author name: balaguruswamy

  Enter the book ID: 23413

  Enter the book price: 500

Sample Output:

The details of the book are:

The book name is: c Programming

The author name is: balaguruswamy

The book ID is: 23413

The book price is: 500.00

- Ramesh wants to do addition on complex numbers. He did it with regular practice but Charan asked him to do with the help of structures by following below Criteria. Write a C program that defines a structure named 'Complex' consisting of two floating point members called "real and imaginary". Let c1 and c2 are two Complex variables; compute the sum of two variables.

  Example:

  c1= 2 8

  c2= 6 4

  Sum= 8.000000+12.000000i

- Customer Payment Details is a structure with members as customers_name, address, account_number, payment_status(paid(1)/ not_paid(0)), due_date, and amount. In this example, payment_date is another structure with month, day and year as integer members. So, every customer record can be considered as an array of structures.
- Write a C program that displays the amount to be paid by each customer along with their names. If payment_status is 1, display NIL for such customers.

  Input Format:

  First line of input contains 'n' number of customers, followed by 8 lines of input for each customer. Each line represents (customers_name, address, account_number, amount payment_status(paid(1)/ not_paid(0)), and due_date).

  Output Format:

  First line of output is Amount to be paid by each customer as on date: followed by n lines of output. Each line contains name of the customer followed by tab space, and amount to be paid.

  Hint: Use nested structure to represent date.

  Write a 'C' program to accept customer details such as: Account_no, Name, Balance using structure. Assume 3 customers in the bank. Write a function to print the account no. and name of each customer whose balance < 100 Rs.
- Write a C program to accept details of 'n' employee(eno, ename, salary) and display the details of employee having highest salary. Use array of structure.
- Write a C program to print the bill details of 'N' number of customers with the following data: meter number, customer name, no of units consumed, bill date, last date to deposit and city. The bill is to be calculated according to the following conditions:

No. of units	**Charges**
For first 100 units	Rs.0.75 per unit
For the next 200 units	Rs.1.80 per unit
For the next 200 units	Rs.2.75 per unit

  Sample Input

  Enter no. of customers

  1

  Enter Meter Number AP01213

  Enter Customer Name: Karthik

  Enter No. of units consumed: 200

  Enter Bill date: 22/01/2021

  Enter Last date: 12/2/2021

  Enter City: Guntur

Sample Output

Meter Number AP01213

Customer Name: Karthik

No. of units consumed: 200

Bill date:22/01/2021

Last date: 12/2/2021

City: Guntur

Total Amount: 255.000000

- Write a C program that creates a student file containing {Roll No, Student Name, Address, Stream}, where the data will be inserted and display the list of students who are in CSE (Stream=CSE).

  Input: A file name

  Output: The attributes such as Roll_No, Student_Name, Stream, Address.

  Sample Input

201fa4200	Raja	CSE	Guntur
201fa4201	Bala	IT	Tenali

  Sample Output

201fa4200	Raja	CSE	Guntur

- Write a C program that reads content from an existing text file and write the same in a new file by changing all lowercase alphabetic character to upper case. (Existing file may contain digit and special characters).

  Example:

  Input: Enter the file name.

  Output: New file with updated content.

- Write a C program to count the occurrences of the given string in a file.

  Example:

  Input: Enter the File name to read the string to be counted.

  Output: Display the count of occurrences of the string.

- Write a C Program to transfer the data from one location to another location without changing the order of the content.

  Example:

  Read the file name from the user. If the source file exists, Transfer the data and display the message as “Data is transferred successfully” otherwise display the message “No such file is existing in the directory.”

- Write a C program that reads numbers and write them into a text-file. Also find odd and even numbers in that file and store it in 2 separate files named odd.txt and even.txt. All the values should be in ascending order.

  Input: Enter the values.

  Output: Creates a separate file for Even and Odd numbers.

  Sample Input:

  4 43 2 53 45

  Sample Output:

  Even.txt: 2 4

  Odd.txt: 43 45 53

- Write a C program to replace the content in the given text file.

  Input: Enter the file name, line number to be replaced and the new content

  Output: New file with replaced lines.

  Example:

Sample Input: Enter the file name: abc.txt

Enter the line no to replace: 3

Enter the content: Files stores data presently.

Sample Output:

Line no 3 is replaced with the given content.

The content of the file abc.txt contains:

test line 1

test line 2

Files stores data presently

test line 4

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Identify suitable data type for operands and design of expressions having right precedence.	Apply	1, 2	1
2	Apply decision making and iterative features of C Programming language effectively.	Apply	1, 2	1
3	Select problem specific data structures and suitable accessing methods.	Analyze	1, 2	1, 2
4	Design and develop non- recursive and recursive functions and their usage to build large modular programs and also able to design string manipulation functions.	Create	1, 2	3
5	Develop C programs that are understandable, debuggable, maintainable and more likely to work correctly in the first attempt.	Evaluate	1, 2	3, 4

TEXT BOOKS:

1. Behrouz A. Forouzan, Richard F.Gilberg, “Programming for Problem Solving”, 1st edition, Cengage publications, 2019.
2. Ajay Mittal, “Programming in C - A Practical Approach”, 1st edition, Pearson Education, India, 2010.

REFERENCE BOOKS:

1. Reema Thareja, “Computer Fundamentals and Programming in C”, 1st edition, Oxford University Press, India, 2013.
2. Herbert Schildt, “C: The Complete Reference”, 4th edition, Tata McGraw-Hill, 2017.
3. Byron S Gottfried, “Programming with C”, 4th edition, Tata McGraw-Hill, 2018.

22EN102 ENGLISH PROFICIENCY AND COMMUNICATION SKILLS

Hours Per Week :

L	T	P	C
0	0	2	1

PREREQUISITE KNOWLEDGE: Basics of grammar, Read andunderstand for global context, Cultural sensitivity and Basic writing skills.

COURSE DESCRIPTION AND OBJECTIVES:

English Proficiency and Communication Skillsseeks to develop the students' abilities in grammar, speaking, reading, writing and overall comprehension skills. The course will provide students an exposure on a wide range of language use in everyday situations. It will make the students to equip with functional English and make them use it confidently in their professional and social contexts. Finally, students will strengthen their reading, writing, listening and speaking skills in English.

MODULE-1

UNIT-1 **0L+0T+8P=8 Hours**

MY LIFE AND HOME – MAKING CHOICES – HAVING FUN:

Reading: Understanding main message, factual information global meaning, specific information and paraphrasing.

Writing: Developing hints based mail, Writing short messages/paragraphs.

Listening: Understanding short monologues or dialogues and choose the correct visual.

Speaking: Express simple opinions /cultural matters in a limited way.

Vocabulary: Discerning use of right word suiting the context, B1 Preliminary word list.

Grammar: Frequency Adverbs, State Verbs, AFV and Prepositions.

UNIT-2 **0L+0T+8P=8 Hours**

ON HOLIDAY - DIFFERENT FEELINGS – THAT'S ENTERTAINMENT!:

Reading: Longer text for detailed comprehension, gist and inference.

Writing: Developing notes and responding to penfriends or 'e-pals'.

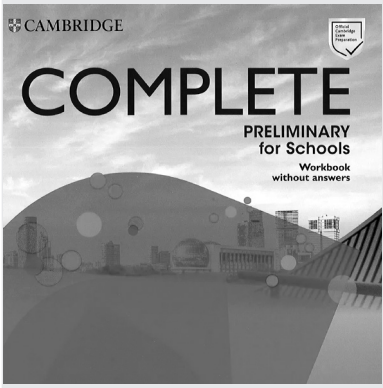
Listening: Understand straightforward instructions or public announcements.

Speaking: Describing people, things and places in a photograph.

Vocabulary/Grammar: Comparatives and Superlatives, Gradable and non-gradable adjectives, Cloze tests.

PRACTICES:

- Developing hints based mail.
- Writing short message.
- Writing paragraphs.
- Expressing opinions and cultural matters.
- Understanding short monologues.
- Understanding straightforward instructions and public announcements.
- Describing people, things and places in a photograph.



Source: https://www.scribd.com/document/502301821/Cambridge-Complete-B1-Preliminary-for-Schools-Workbook-2020-Edition

SKILLS:

- ✓ *Use of appropriate grammar and vocabulary with syntactic patterns in short texts.*
- ✓ *Read and extract the main message, global meaning, specific information, detailed comprehension, understanding of attitude, opinion and writer purpose and inference.*
- ✓ *Listen to understand key information, specific information, gist and detailed meaning and to interpret meaning.*
- ✓ *Understand questions and make appropriate responses and talk freely on everyday topics.*

MODULE-2

UNIT-1 **0L+0T+8P=8 Hours**

GETTING AROUND – INFLUENCES - STAY FIT AND HEALTHY:

Reading: Reading for understanding coherence of the text and drawing inferences.

Writing: Reading an announcement from a magazine or website for preparing an article.

Listening: Discussion activities and listening to understand the gist of each short dialogue.

Speaking: Snap Talks, Make and respond to suggestions, discuss alternatives and negotiate agreement.

Vocabulary / Grammar: Punctuation, Prepositions, Phrasal Verbs, B1 Preliminary word list.

UNIT-2 **0L+0T+8P=8 Hours**

LOOKS AMAZING! – THE NATURAL WORLD – EXPRESS YOURSELF!:

Reading: Content, Communicative Achievement, Organisation and Language.

Writing: Developing a story with clear links to the given opening sentence.

Listening: An interview for a detailed understanding of meaning and to identify attitudes and opinions.

Speaking: Discuss likes, dislikes, experiences, opinions, habits, etc.

Vocabulary/Grammar: Modals, Conditionals, Verb forms (Time and Tense).

PRACTICES:

- Listening to understand the gist of each short dialogue.
- Listening to an interview for a detailed understanding of meaning and to identify attitudes and opinions.
- Preparing an article.
- Discuss for alternatives andnegotiate agreement.
- Discussion on likes, dislikes, experiences, opinions, habits, etc.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply to read and grasp content on a range of topics/texts related to their everyday life like notifications, advertisements, travel brochures, news reports, articles.	Apply	1	7, 8, 9, 10, 12
2	Apply suitable strategies to achieve comprehension, like listening for main points and checking comprehension using contextual clues etc.	Apply	1	7, 8, 9, 10, 12
3	Use functional English to communicate and interact effectively in everyday situations.	Apply	1, 2	7, 8, 9, 10, 12
4	Demonstrate vocabulary beyond that of the familiar subjects.	Analyze	1, 2	7, 8, 9, 10, 12
5	Show sufficient control of English grammar and sentence variety to coherently organise information at sentence and discourse levels.	Evaluate	2	7, 8, 9, 10, 12

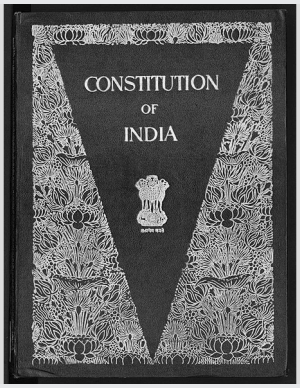
TEXT BOOKS:

1. Emma Heyderman and Peter May, “Complete Preliminary”, Student’s Book with Answers, 2nd edition, Cambridge University Press, 2019.

REFERENCE BOOKS:

1. Annette Capel and Rosemary Nixon, “Introduction to PET”, Oxford University Press, 2009.
2. Adrian Doff and Craig Thaine, “Empower Pre intermediate”, Cambridge University Press, 2015.
3. Louise Hashemi and Barbara Thomas, “Objective PET”, Cambridge University Press, 2010.

22TP101 CONSTITUTION OF INDIA



Source: https://commons.wikimedia.org/wiki/File:Constitution_india.jpg

Hours Per Week :

L	T	P	C
0	2	0	1

PREREQUISITE KNOWLEDGE: High School-level Civics and Social Studies.

COURSE DESCRIPTION AND OBJECTIVES:

To provide students with a basic understanding of Indian Polity and Constitution and make students understand the functioning of government at the center and state level besides local self-government. This course also equips students with knowledge pertaining to fundamental rights and fundamental duties of a citizen in a democracy such as India.

MODULE-1

UNIT-1 **0L+8T+0P=8 Hours**

HISTORICAL BACKGROUND TO THE INDIAN CONSTITUTION:

Meaning of the constitution law and constitutionalism; Historical perspective of the Constitution of India; Salient features and characteristics of the Constitution of India.

UNIT-2 **0L+8T+0P=8 Hours**

FUNDAMENTAL RIGHTS, DUTIES, DIRECTIVE PRINCIPLES, AND AMENDMENT:

Scheme of the fundamental rights - scheme of the Fundamental Right to Equality; scheme of the Fundamental Right to certain Freedom under Article 19; scope of the Right to Life and Personal Liberty under Article 21; Scheme of the Fundamental Duties and its legal status; Directive Principles of State Policy – its importance and implementation; Amendment of the Constitution - Powers and Procedure.

PRACTICES:

- Enactment of Constituent Assembly debates to further understand the rationale for the provisions of the constitution.
- Fundamental Rights in our popular culture - discussion in the movie Jai Bhim.

MODULE-2

UNIT-1 **0L+8T+0P=8 Hours**

STRUCTURE AND FORM OF GOVERNMENT:

Federal structure and distribution of legislative and financial powers between the Union and the States; Parliamentary Form of Government in India – The constitution powers and status of the President of India; Emergency Provisions: National Emergency, President Rule, Financial Emergency.

UNIT-2 **0L+8T+0P=8 Hours**

LOCAL SELF GOVERNMENT:

Local Self Government – Constitutional Scheme in India – 73rd and 74th Amendments.

PRACTICES:

- Debate on federalism in India.
- Collect news published in the local papers about panchayats in the nearby areas.

SKILLS:

- ✓ *Understanding the basics of the Indian constitution.*
- ✓ *Know the fundamental rights, fundamental duties, and Directive Principles of State Policy.*
- ✓ *Fair knowledge about the functioning of various institutions in a democracy.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyse major articles and provisions of the Indian constitution.	Analyze	1	6
2	Appreciation for the constitution and safeguarding individual rights.	Apply	1	6
3	Evaluating functions of various organs of the State in a democracy.	Evaluate	2	6

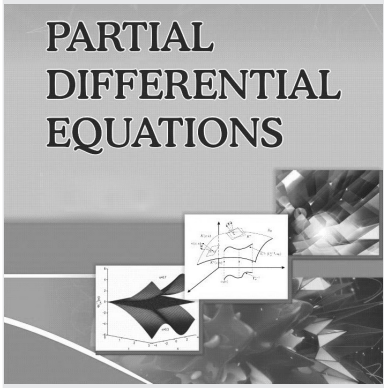
TEXT BOOKS:

1. PM Bhakshi, “Constitution of India”, 15th edition, Universal Law Publishing, 2018.

REFERENCE BOOKS:

1. B. R. Ambedkar, “The Constitution of India” Educreation Publishing, India, 2020.
2. Subhash Kashyap, “Our Constitution” 2nd edition, National Book Trust, India, 2011.
3. Arun K. Thiruvengadam, “The Constitution of India: A Contextual Analysis”, Hart Publishing India, 2017.

22MT112 PARTIAL DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS



Source:
https://www.google.com/

Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Differentiation, Integration, Vectors.

COURSE DESCRIPTION AND OBJECTIVES:

The goal of this course is to build an ability of understand how partial differential equations arise in the mathematical description of heat flow and vibration. The methods to explain the physical interpretations of common forms of PDEs and solution for initial and boundary value problems will be the primary focus. Students will gain deeper knowledge of multiple differentiation operations such as Gradient, Divergent and Curl.

MODULE-1

UNIT-1 **12L+8T+0P=20 Hours**

PARTIAL DIFFERENTIAL EQUATIONS:

Partial differential equations: Order and degree, Formation of partial differential equations, Lagrange linear equations, Method of multipliers.

Classification of Second Order PDE, Method Separation of variables.

UNIT-2 **12L+8T+0P=20 Hours**

APPLICATIONS AND NUMERICAL METHODS:

Solution to one dimensional wave equation, heat equation and Laplace's equation.

Numerical Methods: Numerical methods to solve Laplace's equation: Standard five-point formula, Diagonal five-point formula (Liebmenn's iteration process).

PRACTICES:

- Learn method of forming partial differential equations.
- Identify and apply different methods to solve differential equations.
- Determine the displacement of a vibrational string is initially at rest in equilibrium position.
- Evaluate the temperature distribution in insulated rods.
- Determine solutions of Laplace equation.

MODULE-2

UNIT-1 **12L+8T+0P=20 Hours**

VECTOR CALCULUS:

Vector Differentiation: Scalar and vector point functions, Differentiation of vector functions, Gradient, Divergence, Curl.

Vector Integration: Introduction to multiple integrals (Review), Line integral, Surface integral, Volume integral.

SKILLS:

- ✓ *Apply the transformation between line integral, surface integral and volume integral.*
- ✓ *Gain deeper knowledge of differential operators.*
- ✓ *Be able to use the separation of variables technique to solve partial differential equations.*

UNIT-2 **12L+8T+0P=20 Hours**

APPLICATIONS OF VECTOR CALCULUS:

Normal vector, Directional Derivate, Solenoidal and Irrotational flow.

Green's theorem for plane, Gauss divergence theorem, Stokes' theorem (without proofs).

PRACTICES:

- Compute the work done when an object moves along the path subject to a force.
- Use divergence and curl to measure the tendency of the fluid to collect or disperse at a point and the tendency of the fluid to swirl around the point.
- Compute the flux of a vector per unit time flowing across in the direction of a vector.
- Verify Green's theorem, stokes theorem and Divergence theorem for the functions over a region.
- Compute the tangent vector to a curve in space.
- Compute the directional derivative of a scalar point function at a point.
- Compute any integral which is to be evaluated over a curve, over a surface or over a volume.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the numerical methods to solve Laplace's equation.	Apply	1	1, 2, 9, 10, 12
2	Apply Green's theorem for plane, Gauss divergence theorem, Stokes' theorem.	Apply	2	1, 2, 9, 10, 12
3	Evaluate differential operators and the solutions of first order and some second order partial differential equations.	Evaluate	1	1, 2, 9, 10, 12
4	Evaluate the line integrals, surface integrals and volume integrals.	Evaluate	2	1, 2, 9, 10, 12

TEXT BOOKS:

1. N. P. Bali, K. L. Sai Prasad, "A Textbook of Engineering Mathematics I, II, III", 2nd Edition, Universal Science Press, New Delhi, 2018.
2. B. S. Grewal, "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, 2018.

REFERENCE BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley and Sons, Inc, 2015.
2. H. K. Dass and Er. Rajanish Verma, "Higher Engineering Mathematics", S. Chand and Co., Third revised edition, 2015.
3. B. V. Ramana, "Advanced Engineering Mathematics", TMH Publishers, 2020.
4. T. K.V. Iyengar et al, "Engineering Mathematics, I, II, III", S. Chand and Co., New Delhi, 2018.

22CT103 ENGINEERING CHEMISTRY

Source: https://www.rsc.org/journals-books-databases/about-journals/reaction-chemistry-engineering/

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Concept of bonding, chemical reactions and electrochemical cell.

COURSE DESCRIPTION AND OBJECTIVES:

The course aims to cover the importance of chemistry and its applications in engineering disciplines particularly focusing on developing new engineering materials (such as polymers, nanomaterials etc.) and understanding their property for scientific and engineering applications. In addition, the students are also expected to acquire knowledge on electrochemistry and construction of batteries and fuel cells.

MODULE-1

UNIT-1 **8L+0T+8P=16 Hours**

POLYMERS:

Introduction, classification, molecular weight determination, (Mw & Mn), types of polymerization, preparation, properties and applications of PE, PMA, Nylon-6,6; Rubber-vulcanization, synthetic rubbers – Neoprene, Introduction to polymer composites, glass fiber and metal oxide/metal composites.

UNIT-2 **8L+0T+8P=16 Hours**

NANOMATERIALS & ENGINEERING MATERIALS:

Nanomaterials: Introduction, classification, properties, Top-down (Ball Milling) and Bottom-up (Sol-Gel) synthetic methods; Synthesis, properties and applications of Carbon Nanotubes and Graphene.

Engineering Materials: Lubricants – classification, viscosity, viscosity index, flash and fire points, cloud and pour points and mechanical stability; Refractories – classification, refractoriness RUL, chemical & thermal stability.

PRACTICES:

- Synthesis of Nanoparticles.
- Synthesis of Bakelite.
- Determination of viscosity of oil (Biodiesel, castor oil and coconut oil).
- Water Analysis.
- Synthesis of Iron oxide nanoparticles.
- Synthesis of Au/Ag nanoparticles using plant extract.
- Preparation of Nylon-6,6.
- Preparation of Polystyrene.

MODULE-2

UNIT-1 **8L+0T+8P=16 Hours**

ELECTROCHEMISTRY & CORROSIONS:

Electrochemical Cells: Galvanic and electrolytic cells; Redox reactions; Electrode potential; Electrochemical series, EMF of an electrochemical cell; Nernst equation - applications and significances; Reference electrodes – Standard hydrogen electrode.

Corrosion: Introduction, dry & wet corrosion; Galvanic series; Corrosion prevention by cathodic protection.

SKILLS:

- ✓ *Synthesize various polymers.*
- ✓ *Synthesize nanomaterials.*
- ✓ *Identify the properties of different industrially relevant engineering materials.*
- ✓ *Understand the different components of an electrochemical cell.*
- ✓ *Design electrochemical cell such as battery.*
- ✓ *Identify the types of energy conversion/ storage systems.*

UNIT-2 **8L+0T+8P=16 Hours**

BATTERIES & FUEL CELLS:

Batteries: Introduction and importance; Classification of batteries - Lead-acid storage cell and Lithium-ion batteries.

Fuel Cells: Classification of Fuel Cells; Construction, working principle and applications of Hydrogen-Oxygen fuel cell, Biofuel cells - Microbial fuel cells.

PRACTICES:

- Determination of EMF and ΔG of an electrochemical cell.
- Determination of rate of corrosion by weight loss method.
- Construction of Batteries.
- Determination of Molecular weight by viscometer.
- Determination of Fe (II) by dichrometry method.
- Determination of available chlorine in bleaching powder.
- Determination of strength of Weak acid by pH-method.
- Determination of concentration of mixture of acids by conductometry.
- Electroplating of Copper and Zinc on metallic objects.
- Determination of rate of corrosion by weight loss method.
- Construction of galvanic cell and measure the EMF.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply various synthetic methods for preparing polymers for engineering applications.	Apply	1	1, 2, 4, 9, 10, 11, 12
2	Analyze characteristics in different engineering nanomaterials for the applications of electronic engineering.	Analyze	1	1, 2, 3, 5, 9, 10, 11, 12
3	Distinguish different types of electrochemical cells and corrosions for the real time analysis.	Analyze	2	1, 2, 3, 5, 6, 7, 9, 10, 11, 12
4	Analyze possible corrosion types and their different protection methods.	Analyze	2	1, 2, 3, 5, 6, 7, 9, 10, 11, 12
5	Recommend the principle of electrochemistry for designing various batteries and fuel cells.	Evaluate	2	1, 2, 3, 5, 6, 7, 9, 10, 11, 12

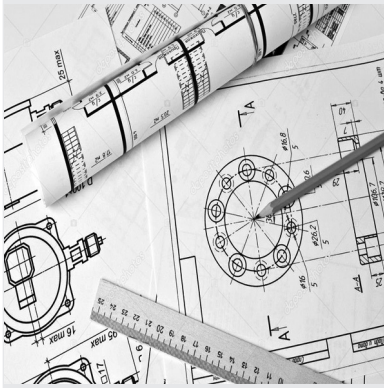
TEXT BOOKS:

1. S. Chawala, “A Textbook of Engineering Chemistry Engineering Materials and Applications”, Dhanpat Rai Publications, 3rd Edition, 2015.
2. P.C. Jain and M. Jain, “Engineering Chemistry”, Dhanpat Rai Publications, 17th Edition, 2015.

REFERENCE BOOKS:

1. K. S. Maheswaramma and M. Chugh, “Engineering Chemistry”, Pearson, 1st Edition, 2015.
2. B. S. Bahl, Arun Bahl and B. D. Tuli, “Essentials of Physical Chemistry”, S. Chand and Co. Ltd., 2007.
3. G. Raj and C. Anand, “Instrumental Methods of Analysis”, Himalaya Publications, 5th edition, 2007.
4. T. Pradeep, “Nano: The Essentials; Understanding of Nano Science and Technology” Tata McGraw-Hill, New Delhi, 2012.
5. J. Mendham, R. C. Denney, J. D. Bares, M. Thomas and B. Siva Sankar, “Vogel’s Textbook of Qualitative Chemical Analysis” (vol. 1), Pearson Publications, 2009.

22ME101 ENGINEERING GRAPHICS



Source: https://depositphotos.com/5087383/stock-photo-the-engineering-drawing.html
Image file name: Engineering Graphics.

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Basics of Geometry.

COURSE DESCRIPTION AND OBJECTIVES:

Engineering graphics is the language of engineers and is the most effective way of communicating and sharing technical ideas in the form of pictures/drawings. The objective of this course is to familiarize the students with the conventional concepts of engineering drawing and computer aided drawing.

MODULE-1

UNIT-1 **6L+0T+6P=12 Hours**

Engineering Curves: Types of lines; Lettering, Dimensioning, Geometric constructions - lines, polygons (Angle, ARC, General and Inscribe in circle method), Conical curves (General method), Ellipse by Oblong method.

UNIT-2 **10L+0T+10P=20 Hours**

Orthographic Projections of Points, Lines & Planes: Principles of projection; Projections of points; Projection of straight lines - Inclined to one plane, inclined to both planes; Projection of planes - Inclined to one plane.

PRACTICES:

- Construction of polygons using different methods (i.e. ARC, Angle, General).
- Inscribe a regular hexagon & pentagon in a circle of the given diameter.
- Tracing of conical curves (Ellipse, Parabola, Hyperbola) by using General Method.
- Draw the projections of the points situated in all the 4 quadrants.
- Draw the projections of a line when it is inclined to one plane (HP or VP).
- Draw the projections of a line when it is inclined to both the planes (HP &VP).
- Draw the projections of a plane when it is inclined to one plane (HP or VP).

MODULE-2

UNIT-1 **6L+0T+6P=12 Hours**

Projections of Solids: Projection of solids axis inclined to one reference plane - Prisms, pyramids, Cylinder and cone.

Development of Surfaces: Development of lateral surfaces of simple solids - Prisms, Pyramids, Cylinder and cone.

UNIT-2 **10L+0T+10P=20 Hours**

Orthographic Views: Conversion of pictorial views into orthographic views.

Drafting Using Computer Package: Introduction to 2D modelling software - AutoCAD; Conversion of Isometric view into Orthographic views of simple castings; Conversion of Orthographic views into Isometric view of simple solids - Prisms, Pyramids, Cylinders and cones.

SKILLS:

- ✓ *Convert isometric views of objects into orthographic views and vice versa.*
- ✓ *Visualize the shape of the 3D components.*
- ✓ *Create pictorial views by using AutoCAD.*
- ✓ *Understand projections by visualization.*

PRACTICES:

- Draw the projections of Prisms, when they are inclined to one reference plane (HP or VP).
- Draw the projections of Pyramids, when they are inclined to one reference plane (HP or VP).
- Draw the projections of cylinder & cone, when they are inclined to one reference plane (HP or VP).
- Draw the complete surface development of prisms & pyramids with the given dimensions.
- Draw the complete surface development of cylinder & cone with the given dimensions.
- Draw the orthographic view's (i. e. front view, top view, and side view) of the given pictorial view of the sketches by using AutoCAD.
- Draw the Isometric view of simple solids (Prisms & Pyramids) by using AutoCAD.
- Draw the Isometric view of simple solids (Cylinder & Cone) by using AutoCAD.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Communicate the technical ideas in the form of drawings.	Apply	1	1, 2, 3, 5
2	Apply the drawing skills in representing various geometrical features.	Apply	1	1, 2, 3, 5
3	Develop orthographic projections and isometric views of various objects.	Apply	1	1, 2, 3, 5
4	Estimate the lateral surface area of regular geometrical solids.	Analyze	2	1, 2, 3, 5
5	Sketch simple objects and their pictorial views using AutoCAD.	Analyze	2	1, 2, 3, 5

TEXT BOOKS:

1. J Hole, "Engineering Drawing", Tata McGraw-Hill, 2nd Edition, 2019.
2. N D Bhatt, "Engineering Drawing", Charotar Publication, 53rd Edition, 2014.

REFERENCE BOOKS:

1. Basant Agrawal and C.M. Agrawal "Engineering Drawing", Tata Mc Graw- Hill, 2nd Edition 2018.
2. K L Narayana, "Engineering drawing", SciTech Publications, 3rd Edition, 2011.
3. Colin H. Simmons, Dennis E. Maguire, Manual of Engineering Drawing, 2nd Edition, 2003.

22TP104 BASIC CODING COMPETENCY

Source: https://www.geeksforgeeks.org/best-way-to-start-with-competitive-programming-geeksforgeeks-cp-live-course/

Hours Per Week :

L	T	P	C
0	1	3	2

PREREQUISITE KNOWLEDGE: Programming in C.

COURSE DESCRIPTION AND OBJECTIVES:

This course is aimed to impart knowledge on advanced concepts of C programming language and problem solving. At the end of this course, students will be able to design, implement, test and debug complex problems using features of C.

MODULE-1

UNIT-1 **0L+4T+12P=16 Hours**

NUMBER CRUNCHING:

PRACTICES:

PROBLEMS ON NUMBER CRUNCHING:

- Write a program to check if a given number is perfect or not.
- Write a program to check if a given number is deficient or not.
- Write a program to check if 2 given numbers are amicable or not.
- Write a program to check if 2 given numbers are betrothed or not.
- Write a program to check whether a given number is an Armstrong number or not.
- Write a program to print the series of prime numbers in the given range.
- Write a program to print all the perfect numbers in a given range.
- Write a program to generate all deficient numbers in a given range.
- Write a program to generate all the amicable numbers in a given range.
- Write a program to generate all the betrothed numbers in a given range.
- Write a program to find the largest prime factor of a given number.
- Write a program to check whether the given number is a palindrome or not.
- Write a program to calculate sum of the individual digits for the given number.
- Write a program to find the first number that has more than ‘n’ factors, excluding 1 and that number.
- Write a program to accept a number as input and print its factorial.
- Write a program to accept a number n, print first N Fibonacci numbers.
- Write a program to check if an input number is Armstrong number or not.
- Write a program that takes input a,b. Print a power b.
- Write a program that takes input a number n, check if it a perfect square or not.
- Print array in spiral format.
- Print sum of each row in a matrix.
- Print sum of each column in matrix.
- Print left->right and right->left diagonals in a matrix.
- Initially you are at (0,0) find the shortest path count to reach the (n, n) block in matrix.
- Remove all the elements present in row and column of unsafe elements. An element is called unsafe if it is equal to smallest or largest value. Count number of remaining elements.
- Write a program to check if the string contains all the letters of alphabet.
- Check if a string is matching password requirements.

SKILLS:

- ✓ *Analysis of the problem to be solved.*
- ✓ *Application of various file operations effectively in solving real world problems.*
- ✓ *Develop C programs that are understandable, debuggable, maintainable and more likely to work correctly in the first attempt*

- Check if String A contains String B (String searching).
- Check if a number is harshad number or not.
- Write a program to get 3 numbers as input. The first is the number num1 and second is the digit that needs to be replaced. The third is the digit that is to replace the 2nd digit. Print the number after performing this operation.
- Write a program to accept a number and swap its alternate digits. Print the number generated.
- Write a program to accept a number and choice as input. If the choice is 0 rearrange the number such that the odd digits are ordered first followed by the even digits. If the choice is 1 rearrange the number such that the even digits are ordered first followed by the odd digits. Print the rearranged number. The order of occurrence of the digits is to be preserved.
- Write a program to determine that whether the given quadrilateral is cyclic or not. You are given the sizes of angles of a simple quadrilateral (in degrees) A, B, C and D, in some order along its perimeter.

  Note: A quadrilateral is cyclic if and only if the sum of opposite angles is 180◦.
- Chef is a very lazy person. Whatever work is supposed to be finished in x units of time, he finishes it in $m*x$ units of time. But there is always a limit to laziness, so he delays the work by at max d units of time. Given x,m,d, find the maximum time taken by Chef to complete the work.
- Suppose Chef is stuck on an island and currently he has x units of food supply and y units of water supply in total that he could collect from the island. He needs xr units of food supply and yr units of water supply per day at the minimal to have sufficient energy to build a boat from the woods and also to live for another day. Assuming it takes exactly D days to build the boat and reach the shore, tell whether Chef has the sufficient amount of supplies to be able to reach the shore by building the boat? Read five integers x,y,xr,yr,D from the user and display “YES” if Chef can reach the shore by building the boat and “NO” if not (without quotes).
- There are 3 problems in a contest namely A,B,C respectively. Alice bets Bob that problem C is the hardest while Bob says that problem B will be the hardest.
- You are given three integers SA,SB,SC which denotes the number of successful submissions of the problems A, B, C respectively. It is guaranteed that each problem has a different number of submissions. Determine who wins the bet.

  1) If Alice wins the bet (i.e. problem C is the hardest), then output Alice.
  2) If Bob wins the bet (i.e. problem B is the hardest), then output Bob.
  3) If no one wins the bet (i.e. problem A is the hardest), then output Draw.

  Note: The hardest problem is the problem with the least number of successful submissions.

  Input Format
- The first line of input contains a single integer T denoting the number of test cases. The description of T test cases follows.
- The first and only line of each test case contains three space-separated integers SA,SB,SC, denoting the number of successful submissions of problems A,B,C respectively.

  Output Format

  For each test case, output the winner of the bet or print Draw in case no one wins the bet.

  Sample Input 1

  3

  1 4 2

  16 8 10

  14 15 9

  Sample Output 1

  Draw

  Bob

  Alice
- In a season, each player has three statistics: runs, wickets, and catches. Given the season stats of two players A and B, denoted by R, W, and C respectively, the person who is better than the other in the most statistics is regarded as the better overall player. Tell who is better amongst A and B. It is known that in each statistic, the players have different values.

Input

The first line contains an integer T, the number of test cases. Then the test cases follow.

Each test case contains two lines of input.

The first line contains three integers R1, W1, C1, the stats for player A.

The second line contains three integers R2, W2, C2, the stats for player B.

Output

For each test case, output in a single line "A" (without quotes) if player A is better than player B and "B" (without quotes) otherwise.

- Write a program to find the direction.

  Chef is currently facing the north direction. Each second he rotates exactly 90 degrees in clockwise direction. Find the direction in which Chef is facing after exactly X seconds.

  Note: There are only 4 directions: North, East, South, West (in clockwise order). Initially chef is at 0th second i.e., facing North direction.

  Input Format

- First line will contain T, number of testcases. Then the testcases follow.
- Each testcase contains of a single integer X.

  Output Format

  For each testcase, output the direction in which Chef is facing after exactly X seconds.

  Sample Input 1

  3

  1

  3

  6

  Sample Output 1

  East

  West

  South

- Chef is playing in a T20 cricket match. In a match, Team A plays for 20 overs. In a single over, the team gets to play 6 times, and in each of these 6 tries, they can score a maximum of 6 runs. After Team A's 20 overs are finished, Team B similarly plays for 20 overs and tries to get a higher total score than the first team. The team with the higher total score at the end wins the match.

  Chef is in Team B. Team A has already played their 20 overs, and have gotten a score of R. Chef's Team B has started playing, and have already scored C runs in the first O overs. In the remaining 20−O overs, find whether it is possible for Chef's Team B to get a score high enough to win the game. That is, can their final score be strictly larger than R?

  Input: There is a single line of input, with three integers, R, O, C.

  Output: Output in a single line, the answer, which should be "YES" if it's possible for Chef's Team B to win the match and "NO" if not.

- Make Array Zeros using pointers

  You are given an array A of length N (size should be created using Dynamic memory allocation) and can perform the following operation on the array:

  Select a subarray from array A having the same value of elements and decrease the value of all the elements in that subarray by any positive integer x.

  Find the least possible number of operations required to make all the elements of array A equal to zero.

  The first line contains an integer N denoting the number of elements in the array.

  The next line contains space-separated integers denoting the elements of array A.

  Print the least possible number of operations required to make all the elements of array A equal to zero.

Sample Test case

Input:

5

2 2 1 3 1

Output:

4

UNIT-2 **0L+4T+12P=16 Hours**

PATTERNS

PRACTICES:

Problems on Number Patterns

- Write a program to generate Floyd triangle. Sample input N= 4.

  1

  2 3

  4 5 6

  7 8 9 10
- Write a program to generate the following pattern. Sample input N=5.

  13579

  3579

  579

  79

  9
- Write a program to generate the following pattern. Sample input N=4.

  1111111

  222222

  33333

  4444

  333

  22

  1
- Write a program to generate the following pattern. Sample input N=5.

  5432*

  543*1

  54*21

  5*321

  *4321
- Write a program to generate the following pattern. Sample input N=5.

  12 21

  123 321

  1234 4321

  123454321
- Write a program to generate the following pattern. Sample input N=5.

  1

  2*2

  3*3*3

  4*4*4*4

4*4*4*4
3*3*3
2*2
1

- Write a program to generate the following pattern. Sample input N=4.
  1
  212
  32123
  4321234
- Write a program to generate the following pattern. Sample input N=5.
  *
  * *
  * * * *
  * *
  *
- Write a program to print Pascal triangle for the given number of rows. Sample input N=5.

```
                1
            1       1
        1       2       1
    1       3       3       1
1       4       6       4       1
```

- Write a program to generate the following pattern. Sample input N=4.
  1234
  2341
  3421
  4321
- Print Hollow Diamond pattern.
- Print pascals triangle.
- Print Floyds triangle.
- Print Butterfly Pattern.
- Print palindromic pattern.
- Print full inverted number triangle.
- Check if a number is prime or not (Efficient Approach).
- Find sum of all the digits of the number.
- Print transpose of given matrix.
- Rotate a two dimensional matrix by 90, 180, 270 degrees.

MODULE-2

UNIT-1 **0L+4T+12P=16 Hours**

ARRAYS:

PRACTICES:

Problems On Arrays:

- Given an unsorted array of size N, and the array elements are in the range of 1 to N. There are no duplicates, and the array is not sorted. One of the integers is missing. Write a program to find the missing number.
- Given an array consisting of only 0s and 1s in random order rearrange the array such that all the 0s are to the left of the array and 1s to the right.

- Give an array consisting of odd and even numbers in random order, rearrange the array such that all the odd numbers are to the left of the array and even numbers are to the right of the array.
- Write a program to find all the unique elements in an array.
- Write a program to merge two arrays of the same size sorted in descending order.
- Write a program to count the frequency of each element in an array of integers.
- Write a program to find the second largest element in an array.
- Write a program to find the second smallest element in an array.
- Write a program to find that one element in array that occurs odd number of times, where every other element appears even number of times.
- Create a jagged array (adjacency list representation of a graph) with no of rows and no of columns in each row as specified by the user.

  Hint: Use Dynamic memory allocation (malloc() or calloc())

  Input:

  Enter no of rows: 3

  Enter no of columns Row in 1: 3

  Enter no of columns Row in 2: 5

  Enter no of columns Row in 3: 2

  Enter the elements row wise:

  8 6 5

  8 4 6 9 7

  9 2

  Output:

  8 6 5

  8 4 6 9 7

  9 2
- Write a program to find second largest number in the array.
- Write a program to find first repeating element in the array.
- Write a program to left rotate the array.
- Write a program to right rotate the array.
- Write a program to find the largest continuous sum.
- Write a program to print the sum of 2nd largest and 2nd smallest elements.
- Write a program to find the maximum product of two numbers multiplies in array (same index should not be used twice).
- Rearrange an array consisting of 1s and 0s such that they are alternatively arranged. Print minimum number of moves required.
- In a given array, find two numbers whose sum equal k.
- Find the difference between positive and negative elements in the array.
- Implement sorting algorithms (Insertion, selection, bubble).

UNIT-2 **0L+4T+12P=16 Hours**

STRINGS:

PRACTICES:

Problems on Strings:

- Write a program to reverse a given string word by word.
- Write a program to find the first occurrence of non-repeating character in the given string.
- Write a program to compress the string as provided in the example.
- Write a program to expand a string as provided in the example.
- Write a program to reverse those words of a string whose length is odd.
- Write a program to check if a given matrix is symmetric or not.

- Write a program to convert all the cases of letter (Lower case -> Upper Case, Upper Case-> Lower Case).
- Write a program to reverse all the words (Not the entire sentence but individual words).
- Find the longest palindrome in a given string.
- Check if two strings are anagrams or not.
- Find minimum number of changes to be done to make a string palindrome.
- Convert Excel sheet name to number (A-1, B-2, Z-26, AA-27).
- Find number of possible palindromes present in a string.
- Write a C program to read a string s, and determine the number of words in s.

  Example : s=oneTwoThree

  There are 3 words in the string: 'one', 'Two', 'Three'.
- Write a C program that reads a string S and remove all duplicates characters from the given string S.

  NOTE:

  1) Order of characters in output string should be same as given in input string.

  2) String S contains only lowercase characters ['a'-'z'].

  Example: S = Vignanuniversity

  The program should generate the output as: Vignauersty
- Today Ron is reading the book. Due to some reason, he started hating the word 'are' (without quotes). So he decided to replace the substring 'are' with 'R'. Write a C program that reads a line of message 's' and replace the substring 'are' with 'R'. Example: s= Howareyou.

  The program should generate the output as: HowRyou
- Write a program to concatenate the characters of the two given strings alternatively.
- Given a string S consisting of uppercase and lowercase letters, change the case of each alphabet in this string. That is, all the uppercase letters should be converted to lowercase and all the lowercase letters should be converted to uppercase.

  Input: Vignan University

  Output: vIGNAN uNIVERSITY
- Write a program to insert a given character at the beginning and end of the given string.
- Given two Strings A and B. They are said to be friends if ASCII sum of the each individual string is divisible by 4 else they are not friends. You need to find whether given two strings are friends or not.

  Sample Test case:

  Input:

  man nam

  vignan university

  Output:

  YES

  NO
- Write a program to find the frequency of each digit in the given string.

  Input Format

  The first line contains a string, which is the given number.

  Output Format

  Print ten space-separated integers in a single line denoting the frequency of each digit, indicate that the integers are from 0 to 9.

  Sample Input 0

  a11472o5t6

  Sample Output 0

  0 2 1 0 1 1 1 1 0 0

  Explanation 0

Source : https://www.kgi.edu/news/what-is-bioprocess-engineering/

In the given string:

- 1 occurs two times.
- 2,4,5,6 and 7 occur one time each.
- The remaining digits and don't occur at all.

- Sherlock considers a string to be valid if all characters in the given string appear the same number of times. It is also valid if he can remove just 1 character at 1 index in the string, and the remaining characters will occur the same number of times.

  Write a C program that reads a string s and determine whether it is valid or not. If valid, return YES, otherwise return NO.

  Example: S=abc

  This is a valid string because frequencies are {a:1,b:1,c:1}

  S=abcc

  This is a valid string because we can remove one c and have 1 of each character in the remaining string.

  S=abccc

  This string is not valid as we can only remove 1 occurrence of c. That leaves character frequencies of {a:1,b:1,c:2}

- Read a string containing characters A and B only. Your task is to change it into a string such that there are no matching adjacent characters. To do this, you are allowed to delete zero or more characters in the string.

  Write a C program that finds the minimum number of deletions required.

  Example: S=AABAAB

  Remove A at positions 0 and 3 to make S=ABABA in 2 deletions.

  Input Format

  The first line contains an integer (the number of queries).

  The next q lines each contain a string s to analyze.

  Sample Input:

  5

  AAAA

  BBBBB

  ABABABAB

  BABABA

  AAABBB

  Sample Output:

  3

  4

  0

  0

  4

- Write a C program that reads a string 's' and it is said to be complete if it contains all the characters from a to z.

  Input Format

  First line of the input contains the number of strings N. It is followed by N lines each contains a single string.

  Output Format

  For each test case print "YES" if the string is complete, else print "NO"

  Constraints 1 <= N <= 10

  The length of the string is at max 100 & the string contains only the characters a to z.

- Write a C program that reads two strings and determine whether they share a common substring or not. A substring may be as small as one character.

  Example:

  S1=and

  S2=art

  The common substring in these two strings: a.

  Sample Input

  2

  hello

  world

  hi

  world

  Sample Output

  YES

  NO

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Write simple, but complete, C programs.	Apply	1, 2	1
2	Identify suitable data type for operands and design of expressions having right precedence.	Apply	1, 2	1
3	Apply decision making and iterative features of C Programming language effectively.	Apply	1, 2	1
4	Select problem specific data structures and suitable accessing methods.	Analyse	1, 2	1, 2
5	Design and develop non- recursive and recursive functions and their usage to build large modular programs and also able to design string manipulation functions.	Create	1, 2	3
6	Develop C programs that are understandable, debuggable, maintainable and more likely to work correctly in the first attempt.	Create	1, 2	3, 4

TEXT BOOKS:

1. Behrouz A. Forouzan, Richard F.Gilberg, “Programming for Problem Solving”, 1st edition, Cengage publications, 2019.
2. Ajay Mittal, “Programming in C - A Practical Approach”, 1st edition, Pearson Education, India, 2010.

REFERENCE BOOKS:

1. Reema Thareja, “Computer Fundamentals and Programming in C”, 1st edition, Oxford University Press, India, 2013.
2. Herbert Schildt, “C: The Complete Reference”, 4th edition, Tata McGraw-Hill, 2017.
3. Byron S Gottfried, “Programming with C”, 4th edition, Tata McGraw-Hill, 2018.

source: https://www.abebooks.com/9781316640081/English-Technical-Communication-Students-Book-1316640086/plp

22EN104 TECHNICAL ENGLISH COMMUNICATION

Hours Per Week :

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Basic sentence formation, understanding contextual meanings, basic writing skills and moderate fluency in English.

COURSE DESCRIPTION AND OBJECTIVES:

In this course students will read, analyze, and interpret material from technical and general fields, and practice reading, writing, listening and speaking skills to gain exposure and functional English on a variety of contemporary topics. The overall course objective is to provide English for Specific Purposes(ESP) instruction to enhance students' reading, writing, listening and speaking skills through a practice in the language. It will aim to build students' confidence and motivation through exposure to academic skills like Note making/taking, Paraphrasing, Summarizing, Report Writing, Making Presentations etc., so as to generate interest in the language from an ESP perspective. Finally, students are expected through the course to gain key strategies and expression for communicating with professionals and non-specialists.

MODULE-1

UNIT-1 **8L+0T+8P=16 Hours**

GENETICS:

Reading: Reading for Note Making Sub skills: Reading for global understanding (skimming), specific information (scanning), understanding main ideas and supporting ideas, guessing contextual meanings from the text. -Vocabulary building: commonly used roots, prefixes, and suffixes.

Writing: Note making, organising main points and sub points, numbering and sequencing, suggesting titles, paraphrasing and summarising.

Functional grammar: Common Errors in Articles and Prepositions (Handout).

Listening: Listening for Note Taking: top down and bottom up approach, listening for main ideas and supporting points.

Speaking: Presentation in teams - ideas on the topic summarised, making a PPT, effective introductions and conclusions, logical organisation of content, using appropriate structure and cohesive devices.

UNIT-2 **8L+0T+8P=16 Hours**

ALIENS:

Reading: Reading: predicting, skimming, scanning, reading for inference, extrapolative reading.

Vocabulary building: Academic vocabulary from the text: synonyms, antonyms, Words often confused.

Writing: Paragraph writing; writing a topic sentence, supporting sentences, effective introductions and conclusions, use of cohesive devices. Types of Paragraphs: Descriptive, narrative, argumentative and expository.

Functional grammar: Common Errors inVerb forms and Conditional sentences (Handout).

Listening: Listening for identifying parts from a description, listening to and sorting information, listening for specific information.

Speaking: Narrating/Retelling an incident, using suitable cohesive devices/discourse markers Speaking of past and present habits/activities/events - Speaking of future plans.

PRACTICES:

- Note making.
- Summarizing.
- Paragraph Writing.
- Error correction and Restructuring.
- Vocabulary building.
- Listening comprehension.
- Note taking.

SKILLS:

- ✓ *Apply different sub skills like skimming, scanning, reading for information, reading for inference etc. to understand different kinds of text.*
- ✓ *Apply different sub skills like top down, bottom up approaches to listening.*
- ✓ *Use functional vocabulary relevant to engineering and technology to express ideas lucidly.*
- ✓ *Use appropriate sentence structure, cohesive devices to construct simple text in regular correspondence like e-mails and letters.*

MODULE-2

UNIT-1 **8L+0T+8P=16 Hours**

SOCIAL MEDIA – HEALTH AND NUTRITION:

Reading: Reading for factual information researching for supporting evidence - skimming, scanning, Vocabulary building: One-word substitutes.

Writing: Letter Writing- E-mail writing – New age communication – Format, protocol, and style- WhatsApp, Facebook and Twitter Functional grammar: Common Errors in Sub-Verb Agreement and Modals.

Listening: Listening to a Business Presentation: Listening for deducing information, for abstract details and specific details, listening for taking a message.

Speaking: Making a presentation with a PPT on a topic assigned- organising the presentation using appropriate discourse markers - presenting a point of view - Extempore.

UNIT-2 **8L+0T+8P=16 Hours**

FASHION:

Reading: Reading for data interpretation and information transfer from graphical aids to text reports (pictograms. tables, graphs, pie charts, flow charts), deducing specific information and general information.

Vocabulary building: business vocabulary, collocations, idioms and phrasal verbs.

Writing: Writing a Report: Drafting general and factual reports - writing an overview - an effective introduction - organising information into paragraphs (Stages of writing: planning /organising /writing / editing /rewriting)

Functional grammar: transformations and miscellaneous common errors.

Listening: Listening to a Ted talk and sorting information – taking notes from a discussion.

Speaking: Group Discussion – prerequisites -generating content - initiating a discussion - expressing one's opinion ~ leading a discussion - agreeing/ disagreeing to someone's view - cutting into a speech - body language and voice modulation.

PRACTICES:

- E-mail writing.
- Letter writing.
- Report writing.
- Messaging in Social media.
- Extempore.
- Making PPTs.
- Session - 1: Dictionary Skills.
- Session - 2: Introduction to Phonetics and Identifying Phonemes.
- Session - 3: Pronunciation Practice (Commonly mispronounced words).
- Session - 4: Rosetta Stone (Exercises on LSRW).
- Session - 5: Listening Comprehension (Summarising exercise on a Ted Talk).
- Session - 6: Technical Presentations (Individual).
- Session - 7: Technical Presentations (Team).
- Session - 8: TOEFL Mastery.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply a variety of strategies to interpret and comprehend spoken texts/ discourse using contextual clues.	Apply	1	6, 7, 8, 9, 10, 12
2	Apply appropriatereading strategies to interpret content / material related to engineering and technology domain.	Apply	1	6, 7, 8, 9, 10, 12
3	Participate in discussions and make short presentations on general and technical topics.	Apply	1, 2	6, 7, 8, 9, 10, 12
4	Possess an ability to write clearly on topics related to technology and workplace communication.	Analyze	2	6, 7, 8, 9, 10, 12
5	Choose functional language, grammar structures, cohesive devices and skills of organisation to express clearly in speaking.	Evaluate	2	6, 7, 8, 9, 10, 12

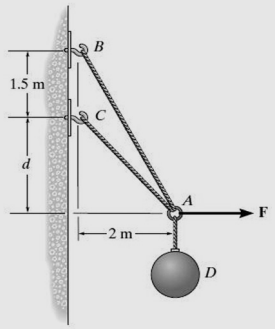
TEXT BOOKS:

1. N P Sudharshana & C Savitha, “English For Technical Communication”, Cambridge University Press, 2016.

REFERENCE BOOKS:

1. Balasubramanian T,“A Text book of Phonetics for Indian Students”, Orient Longman, New Delhi, 1989.
2. Krishnaswamy, N and Sriraman, T, “Current English for Colleges”, Trinity publications, 2016.
3. Mohan Krishna and Meera Banerjee, “Developing Communication Skills”, Macmillan India Ltd. New Delhi, 1990.
4. Ashraf Rizvi M, “Effective Technical Communication”, 2ndEdition, McGraw Hill Education, 2017.
5. Narayana Swamy V R, “Strengthen your Writing”, Third Edition Orient Black Swan, New Delhi, 2005.

22ME102 ENGINEERING MECHANICS



Source: http://www.mathskey.com/question2answer/31644/engineering-mechanics-statics-13th-hibbler-chapter-problem.

Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Basics of physics and mathematics.

COURSE DESCRIPTION AND OBJECTIVES:

This course applies the fundamental laws of mechanics to rigid bodies and gives a working knowledge of static equilibrium and free body diagrams. The objective of this course is to determine the net force acting and the effect of forces on engineering structures.

MODULE-1

UNIT-1 **9L+6T+0P=15 Hours**

Resultant and Equilibrium: Laws of mechanics, Characteristics of a force, System of forces, Resolution of forces, Moment, Couple. Conditions of equilibrium, Free body diagram, Lami's theorem. Simple trusses, Method of joints, Method of sections.

UNIT-2 **15L+10T+0P=25Hours**

Forces on Structures: Determining the resultant force using the parallelogram law of forces and the resolution of the forces methods. Effect of moment and couple on rigid bodies, Application of equations of equilibrium, law of transmissibility of forces, Lami's theorem, Determination of forces on connected bodies, nature of forces on members of a truss, zero force member.

PRACTICES:

- Basic force concepts: resultant, equilibrant, moment and couple.
- Lami's theorem and the laws of mechanics to predict the stability of a structure.

MODULE-2

UNIT-1 **9L+6T+0P=15 Hours**

FRICTION AND MOMENT OF INERTIA:

Laws of friction, Coefficient of friction, Angle of friction, Angle of repose, cone of friction. Centroid and Center of gravity, Parallel axis theorem, Perpendicular axis theorem, Moment of inertia of plane areas, Polar moment of inertia. Moment of inertia of composite areas, Mass moment of inertia.

UNIT-2 **15L+10T+0P=25 Hours**

Force Analysis: Determination of minimum force to overcome friction, Analyze the ladder friction, wedge friction, angle of repose, Calculations of area moment of inertia of composite sections, polar moment of inertia, Mass moment of inertia of cylinder and circular disc. Application of area moment of inertia and mass moment of inertia.

PRACTICES:

- Force required to overcome friction.
- Position of the centroid of composite shapes and C.G. of rigid bodies.

SKILLS:

- ✓ *Net force in a system.*
- ✓ *Equilibrium conditions.*
- ✓ *Force required to overcome friction.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Estimate the forces in statically determinate structures by using principles of mathematics and physics.	Analyzing	1	1, 2, 11
2	Apply the equilibrium conditions and Lami's theorem in statically determinate structures.	Applying	1	1, 2, 11
3	Analyze the friction force, angle of repose, ladder friction, and wedge friction.	Analyzing	2	1, 2
4	Locate the centroid of a section and centre of gravity of a rigid body.	Applying	2	1, 2

TEXT BOOKS:

1. James L. Meriam and L. G. Kraige, "Engineering Mechanics: Statics", SI Version, 9th edition, 2020, John Wiley & Sons.
2. S. Timoshenko, D.H. Young, "Engineering-Mechanics-SI-Units", 5th Edition, 2017, TATA McGraw-Hill Education.

REFERENCE BOOKS:

1. Russell Hibbeler, "Engineering Mechanics: Statics", Pearson 14th Edition, 2016.
2. Dr. U.C. Jindal, "Engineering Mechanics", Made Easy Publications, 2nd Edition, 2019.

II YEAR

B.Tech.

ROBOTICS AND AUTOMATION ENGINEERING

COURSE CONTENTS

I SEM & II SEM

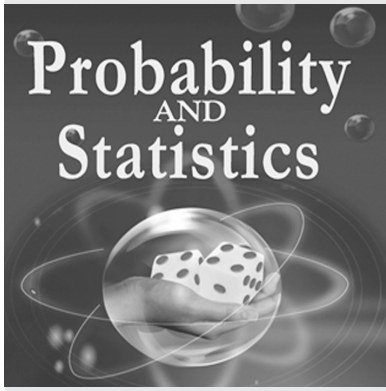
I SEMESTER

22ST202	-	Probability and Statistics
22CT201	-	Environmental Studies
22TP201	-	Data Structures
22MS201	-	Management Science
22RA201	-	Fundamentals of Robotics
22EE206	-	Electric Motors for Robotics
22EC204	-	Electronics for Automation
22SA201	-	Life Skills-I

II SEMESTER

22TP203	-	Advanced Coding Competency
22TP204	-	Professional Communication
22RA202	-	Mobile Robotics
22RA203	-	Robot Mechanisms
22RA204	-	ROS Programming
22SA202	-	Life Skills-II
	-	Department Elective-1
	-	Open Elective-1
	-	Minor/Honors-1

22ST202 PROBABILITY AND STATISTICS



Source: https://www.google.com/search

Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Basic knowledge in statistics and mathematics.

COURSE DESCRIPTION AND OBJECTIVES:

To provide students with foundation in elementary topics of statistics and probability such as descriptive statistics, correlation, probability, random variables, correlation, regression, and testing of hypothesis. The course emphasizes statistics to solve engineering and management problems.

MODULE-1

UNIT-1 **9L+6T+0P=15 Hours**

DESCRIPTIVE STATISTICS:

Basic Definitions, Frequencies, Graphical Representation, Histogram, Ogive curves; Measures of Central tendency, Arithmetic mean, Median, Mode, Mean deviation, Standard deviation; Symmetry and Skewness, Karl Pearson's Coefficient of skewness.

UNIT-2 **15L+10T+0P=25 Hours**

PROBABILITY AND RANDOM VARIABLES:

Probability: Introduction, Definition (Classical and Axiomatic approach), Addition theorem, Conditional probability, Multiplication theorem and Bayes theorem.

Random Variables: Random variables, Discrete and Continuous variables and distribution function.

PRACTICES:

- Various graphical presentation techniques.
- Measures of central tendency.
- Skewness.
- Karl Pearson's coefficient of skewness.
- Applications of addition theorem.
- Applications of multiplication theorem.

MODULE -2

UNIT-1 **9L+6T+0P=15 Hours**

REGRESSION ANALYSIS AND DISTRIBUTIONS:

Correlation and Regression: Correlation, types, Pearson's coefficient of correlation, regression, regression lines.

Distributions: Introduction to distributions: Binomial, Poisson and Normal distributions with properties and applications.

SKILLS:

- ✓ *Collect the data from various data sources and evaluate mean, median, mode mean deviation and standard deviation.*
- ✓ *Identify the areas which we can apply the probability theory.*

UNIT-2 **15L+10T+0P=25 Hours**

TESTING OF HYPOTHESIS:

Testing large samples-one mean, two means, one proportion and two proportions. Testing small samples- one mean, two means (independent and paired samples), Chi square tests-goodness of fit and independence of attributes.

PRACTICES

- Correlation.
- Karl Pearson's coefficient of correlation.
- Regression and regression lines.
- Applications of statistical distributions.
- Testing the large sample tests-one mean and two sample means.
- One proportion and two proportion tests.
- Testing small samples-one, two samples and paired tests.
- Chi-square test for goodness of fit.
- Chi-square test for independence of attributes.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply measures of central tendency, skewness, and Karl Pearson's coefficient of skewness to study the statistical data sets.	Apply	1	1, 2
2	Apply the probability theory and their applications to measure the uncertainty.	Apply	1	1, 2
3	Study the relations between statistical variables and can fit the mathematical models for association.	Analyze	2	1, 2, 3
4	Test the statistical significances for various samples.	Evaluate	2	1, 2, 4
5	Identify the distribution type to measure the occurrences of chance.	Evaluate	2	1, 4, 5

TEXT BOOKS:

1. Sheldon M. Ross, An Introduction to Probability and Statistics for Engineers and Scientists, 3rd Edition, Academic Press, Elsevier.
2. S. C. Gupta and V. K. Kapoor, "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, 2012.

REFERENCE BOOKS:

1. P. R. Vittal, "Mathematical Statistics", Margham Publications, Chennai, 2018.
2. Kishore S. Trivedi, "Probability and Statistics with Realiability, Queueing and Computer Science Applications", 2nd edition, Wiley Student edition, 2008.
3. A. Singaravelu, "Probability and Statistics", 22nd edition, Meenakshi Agency, 2015.

22CT201 ENVIRONMENTAL STUDIES

Source: Biogas plant at VFSTR

Hours Per Week :

L	T	P	C
1	1	0	1

PREREQUISITE KNOWLEDGE: General awareness regarding environmental problems and importance of environmental protection.

COURSE DESCRIPTION AND OBJECTIVES:

It is a multidisciplinary subject where different aspects of society and environment are dealt using a holistic approach. It is evolving to be the education for sustainable and ethical development both at a local and global level. It helps to prepare the next generation for planning appropriate strategies to address environmental issues. It identifies and creates solutions that conserve to manage ecosystem and biodiversity and helps to eliminate pollutants, toxicants, preserve air, water and soil quality. Environmental education recognizes impacts of global issues, enhances the public awareness and helps to take decisions towards environmentally responsible actions.

MODULE-1

UNIT-1 **4L+4T+0P=8 Hours**

INTRODUCTION TO ENVIRONMENT: NATURAL RESOURCES, ECOSYSTEMS AND BIODIVERSITY:

Environment and sustainable development; Natural resources- forest, water, energy and land resources; Ecosystem – basic structural components, function and interactions in ecosystem, ecological succession.

UNIT-2 **4L+4T+0P=8 Hours**

BIODIVERSITY AND CONSERVATION:

Introduction to biodiversity, types of biodiversity - species, genetic and ecosystem diversity; Threats to biodiversity - natural and anthropogenic, species extinctions, man wildlife conflicts; Biodiversity conservation - principles and strategies; in-situ and ex-situ conservation.

PRACTICES:

- Visit to a Biogas plant, Solar Power plant.
- Visit to a local area: river / pond / lake / forest / grassland / hill / mountain and study of different types of ecosystems, biodiversity study and documentation (herbarium sheet preparation).
- Set up an aquarium.
- Case study: Renewable energy use.

MODULE-2

UNIT-1 **4L+4T+0P=8 Hours**

ENVIRONMENTAL POLLUTION AND CLIMATE CHANGE:

Air, water, soil, radioactive and noise pollution; Study of different pollutants (SOx, NOx, PAN, PAH etc.); Toxicity study; Climate change - greenhouse effect, acid rain, ozone layer depletion.

UNIT-2 **4L+4T+0P=8 Hours**

POLLUTION CONTROL DEVICES AND WASTEWATER TREATMENT TECHNOLOGIES:

Air pollution control devices - Gravitational settling chambers, cyclonic separators, electrostatic precipitators, fabric filters and bio filters, Wastewater management.

SKILLS:

- ✓ *Create a biodiversity map of any habitat/ ecosystem.*
- ✓ *Strategize different ways of using renewable energy resources.*
- ✓ *Design novel strategies and approaches for pollution control and waste management.*

PRACTICES:

- Visit to a sewage treatment plant and wastewater analysis.
- **Case study:** Recycling Technologies.
- **Case study:** Effects of contaminants on microorganisms.
- **Report writing:** 12 principles of green chemistry for environmental sustainability.
- **Report writing:** Environmental Impact Analysis, Local Disaster Management Plan.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the basic concepts of sustainable development, natural resource utilization and ecology for the purpose of environmental protection.	Apply	1	1, 6, 7, 9, 10, 11, 12
2	Design remediation technologies for their abatement.	Apply	2	1, 3, 6, 7, 9, 10, 11, 12
3	Analyze the biodiversity of different ecosystems and formulate various conservation approaches.	Analyze	1	1, 7, 8, 9, 10, 11, 12
4	Analyze the presence of various environmental pollutants.	Analyze	2	1, 6, 7, 9, 10, 11, 12
5	Recommend various waste management approaches and their implementation strategies.	Evaluate	2	1, 2, 7, 8, 9, 10, 11, 12

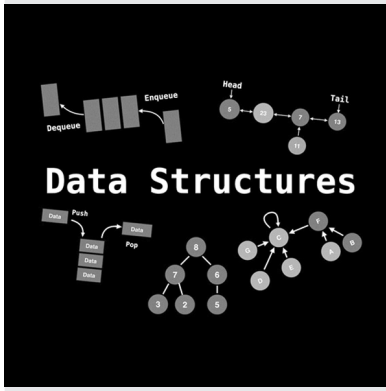
TEXT BOOKS:

1. A. Kaushik and C. P. Kaushik, “Perspectives in Environmental Studies”, New Age International Publishers, 5th Edition, 2016.
2. Y. Anjaneyulu, “Introduction to Environmental Science”, B. S. Publications, 2015.

REFERENCE BOOKS:

1. B. Joseph, “Environmental Studies”, Mc Graw Hill Education, 2nd Edition, 2015.
2. S. Subash Chandra, “Environmental Science”, New Central Book Agency, 2011.
3. M. Basu and S. Xavier, “Fundamentals of Environmental Studies”, Cambridge University Press, 2016.
4. K. Mukkanti, “A Textbook of Environmental Studies”, S. Chand Company Ltd., 2009.
5. M. Anji Reddy, “A Textbook of Environmental Science and Technology”, B. S. Publications, 2008.

22TP201 DATA STRUCTURES



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Hours Per Week :

L	T	P	C
2	2	2	4

PREREQUISITE KNOWLEDGE: Programming in C.

COURSE DESCRIPTION AND OBJECTIVES:

This course is aimed at offering fundamentals concepts of data structures and explains how to implement them. It begins with the basic concepts of data, data structures and then introduces the primitive and non-primitive data structures in detail. It forms the basis for understanding various ways of representing data and its usage in different computing applications.

MODULE-1

UNIT-1 **6L+6T+6P=18 Hours**

DATA STRUCTURES BASICS:

Basic Terminology – data, information, datatype; Data Structures – Introduction, storage structures-sequential and linked storage representations; classification of data structures; Applications of data structures.

Sorting: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort and Merge Sort.

Searching: Linear Search and Binary Search.

UNIT-2 **10L+10T+10P=30 Hours**

LINKED LISTS AND STACKS, QUEUES:

Linked List: Introduction, Types of linked list – Singly linked list, doubly linked list and circular linked list, representation of linked list, Operations of linked list: Traverse forward/ reverse order, searching, insertion and deletion; Applications of linked lists.

Stack – Introduction, array and linked representations, implementation and their applications; Queue – Introduction, array and linked representations, implementation; Types – Linear, circular and doubly ended queues – operations; Applications of Queues.

PRACTICES:

PROBLEMS ON RECURSION – LEVEL 1

- Find the product of 2 numbers using recursion.
- Find the sum of natural numbers using recursion.
- Find the factorial of a number using recursion.
- Find the Nth term of Fibonacci series using recursion.
- Calculate the power using recursion.
- Write a recursive program for checking if a given number is a prime number.
- Given two integers write a function to sum the numbers without using any arithmetic operators.
- Convert a decimal to binary using recursion.
- Print all factors using recursion.
- Find the maximum product of digits among numbers less than or equal to N.

SKILLS:

- ✓ *Experienced to Store data and various types of data to handle.*
- ✓ *Ordering and sorting of data.*
- ✓ *Indexing and Searching of required data from large data sequences.*
- ✓ *Exposed to various characteristics such as Linear or non-linear, Homogeneous or heterogeneous and Static and Dynamic.*

PROBLEMS RECURSION – LEVEL 2

- Implement insertion sort recursively.
- Write a program to find the numbers less than N that are product of exactly 2 distinct prime numbers - using recursion.
- Implement selection sort recursively.
- Find the middle of a singly linked list using recursion.
- Find the sum of even numbers of an array using recursion.
- Check if a given array is in sorted order using recursion.
- Print alternate nodes of a linked list using recursion.
- Reverse a doubly linked list using recursion.
- Write a recursive function that returns all permutations of a given list.
- Implement bubble sort recursively.

PROBLEMS ON SORTING AND SEARCHING – LEVEL 1

- Implement the insertion sort function.
- Implement the bubble sort function.
- Implement the quick sort function.
- Implement the merge sort function.
- Implement the selection sort function.
- Implement linear search function.
- Implement binary search function.

PROBLEMS ON SLL – LEVEL 1

- Implement the insert function to insert nodes into a singly linked list (ascending order).
- Implement the insert function to insert nodes into a singly linked list (descending order).
- Implement the search node function.
- Implement the delete node function.
- Display forwards function.
- Display backwards function.
- Count the number of nodes in a singly linked list.
- Swap alternate nodes of a singly linked list.
- Move last node to the front of the linked list.
- Move first node to the last of the linked list.

PROBLEMS ON STACKS – LEVEL 1

- Implement two stacks using a single array.
- Given an array replace every element with nearest greater element on the right.
- Given a stack reverse the elements using only push and pop functions.
- Postfix evaluation using stack.
- Balance symbols.
- Find middle element in a stack.
- Remove middle element from a stack.
- Implement push and pop using linked list.
- Given an array of characters with the middle marked by X, check if the string is a palindrome.
- Maximum sum in sliding window.

PROBLEMS ON QUEUES – LEVEL 1

- Write a program to accept two numbers as input check if they are equal.
- Write a program to accept two characters as input and check if they are equal.
- Write a program to accept two numbers as input and print the greater of the 2 numbers.
- Write a program to accept two numbers as input and print the lesser of the 2 numbers.
- Write a program to accept 3 numbers as input and print the maximum of the 3.

- Write a program to accept 3 numbers as input and print the minimum of the 3.
- Write a program to accept a number as input and print EVEN if it is an even number and ODD if it is an odd number.
- Write a program to accept a number as input and check if it is divisible by 3. If it is divisible by 3 print YES else print NO.
- Write a program to accept a number as input and check if it is divisible by both 3 & 5. If it is divisible print YES else print NO.
- Write a program to accept a number as input and check if it is positive, negative or zero.

PROBLEMS ON DLL – LEVEL 1

- Implement insert function.
- Implement display forward function.
- Implement display backward function.
- Implement search function.
- Implement delete function.
- Reverse a doubly linked list from M to N.
- Find the sum of the odd and even nodes.
- Count odd keys of the linked list.
- Merge two sorted lists.
- Delete adjacent duplicate nodes.

PROBLEMS ON CLL – LEVEL 1

- Insert function (circular doubly linked list).
- Search function.
- Display forward.
- Display backward.
- Delete node (circular doubly linked list).
- Print the middle N nodes of a circular singly linked list.
- Move the last node of a circular singly linked list to the beginning.
- Delete adjacent duplicate nodes of a circular singly linked list.
- Delete nodes greater than a value from a circular doubly linked list.
- Find the sum of the nodes of a circular linked list.

PROBLEMS ON LINKED LIST – LEVEL 2

- Given 2 sorted linked lists, print the common elements.
- Reverse a list (using Stack).
- Given a pointer to a node (not the last node), delete the node.
- Reverse a list (Recursive).
- Reverse a list (Iterative).
- Reverse a singly linked list in pairs (recursive).
- Reverse a singly linked list in pairs (iterative).
- Check if a singly linked list is a palindrome or not.
- Remove the loop if exists.
- Given 2 linked lists with data in the ascending order, merge them into a single list.

MODULE-2

UNIT-1 **6L+6T+6P=18 Hours**

TREES:

Trees: Basic Terminology, Types of Trees, Binary Tree – Introduction, properties, array and linked representations; Tree traversals and their implementation; Expression trees; BST – definition and operations, AVL trees – definition and construction; Applications of binary trees.

UNIT-2 **10L+10T+10P=30 Hours**

GRAPHS & HASHING:

Graphs: Basic Terminology, Types of Graphs, Graphs representations – adjacency matric, adjacency list; Traversals - breath first search and depth first search; Applications of graphs.

Hashing: Introduction, Different hash functions, collision: avoidance and handling methods.

PRACTICES:

PROBLEMS ON BST – LEVEL 1

- Insert function.
- Insert function (recursive).
- Search function.
- Pre order traversal.
- Post order traversal.
- In order traversal.
- Level order traversal.
- Delete child node.
- Delete parent node.
- Delete nodes greater than a value from a circular doubly linked list.

PROBLEMS ON PRIORITY QUEUES – LEVEL 1

- Meeting rooms problem.
- Ugly number.
- Find median from data stream.
- Find the top K frequent elements.
- Find K Pairs with smallest sums.
- Find the Kth smallest element in a sorted matrix.
- Trapping Rain Water.
- Rearrange String k distance apart.
- Sort characters by frequency.
- Solve the maze problem.

PROBLEMS ON GRAPHS – LEVEL 1

- Implement Graph data structure.
- Implement BFS - iterative solution.
- Implement BFS - recursive solution.
- Implement DFS - iterative solution.
- Implement DFS - recursive solution.
- Check if given graph is strongly connected or not.
- Check if given graph is strongly connected or not - using DFS.
- Given a graph find the arrival and departure time of its vertices in DFS. Arrival time is the time when the vertex was explored for the first time, and departure time is the time at which all the neighbours are explored and are ready to backtrack.
- Given a directed acyclic graph and a source vertex, find the cost of the shortest path from source vertex to all other vertices present in the graph. If a vertex cannot be reached from given source vertex that distance may be printed as infinite.
- Given an undirected graph, check if the graph is 2 edge connected or not.

PROBLEMS ON HASHING – LEVEL 1

- Print a binary tree in vertical order.
- Find whether an array is subset of another array.
- Given an array A [] and a number x, check for pair in A [] with sum as x.

- Minimum operation to make all elements equal in array.
- Maximum distance between two occurrences of same element in array.
- Check if a given array contains duplicate elements within k distance from each other.
- Find duplicates in a given array when elements are not limited to a range.
- Most frequent element in an array.
- Smallest subarray with all occurrences of a most frequent element.
- First element occurring k times in an array.

PROBLEMS ON GRAPHS – LEVEL 2

- Find the shortest graph distances between every pair vertex in a given path. Assume that the graph does not have any negative edges.
- Find the shortest graph distances between every pair of vertices in a given path. The graph can have negative edges.
- Detect cycle in DFS.
- Count the number of connected components of a graph represented in the adjacent matrix.
- Count the number of connected components of a graph represented in the adjacent matrix - using DFS.
- Find a spanning tree - not necessarily a minimum spanning tree.
- Detect cycle in an undirected graph.
- Given an undirected graph, find its depth.
- Determine if a directed graph has a unique topological ordering.
- Given a directed acyclic graph and two vertices v and w, find the lowest common ancestor.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Explore the organization of several ADTs and the manipulation (searching, insertion, deletion, traversing) of data stored in various data structures.	Apply	1, 2	1
2	Apply different data structures to solve a given problem.	Apply	1, 2	1
3	Analyze the efficiency of using different data structures and choose the efficient data structure for solving a given problem.	Analyze	1, 2	2
4	Develop new algorithms to solve various problems.	Create	1, 2	3, 4

TEXT BOOKS:

1. Reema Thareja, “Data Structures Using C”, 2nd Edition, Oxford University Press, 2014.
2. Seymour Lipschutz, “Data Structures with C”, 1st Edition, McGraw Hill Education, 2017.

REFERENCE BOOKS:

1. Ellis Horowitz and Sartaj Sahni, “Fundamentals of Data Structures”, illustrated edition, Computer Science Press, 2006.
2. Richard F. Gilberg and Behrouz A. Forouzan, “Data Structures: A Pseudocode Approach with C”, 2nd Edition, CENAGE Learning, 2005.
3. R G Dromey and Pearson, “How to solve it by Computer”, 2nd edition, Impression edition, 1998.

22MS201 MANAGEMENT SCIENCE

Source : https://xueqi326.wordpress.com/semester-3/management-science/

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Nil

COURSE DESCRIPTION AND OBJECTIVES:

By the end of this course it is expected that the student will be able to:

- Analyze the nature and importance of management.
- Significance of operation management.
- Carry out production operations through work-study.
- Analyze the markets, customers, and competition.
- Plan and control the HR function effectively.

MODULE-1

UNIT-1 **9L+6T+0P=15 Hours**

Introduction to Management: Concepts of Management and organization- nature, importance and Functions of Management, Systems approach to Management - Taylor's Scientific Management Theory, Fayol's Principles of Management, Mayo's Hawthorne Experiments, Maslow's Theory of Human Needs, Douglas McGregor's Theory X and Theory Y, Herzberg's Two-Factor Theory of Motivation, Leadership Styles, Social responsibilities of Management.

UNIT-2 **15L+10T+0P=25 Hours**

Operations Management : Principles and Types of Plant Layout-Methods of production (Job, batch and Mass Production), Work Study -Basic procedure involved in Method Study and Work Measurement, Objectives, Need for Inventory control, EOQ, ABC Analysis, Purchase Procedure, Stores Management and Stores Records. Statistical Quality Control: control charts for variables and attributes (simple Problems), Acceptance Sampling.

PRACTICES:

- Collect some examples with videos for types of production.
- Carry out production operations through work-study.
- Practice problems with Inventory control methods and Quality Control charts.

MODULE-2

UNIT-1 **9L+6T+0P=15 Hours**

Human Resources Management (HRM): Concepts of HRM, Basic functions of HR Manager: Manpower planning, Recruitment, Selection, Training and Development, Placement, Wage and Salary Administration, Promotion, Transfer, Separation, Performance Appraisal, Grievance Handling and Welfare Administration, Job Evaluation and Merit Rating.

UNIT-2 **15L+10T+0P=25 Hours**

Marketing Management: Evolution of Marketing, Functions of Marketing Selling Vs Marketing, 4 P's of Marketing – Product Mix - Product Life Cycle – Place Mix – Channels of Distribution – Price Mix – Pricing Methods – Promotion Mix – Tools of Promotions.

PRACTICES:

- Select any Designation in an organization and try to describe its job description and job specifications.
- How do you deal with grievances at your work.
- Analyze marketing mix in various situations.

SKILLS:

- ✓ *To be an expert in managerial skills.*
- ✓ *Able to maintain social relations.*
- ✓ *Able to evaluate pricing strategies.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze the nature and importance of management.	Analyze	1	1, 2, 4, 6
2	Significance of Operations Management.	Analyze	1, 2	1, 2, 5
3	Carry out production operations through work-study.	Apply	1, 2	1, 2, 3, 5
4	Analyze the markets, customers, and competition.	Analyze	2	1, 2, 4, 5, 6
5	Plan and control the HR function effectively.	Evaluate	1, 2	1, 2, 3, 4, 5, 6

TEXT BOOKS:

1. Stoner, Freeman, Gilbert, Management, 6th Ed, Pearson Education, New Delhi, 2004.
2. P. Vijay Kumar, N. Appa Rao and Ashnab, Chnalill, Cengage Learning India, 2012.
3. Aryasri: Management Science, TMH, 2004.

REFERENCES :

1. Kotler Philip & Keller Kevin Lane: Marketing Mangement 12/e, PHI, 2005.
2. Koontz & Weihrich: Essentials of Management, 6/e, TMH, 2005.
3. Thomas N. Duening & John M .Ivancevich Management - Principles and Guidelines, Biztantra, 2003.

Source : https://roboticsbiz.com/fundamentals-of-robotics-technology-robotic-sensors/

22RA201 FUNDAMENTALS OF ROBOTICS

Hours Per Week :

L	T	P	C
2	2	2	4

PREREQUISITE KNOWLEDGE:

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the basic concepts and topics to impart knowledge on Robots and their anatomy, kinematics, Dynamics and Applications. The main objective of this course is to make students familiarize about the concepts of Robotics as an introductory course.

MODULE-1

UNIT-1 **6L+6T+6P=18 Hours**

Introduction, Robot Anatomy - Coordinate System, Matrix Transformations, Kinematic Analysis, Dynamic Analysis.

UNIT-2 **10L+10T+10P=30 Hours**

Kinematic and Dynamic Analysis of SCARA Robot, Articulated Arm, Parallel Manipulator.

PRACTICES:

- Jogging of Scara Robot.
- Jogging of Articulated Robot.
- Jogging of Parallel Manipulator.
- Motion Analysis of Robot using C/MATLAB.
- Evaluation of Joint angles of Robot by Inverse Kinematics using C/MATLAB.

MODULE-2

UNIT-1 **6L+6T+6P=18 Hours**

Robot Cell Layouts, Multiple Robots and Machine Interference, Work Cell Control, Graphical Simulation of Robotic Work Cells, Economic Analysis.

UNIT-2 **10L+10T+10P=30 Hours**

Robot Cycle Time Analysis, Error Detection and Recovery, Payback Method, Equivalent Uniform Annual Cost Method, Return on Investment Method.

PRACTICES:

- Graphical Modeling of Scara, Cartesian, Cylindrical, Polar Robot (Robo Analyzer).
- Graphical Modeling of Multi Robot Cell (ABB Studio/Robo Analyzer).
- Economic Analysis of Robot Cell using C/MATLAB.
- Error Detection and Recovery in Robot Cell using C/MATLAB.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Distinguish robots based on their anatomy.	Apply	1	1, 5, 9, 10, 12
2	Perform kinematic and Dynamic analysis of robots.	Evaluate	1	1, 2, 3, 5, 9, 10, 12
3	Recommend type of robot based on end application.	Apply	2	1, 5, 9, 10, 11, 12
4	Demonstrate the operation of grippers used in industries.	Analyze	2	1, 2, 4, 5, 9, 10, 12

SKILLS:

- ✓ *Explain the basics involved in robots.*
- ✓ *Apply matrix transformation analysis for kinematic modeling.*
- ✓ *Suggest suitable type of robot based on end application.*

TEXT BOOKS:

1. Peter Corke,"Robotics and Control: Fundamental Algorithms in MATLAB", Springer, 2nd Edition, 2021.
2. Nicolas Odrey, Mitchell Weiss, Mikell Groover, Roger Nagel, Ashish Dutta, "Industrial Robotics -Technology, Programming and Applications", McGraw Hill Publications 2nd Edition, 2017.

REFERENCE BOOKS:

1. Laura Menini, Corrado Possieri, Antonio Tornambe, "Algebraic Geometry for Robotics and Control Theory", World Scientific Publishing Europe Ltd. 1st Edition, 2021.
2. Joseph Duffy, "Statics and Kinematics with Applications to Robotics", Cambridge University Press, 1st Edition Reprint, 2009.
3. K. S. Fu, Ralph Gonzalez, C.S.G. Lee, "Robotics", McGraw Hill Publications, Indian Edition, 2017.

Source: https://m.media-amazon.com/images/I/419nx4NToIL._SY445_SX342_QL70_FMwebp_.jpg

22EE206 ELECTRICAL MOTORS FOR ROBOTICS

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Basics of Electrical and Electronics Engineering.

COURSE DESCRIPTION AND OBJECTIVES:

This course focuses on the study and design of electric motors focusing special attention on the design of drive motors for automated production (robots). Throughout the course, students will examine performance considerations, and build methodologies and analysis routines for practise in motor analysis and design. Hardware experience will entail creating and programming a tiny, motor drive utilising a processor from a series of IoT-capable programmable controllers.

MODULE-1

UNIT-1 **9L+0T+6P=15 Hours**

DC Motors: Introduction, Types of DC motors used in Robotics, Advantages and Disadvantages of DC Motors, Constructional details, Operation, Torque equation, Control of DC motors, Selection criteria of DC motor.

UNIT-2 **15L+0T+10P=25 Hours**

Brushless DC Motors: Introduction, Difference between brushed and brushless DC motor, Constructional Details, Voltage and Torque Equations, Selection criteria of Brushless DC Motor, Applications of Brushless DC Motors.

Geared DC Motors: Introduction, Difference between standard and geared DC motor, Constructional Details, Types of Geared DC motors, Selection criteria of DC Geared motor.

PRACTICES:

- Speed control of DC Motor.
- Characteristics of DC Motor.
- Speed control of Brushless DC Motor.
- Speed control of DC Geared Motor.
- Torque calculation of DC Geared motor under different gears

MODULE-2

UNIT-1 **9L+0T+6P=15 Hours**

DC Stepper Motors: Constructional Details, Characteristics- Voltage, Current, Torque, Types of Stepper motors and configurations, Stepper motor control, Selection criteria of Stepper motors and applications

UNIT-2 **15L+0T+10P=25 Hours**

Servo Motors: Constructional details, Operation, Characteristics, Types of Servo motors, Servo motor control, Sizing, Applications, and Selection criteria of Servo motors.

PRACTICES:

- Half-step driving of Stepper motor.
- Full-step driving of Stepper motor.
- Modelling of a DC Servomotor.
- Transfer function of DC Servomotor.
- Armature/Field torque and back emf constant of DC Servomotor.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze the constructional differences and process of commutation in Brushed and Brushless DC Motors.	Analyze	1	1, 2, 5, 12
2	Analyze the performance characteristics and control mechanism of BDC and BLDC motors through simulation and experimentation.	Analyze	1	1, 2, 3, 5, 12
3	Analyze the constructional differences and working principles of Stepper and Servo motors used in Robotics.	Analyze	2	1, 2, 5, 12
4	Analyze the performance characteristics and control mechanism of Stepper and Servo motors through simulation and experimentation.	Analyze	2	1, 2, 5, 12
5	Designing a prototype model of various robotic applications that uses stepper and servo motors	Create	2	1, 2, 5, 12

TEXT BOOKS:

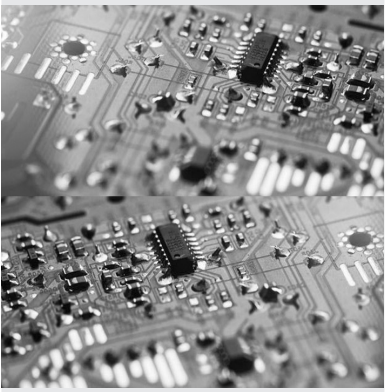
1. Haruhiko Asada, Kamal Youcef-Toumi, “Direct-Drive Robots Theory and Practice”, The MIT Press, Cambridge, Massachusetts, London, England, 2015.
2. Austin Hughes and Bill Drury, “Electric Motors and Drives Fundamentals, Types and Applications”, 4th edition, Elsevier, 2013.

REFERENCE BOOKS:

1. Riazollah Firoozian, “Servo Motors and Industrial Control Theory”, Springer, 2009.
2. Jens Kober, Jan Peters, “Learning Motor Skills From Algorithms to Robot Experiments”, Springer, 2014.
3. R. Krishnan, “Permanent Magnet Synchronous and Brushless DC Motor Drives”, CRC Press Taylor & Francis Group, 2009.

SKILLS:

- ✓ *Identify appropriate motor for based on robotic application.*
- ✓ *Develop protoype model of domestic robotic applications using DC motors.*
- ✓ *Adopting different control mechanisms based on specific application.*



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22EC204 ELECTRONICS FOR AUTOMATION

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basics of Electrical and Electronics Engineering.

COURSE DESCRIPTION AND OBJECTIVES:

This course is aimed at offering fundamental concepts of semiconductor devices and circuits. It starts with the concepts of the Junction Diode, Transistor, MOSFET and other basic devices that are designed with semiconductor materials in module-1. Module-2 deals with fundamentals of number systems and Boolean expressions that are used to realize combinational and sequential circuits. Its objective is to minimize the logical expressions using Boolean postulates and to design various combinational and sequential circuits and to provide with sufficient number of applications to demonstrate the techniques and mathematics used.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

P-N Junction Diode: Formation of PN junction, Energy band diagram of open circuited PN junction, operation of forward and reverse biased PN junction diode, Volt-Ampere characteristics, Temperature dependence on V–I characteristic, Diode resistances and capacitances, zener diode, zener diode as voltage regulator, LED, Photo diode, Photo transistor, Solar cell.

UNIT-2 **10L+10T+0P=20 Hours**

Applications of Diodes: Rectifiers - Analysis of half wave, Full wave and bridge rectifiers Clipping and clamping circuits

Transistor: Bipolar Junction Transistor (BJT) - construction and working of BJT, BJT characteristics; MOSFET - construction and working of MOSFET, MOSFET characteristics; Comparison of BJT and MOSFET.

PRACTICES:

- Design an PN Junction Diode.
- Design a voltage regulator for a specific application.
- Perform analysis of Solar Cell.
- Demonstrate the operational features of Photo diode.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

Number Systems: Review of number systems - conversions, binary codes.

Boolean Algebra: Fundamental concepts of boolean algebra basic theorems and properties; Canonical and standard forms - SOP and POS forms; logic gates, algebraic simplification and realization with basic gates and universal gates, karnaugh maps -3, 4 and 5 variables.

UNIT-2 **10L+10T+0P=20 Hours**

Combinational Logic Design: Design using conventional logic gates, half adder, full adder, Half subtractor, full subtractor, Ripple carry adder, parallel adder/subtractor, Parity generator/detector, Decoder , Encoder, Multiplexer, De-multiplexer.

EXPECTED PRACTICES:

- Design an electronic switch.
- Design an amplifier for a specific application.
- Perform conversions between numbers of different radices.
- Identify the different gates and their properties.
- Design combinational and sequential circuits for a given application.

SKILLS:

- ✓ *Identify a Semi-conductor Diode for a specific application.*
- ✓ *Implement a RPS for a specif-ic Application.*
- ✓ *Construct a stable biasing circuit for an amplifier.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Solve the concepts and working principle of PN junction diode and Zener Diode.	Apply	1	1, 2, 3, 5,10
2	Distinguish the concepts of Half wave and full wave rectifier, transistors characteristics and its types.	Analyze	1	1, 2, 3, 4, 10
3	Demonstrate the concepts of Number systems and boolean algebra.	Apply	2	1, 2, 3, 4
4	Illustrate the working of combinational logic de-sign using adders, subtractors, multiplexers and de-multiplexers.	Evaluate	2	1, 2, 3, 5

TEXT BOOKS:

1. J. Millman and C.C.Halkias, “Electronic Devices and Circuits”, 4th edition, Tata Mc-Graw Hill, 2015.
2. R.L. Boylestad and Louis Nashelsky, “Electronic Devices and Circuit Theory”, Pearson/Prentice Hall, 4th edition, 2015.

REFERENCE BOOKS:

1. Salivahanan and N Suresh Kumar,” Electronic Devices and Circuits”, 4th edition, Tata Mc-Graw Hill, 2022.
2. J B Gupta, “Electronic Devices and Circuits”, 1st Edition, Paperback, S. K. Kataria and Sons, 2013.
3. Varsha Agrawal and Anil K Maini, “Electronic Devices and Circuits”, 2nd Edition (print replica), Wiley, 2019.

Source : https://www.geeksforgeeks.org/best-way-to-start-with-competitive-programming-geeksforgeeks-cp-live-course/

22TP203 ADVANCED CODING COMPETENCY

Hours Per Week :

L	T	P	C
0	0	2	1

PREREQUISITE KNOWLEDGE: Programming in C, Data Structures.

COURSE DESCRIPTION AND OBJECTIVES:

This course helps to understand the impact of the choice of data structures and design strategies to solve the problem in an efficient manner. This course also provides the understanding of advanced graph applications and also throw light in tractable intractable problems.

MODULE-1

UNIT-1 **0L+0T+8P=8 Hours**

STACKS, QUEUES AND SINGLE LINKED LISTS:

PRACTICES:

PROBLEMS ON STACKS & QUEUES:

- Check if given stack of integers are consecutive or not (could be ascending or descending).
- Find the maximum sum in a sliding window using queues.
- Given a queue of integers, rearrange the elements by interleaving the first half with the second half.
- Given an integer k and a queue of integers, reverse the order of the first k elements of the queue.
- Given a maze in the form of a rectangular matrix filled with O, X or M where O represents an open cell, X represents a blocked cell and M represents landmines, find the shortest distance of every open cell in the maze from its nearest mine.
- For a given parenthesis expression, check whether it is balanced parenthesis or not.
- Reverse a number using stack.
- You are given a string s consisting of lowercase English letters. A duplicate removal consists of choosing two adjacent and equal letters and removing them. We repeatedly make duplicate removals on s until we no longer can.
- Find first Unique character in a string (Queue).
- Implement Tower of Hanoi problem.

PROBLEMS ON LINKED LISTS:

- Given a random pointer to a random node in a singly linked list, clone the list.
- Given a list rotate the list to the right by k places.
- Remove duplicates from a sorted list.
- Find fractional node in a singly linked list.
- Sort a linked list using constant space complexity.
- Delete a node in start, middle, end of Singly linked list.
- Add a node in start, middle, end of Singly linked list.
- Find whether given single linked list is circular or not.
- Arrange a singly linked list in Descending order.
- Addition of two numbers using Singly Linked List.

UNIT-2 **0L+0T+8P=8 Hours**

DOUBLY LINKED LISTS, CIRCULAR LINKED LISTS:

PRACTICES:

PROBLEMS ON DOUBLE LINKED LISTS AND CIRCULAR LINKED LISTS:

- Implement a clockwise rotation of a doubly linked list by N places.
- Count triplets in a sorted doubly linked list whose product is equal to a given value x.
- Find the product of all prime nodes in a doubly linked list.
- Find the count of common nodes in two doubly linked lists.
- Find pairs with given product in a sorted doubly linked list.
- Delete all the even nodes of a circular singly linked list.
- Count nodes in a circular linked list.
- Delete all prime nodes from a circular singly linked list.
- Exchange first and last nodes in a circular linked list.
- Reverse a doubly circular linked list.
- Linear search using a stack of incomplete sub problems.
- 1 2 3 4 5 6 in stack S is push X is pop, SSSSXXSSSXXX.
- Recursively remove all adjacent duplicates.
- Check if a given singly linked list is a palindrome using stack.
- Convert a multilevel singly linked list to a singly linked list.
- Remove duplicates from an unsorted doubly linked list.
- Sort a doubly linked list using insertion sort.
- Check if a doubly linked list of characters is palindrome or not.
- Swap Kth node from beginning with Kth node from end in a Double Linked List.
- Convert a Binary Tree into Double Linked List.

MODULE-2

UNIT-1 **0L+0T+8P=8 Hours**

TREES:

PRACTICES:

PROBLEMS ON TREES:

- Given a sorted doubly linked list, convert it into a balanced BST.
- Given a singly linked list with data in the ascending order, convert it into a height balanced BST.
- Print the leaf to root path for every leaf node in a binary tree.
- Write a function to implement the reversed level order traversal of a binary tree.
- Truncate a given binary tree to remove nodes that lie on a path having sum less than K.
- Find the vertical sum in a given binary tree.
- Delete minimum & Maximum element from a BST.
- Implement Inorder, preorder and postorder tree traversal techniques.
- Print Kth largest element in a BST.
- Implement Zig-Zag tree traversal.

SKILLS:

- ✓ *Experienced to Store data and various types of data to handle.*
- ✓ *Ordering and sorting of data.*
- ✓ *Indexing and Searching of required data from large data sequences.*
- ✓ *Exposed to various characteristics such as Linear or non-linear, Homogeneous or heterogeneous and Static and Dynamic.*

UNIT-2 **0L+0T+8P=8 Hours**

GRAPHS:

PRACTICES:

PROBLEMS ON GRAPHS:

- Given a directed acyclic graph, determine whether there is a path that visits every vertex exactly once.
- Reverse a directed graph such that each edge from v to w is replaced by an edge from w to v.
- Find the shortest path in a graph that visits each vertex at least once, starting and ending at the same vertex.
- Find the minimum number of throws required to win a snake and ladder game.
- Implement DFS of a Graph.
- Implement BFS of a Graph.
- Detect whether a cycle is present in an undirected graph.
- Detect cycle in a Directed Graph.
- Find Shortest Distance to goal node from root node in a graph.
- Find no. of nodes in Kth level of a Graph.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply various data structures to solve a different algorithm.	Apply	1, 2	1
2	Investigate the various data structures to solve a given problem in an efficient manner.	Analyse	1, 2	2
3	Design and implement an appropriate hashing function for an application.	Create	1, 2	4

TEXT BOOKS:

1. Reema Thareja, “Data Structures Using C”, 2nd Edition, Oxford University Press, 2014.
2. Seymour Lipschutz, “Data Structures with C”, 1st Edition, McGraw Hill Education, 2017.

REFERENCE BOOKS:

1. Ellis Horowitz and Sartaj Sahni, “Fundamentals of Data Structures”, illustrated edition, Computer Science Press, 2006.
2. Richard F. Gilberg and Behrouz A. Forouzan, “Data Structures: A Pseudocode Approach with C”, 2nd Edition, CENAGE Learning, 2005.
3. R G Dromey and Pearson, “How to solve it by Computer”, 2nd edition, Impression edition, 1998.

22TP204 PROFESSIONAL COMMUNICATION

Source: https://www.coursera.org/specializations/improve-english

Hours Per Week :

L	T	P	C
0	0	2	1

PREREQUISITE KNOWLEDGE: High School-level English.

COURSE DESCRIPTION AND OBJECTIVES:

To improve the overall professional communication skills (LSRW) of students and prepare them for their profession as engineers and managers. To provide them exposure to conventions of corporate communication and training them on how to function in the business world.

MODULE-1

UNIT-1 **0L+0T+8P=8 Hours**

BASICS OF BUSINESS WRITING SKILLS, PRACTICING BUSINESS CORRESPONDENCE AND REPORT WRITING:

Business English Vocabulary: Glossary of most commonly used words (formal and informal usage).

Elements of Technical Writing: Sentence structure, reducing verbosity, arranging ideas logically, building coherence, cohesive devices and transitional words.

Mechanics of Writing: elementary rules of grammar, choice of diction, elementary principles of composition, matters of form, punctuation, conventions of business communication, language and professional tone, code of conduct (not sending illegal, offensive, disparaging personal remarks or comments) in written business communication.

Business Correspondence: E-mail: nature and scope, e-mail etiquette, clear call for action, common errors in composing e-mails, office communication such as meeting agenda and notice, circular and memo.

Letter-Writing: Formal and informal letters, structure of formal letters, expressions of salutations, different types of letters [such as sales letter, complaint letter, response to the complaint letter (dispute resolution), letter of permission, letter of enquiring, claim letter – letter of apology etc], introductory and concluding paragraphs and clear call for action.

Professional Proposal/Report: Differentiating proposals and reports, Drafting formal business proposals, types of reports such as factual reports, feasibility reports and survey reports, parts of a report (such as title page, declaration, acknowledgements, table of contents, abstract, introduction, findings, conclusion and recommendations).

New Age Corporate Communication Media: Importance of social media communication and Etiquettes, form and structure, sharing texts through Twitter, Whatsapp, instgram etc.

UNIT-2 **0L+0T+8P=8 Hours**

PRACTICING COMMUNICATIVE LANGUAGE IN VARIOUS PROFESSIONAL CONTEXTS:

Speaking: Speaking in business context, assertiveness, politeness, making requests, queries and questions, negotiations, asking for information, offering suggestions, conflict resolution, contacting clients, initiating, addressing delegates (in public), delivering the presentation effectively, telephone etiquettes, delivering seminar/proposal/report effectively, team meeting etiquettes (face to face and conference call), making effective one minute presentations(JAM) and participating in Group Discussions.

PRACTICES:

- Basic grammar practice, framing paragraphs on topics allocated, paraphrasing an article or a video in your own words, finding topic sentences in newspaper articles, finding out new words from a professional viewpoint and understanding the meaning and its usage.

SKILLS:

- ✓ *To enhance listening and spoken abilities of students needed for professional and social success in interpersonal situations, group interactions, and personal and professional presentations.*
- ✓ *Understand and practice specific functions and vocabulary in a business context.*
- ✓ *Produce short business reports, proposals and correspondence.*
- ✓ *Write various business documents through reading techniques.*

- Perusing samples of well-prepared business emails, memo, letter writing and short proposals and reports, students will draft business correspondence writing tasks and different proposals/ reports on topics assigned.
- Watching videos/listening to audios of business presentations, classroom activities of team and individual presentations, using PPTs, mock exercises for BEC speaking, agreeing, disagreeing politely, developing content, extended speaking in Group Discussion(s).

MODULE-2

UNIT-1 **0L+0T+8P=8 Hours**

READING AND COMPREHENDING BUSINESS DOCUMENTS:

Reading: Reading and comprehending business documents, learning business register, regularizing the habit of reading business news, suitable vocabulary, skimming and scanning a text for effective and speedy reading and dealing with ideas from different sectors of corporate world in different business contexts.

UNIT-2 **0L+0T+8P=8 Hours**

IMPARTING AND PRACTICING LISTENING SKILLS:

Listening: Specific information in business context, listening to telephonic conversations / messages and understanding the correct intended meaning, understanding the questions asked in interviews or in professional settings, summarizing speaker's opinion or suggestion, enable active listening.

PRACTICES:

- Hand-outs; matching the statements with texts, finding missing appropriate sentence in the text from multiple choices, using right vocabulary as per the given context and editing a paragraph.
- Working out BEC/TOEFL/IELTS listening exercises with hand-outs; matching the statements with texts, finding missing appropriate sentence in the text from multiple choice- multiple choices, using right vocabulary in context-editing a paragraph, listening to a long conversation such as an interview and answer MCQ s based upon listening.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Possess comprehensive skills in listening and reading business texts in formal context.	Apply	2	7
2	Communicate effectively both in their academic as well as professional environment.	Apply	2 &1	10
3	Clear grasp on the register of business language.	Analyze	1	8
4	Possess the ability to write business reports and proposals clearly and precisely to succeed in their future.	Create	1	12
5	Make effective presentations and participate in formal context.	Create	2	10

TEXT BOOKS:

1. S. Schnurr, "Exploring Professional Communication: Language in Action", London: Routledge, 2013.

REFERENCE BOOKS:

1. Brook Hart Guy, "Cambridge English Business Bench Mark: Upper Intermediate", 2nd Edition: CUP, 2014.
2. Cambridge University Publication, "Cambridge: BEC VANTAGE Practice Papers", CUP, 2002.
3. J. Seely, "The Oxford Guide to Effective Writing and Speaking", Oxford University Press, 2005.

22RA202 MOBILE ROBOTICS

Source: https://spectrum.ieee.org/media-library/misty-robot.jpg?id=25584848&width=735&quality=80

Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Basics of Mathematics and Programming.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the fundamental concepts of mobile robots and theoretical aspects of navigation philosophies involved for mobile robots. The objective of this course is to provide knowledge on the concepts of programming requirements for navigation of mobile robots.

MODULE-1

UNIT-1 **6L+6T+6P=18 Hours**

Robot Navigation: Introduction, Navigation Philosophies, Live Reckoning, Navigation as a Filtering process, Sensor Data and Maps, Navigation Software Features, Types of Navigation Sensors and Agents.

UNIT-2 **10L+10T+10P=30 Hours**

Mapping of Robot in a given environment, Navigation of Robot by Collision Avoidance, Path Planning for Navigation, Arbitration and competition among agents.

PRACTICES:

- Hands on the hardware of the mobile Robots.
- Analyze and test the path planning algorithm on mobile robot (viz. Two or Three wheeled robot).
- Develop an algorithm for object recognition.
- Familiarize and test the various sensors involved in mobile robot.

MODULE-2

UNIT-1 **6L+6T+6P=18 Hours**

Navigation Programming: Programming vs Teaching Paths, Data embedding in to maps, Map interpreters, events and targets, Text Programming, Hard and Fuzzy Navigation, graphical generation.

UNIT-2 **10L+10T+10P=30 Hours**

Applications and Case Studies relevance to Uncertainty Reduction, Collision Avoidance, Surveillance, Farming, Mine Exploration.

PRACTICES:

- Fabrication of the mobile robot for Spraying Fertilizers.
- Fabrication of the AGV for carrying 3kgs pay load.
- Fabrication of House cleaning robot.
- Uncertainty Reduction in Mapping using C/MATLAB.

SKILLS:

- ✓ *Recommend software requirements navigation of autonomous robots.*
- ✓ *Explain different types of navigation philosophies using mobile robots.*
- ✓ *Program mobile robots as per requirement.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Identify the software requirements for mobile robot systems.	Apply	1	1, 2, 5, 9, 10
2	Demonstrate navigation of mobile robots.	Analyze	1	1, 2, 5, 9, 10
3	Select appropriate sensor as per guidelines for mobile robots based on end application.	Evaluate	2	1, 2, 5, 9, 10
4	Develop programs for navigation of Mobile Robots.	Develop	2	1, 2, 5, 9, 10

TEXT BOOKS:

1. Alonzo Kelly, “Mobile Robotics”, Cambridge University Press, 1st Edition, 2013.
2. Roland Siegwart, Illa R Nourbakhsh, Davida Scaramuzza, Introduction to Autonomous Mobile Robots, MIT Press, 2nd Edition, 2011.

REFERENCE BOOKS:

1. Volkan Sezer, “Service Robotics”, Intech Open, 1st Edition, 2020.
2. John M Holland, “Designing Autonomous Mobile Robots”, 1st edition, Elsevier, 2004.
3. Marco Hutter, Roland Siegwart, “Field and Service Robotics: Results of 11th International Conference”, 2018, Springer.

22RA203 ROBOT MECHANISMS

ROBOT MECHANISMS

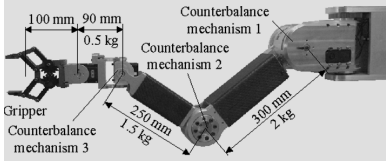


Figure 9. Prototype of counterbalance robot arm.

Source: https://d3i71xaburhd42.cloudfront.net/d48cba482d08715 6d9803d50316ecb271 0c05892/4-Figure9-1.png

Hours Per Week :

L	T	P	C
2	2	2	4

PREREQUISITE KNOWLEDGE: Basics of Mathematics and Programming.

COURSE DESCRIPTION AND OBJECTIVES:

This course offers the basic concepts of mechanisms and performance of kinematic analysis of robotic mechanisms. The objective of the course is to make the students perform kinematic analysis on robot mechanisms for calculating force, velocity etc.

MODULE-1

UNIT-1 **6L+6T+6P=18 Hours**

Introduction and Position Analysis: Motion and Degrees of freedom, kinematic pairs, Dyads, independent contours, planar mechanism decomposition; Absolute Cartesian Method, Slider Crank Mechanism (R - RRT), Four bar Mechanism (R – RRR), R-RTR-RTR Mechanism, R-RTR-RTR Mechanism: Complete Rotation.

UNIT-2 **10L+10T+10P=30 Hours**

Kinematic Analysis: Introduction, Velocity and Acceleration field for a rigid body, relative motion of a point with respect to rigid body, Slider Crank Mechanism (R – RRT), Four bar Mechanism (R – RRR), R-RTR-RTR Mechanism.

PRACTICES:

- Demonstrate the characteristics of Mechanism Decomposition.
- Perform the inversions of Mechanism
- Evaluate the kinematics of Robot Mechanisms

MODULE-2

UNIT-1 **6L+6T+6P=18 Hours**

Dynamic Analysis: Equations for motion of planar motion, D Alembert's principle, Free body diagrams, Force Analysis using Dyads – RRR, RRT, RTR.

UNIT-2 **10L+10T+10P=30 Hours**

Analytical Dynamics: Generalized Coordinates and Constraints, Laws of Motion, Lagrange's Equations for Two-Link Robot Arm, Rotation Transformation, RRT Robot Arm - Direct Dynamics, Inverse Dynamics, Kane's Dynamical Equations, R- RTR Robot Arm.

PRACTICES:

- Demonstrate the characteristics of dynamics of planar motion.
- Perform the dynamic analysis of Robot Mechanism.
- Evaluate the Inverse Dynamics 2 link and 3 link Robot Arm.

Matlab code for performing position analysis, velocity analysis, acceleration analysis and dy-namic force analysis for

- Four bar chain.
- Slider crank chain.
- RRT
- R - RTR -RTR.

SKILLS:

- ✓ *Demonstrate the kinematic analysis of basic kinematic pairs of robots.*
- ✓ *Perform coding for evaluation of kinematic and dynamic analysis of robot mechanisms.*
- ✓ *Evaluate the forces using Analytical method.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Perform the Kinematic analysis of robotic mechanisms.	Apply	1	1, 2, 9, 11
2	Estimate the velocity and acceleration of joints for robotic mechanisms.	Analyze	1	1, 2, 9, 11
3	Evaluate the Dynamic forces in the robot mechanisms	Evaluate	2	1, 2, 9
4	Develop the programs for kinematic and Dynamic analysis of Robot Mechanisms	Develop	2	1, 2, 9

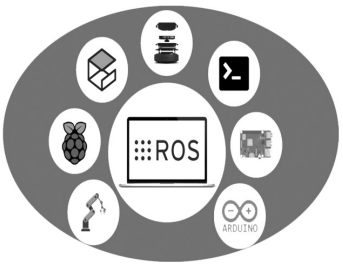
TEXT BOOKS:

1. Dan B Margitu, “Mechanisms and Robot Analysis using MATLAB”, Springer, 1st Edition, 2009.
2. Jardan Lenarcic, Tadej Bajd and Michael M. Stanicic, “Robot Mechanisms”, Springer, 1st Edition, 2013.

REFERENCE BOOKS:

1. Ben - Zion Sandler, “Robotics: Designing the Mechanisms for Automated Machinery”, 2nd Edition, Academic Press, 1999.

22RA204 ROS PROGRAMMING



Source: https://i0.wp.com/opencloudware.com/wp-content/uploads/2021/03/robot-operating-system-ros-intro.png?w=960&ssl=1

Hours Per Week :

L	T	P	C
1	2	2	3

PREREQUISITE KNOWLEDGE: Basic C Programming.

COURSE DESCRIPTION AND OBJECTIVES:

This course offers the basic concepts of robot programming the robots using C++, Python and ROS. The objective of the course is to make the students comfortable on programming the robots with different platforms.

MODULE-1

UNIT-1 **3L+6T+6P=15 Hours**

Robot Programming: Robot Programming and its importance, genesis of robot programming. UBUNTU-Fundamental Concepts, Installation, PC requirements, Installation of Virtual Box, GUI, Terminal commands, cheat sheet.

UNIT-2 **5L+10T+10P=25 Hours**

Basic Programming: C/C++ in Ubuntu, Introduction GCC and G++ compilers, OOP concepts, Case Studies. Introduction to Python, Installation of Python in Ubuntu, Basic Python Commands, Case Studies

PRACTICES:

- Hands on session Arduino interfacing.
- Hands on session on Raspberry interfacing.
- Interfacing ROS and Arduino.
- Interfacing ROS and Raspberry.
- Programming Mobile robot navigation using Python.
- Programming Mobile robot navigation using C++.

MODULE-2

UNIT-1 **3L+6T+6P=15 Hours**

Ros Programming: Getting started with ROS, ROS equation, History of ROS, before and after ROS, use of ROS, Installation of ROS, Robots and Sensors supporting ROS, ROS platforms, ROS Architecture and Platforms, ROS file system, ROS Command Tools.

UNIT-2 **5L+10T+10P=25 Hours**

ROS Programming - Navigation, Hardware Configuration, Sensor Interfacing, Image Capturing.

PRACTICES:

- Interfacing ROS and Arduino.
- Interfacing ROS and Raspberry.
- Programming Mobile sensor interfacing using ROS.
- Programming Mobile image capturing using ROS.
- Programming Mobile robot navigation using ROS.

SKILLS:

- ✓ *Install Ubuntu, C++, python and ROS.*
- ✓ *Perform coding for robot programming using C++, Python and ROS*
- ✓ *Interface ROS with Arduino and Raspberry.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Distinguish the platforms for Robot programming.	Apply	1, 2	1, 2, 5, 9, 10
2	Apply basic coding skills in programming the robot.	Analyze	1, 2	1, 2, 5, 9, 10
3	Demonstrate the ROS programming codes based on end application.	Evaluate	1, 2	1, 2, 5, 9, 10
4	Develop ROS programming for simple applications.	Develop	1, 2	1, 2, 5, 9, 10

TEXT BOOKS:

1. Lentin Joseph, “Robot Operating System for Absolute Beginners”, APRESS, 1st Edition, 2018.
2. Morgan Quigley, Brian Jerkey, William D. Smart, “Programming Robots with ROS: A Practical Introduction to the Robot Operating System”, O’Reilly Media, 1st Edition, 2016.
3. Enrique Fernandez, Luis Sanchez Crespo, Anil Mahtani, Aaron Martinez, “Effective Robotics Programming for ROS”, ⁦Packt Publishing, 3rd Edition, 2016.

REFERENCE BOOKS:

1. Anis Koubaa, “Robot Operating System (ROS): The Complete Reference”, Volume II, Springer, 2017.
2. Wyat S. Newman, “A Systematic Approach to Learning Robot Programming with ROS”, 1st Edition, ⁦Chapman and Hall/CRC, 2017.
3. Enrique Fernandez, Luis Sanchez Crespo, Anil Mahtani, Aaron Martinez, “Learning ROS for Robotics Programming”, 2nd Edition, Packt Publishing, 2015.

III

YEAR

B.Tech.

ROBOTICS AND AUTOMATION ENGINEERING

COURSE CONTENTS

I SEM & II SEM

I SEMESTER

22TP301	-	Soft Skills Lab
22RA302	-	Planning and Navigation
22EE304	-	Power Electronics and Drives
22RA301	-	Automation in Manufacturing
22ME307	-	Industry Interface course
22ME304	-	Inter-Disciplinary Project – Phase I
	-	Department Elective-2
	-	Open Elective-2
	-	Minor/Honors-2

II SEMESTER

22TP302	-	Quantitative Aptitude and Logical Reasoning
22RA305	-	Data Science for Engineers
22RA306	-	Robot Perception
22ME307	-	Inter-Disciplinary Project - Phase II
	-	Department Elective-3
	-	Department Elective-4
	-	Open Elective-3
	-	Minor/Honors-3

22TP301 SOFT SKILLS LAB

Source: https://choosework.ssa.gov/blog/2019-07-23-soft-skills-an-intro-to-effective-communication

Hours Per Week :

L	T	P	C
0	0	2	1

PREREQUISITE KNOWLEDGE: Grasp on their own academic achievements.

COURSE DESCRIPTION AND OBJECTIVES:

To impart employability skills like resume preparation and facing interviews. To enable trainees to develop interpersonal and leadership skills and to train them on work place skills like making presentations, participating in group discussions etc.

MODULE-1

UNIT-1 **0L+0T+8P=8 Hours**

PERSONALITY DEVELOPMENT:

Soft Skills: Need for soft skills, professionalism, employability skills; Communication: Need for effective communication - the process of communication, levels of communication, flow of communication, choice of diction and style with reference to setting (formal, semi-formal or informal); communication networks, barriers to communication, miscommunication, noise and ways to overcome the barriers; Career Planning: Job vs. career, SWOT analysis.

UNIT-2 **0L+0T+8P=8 Hours**

LANGUAGE AND VOCABULARY:

Vocabulary Building: Word etymology, roots, prefixes & suffixes, synonyms & antonyms, collocations, one-word substitutes, analogies, idioms and phrases, contextual guessing of unfamiliar words, task-oriented learning; Reflection of language on Personality, Gender sensitive language in MNCs, Mind your language, Seven essential skills for a team player; attentive listening, intelligent questioning, gently persuading, respecting other's views, assisting others, sharing, participating actively.

PRACTICES:

- Self-Introduction.
- Personal and Academic SWOC.
- Johari Window.
- Giving and taking opinions of Self Vs others and assessing oneself.
- Goal setting.
- Short, Mid and Long Term goals planning the semester.
- Time management: four quadrant system.
- Stephen Covey Time Management Matrix planning a semester.
- Stress-management.
- Questionnaire to assess level of stress.
- 50 words towards resume preparation and interviews.
- Newly coined words.
- Gender sensitive words and Words acceptable in Indian context and objectionable international context.

MODULE-2

UNIT-1 **0L+0T+8P=8 Hours**

LANGUAGE IN ACTION:

Functional English: Situational dialogues, Role plays (including small talk); Group Discussion: Articulation and flow of oral presentation, dynamics of group discussion, intervention, summarizing and conclusion, voice modulation, content generation, Key Word Approach (KWA), Social, Political, Economic,

SKILLS:

- ✓ *Balance social and emotional intelligence quotients though SWOC, JOHARI etc. activities.*
- ✓ *Prepare tailor made resume and face various job interviews with enriched personality traits.*
- ✓ *Career planning with clear personal and professional goals.*
- ✓ *Solve personal and professional life hiccups with confidence and maturity*

Legal and Technical Approach (SPELT), View Point of Affected Part (VAP), language relevance, fluency and coherence – 11th and 12th weeks; Resume preparation: Structure and presentation, defining career objective, projecting one's strengths and skill-sets, summarizing, formats and styles and covering letter-Statement of Purpose.

UNIT-2 **0L+0T+8P=8 Hours**

PREPARING FOR PRESENTATIONS AND INTERVIEWS:

Facing Interviews: Interview process, understanding employer expectations, pre-interview planning, opening strategies, impressive self-introduction, answering strategies, other critical aspects such as body language, grooming, other types of interviews such as stress-based interviews, tele- interviews, video interviews, frequently asked questions (FAQs) including behavioral and HR questions and the aspect looked at by corporate during interviews; Presentation Skills: Selection of a topic, preparing an abstract, gathering information, organizing the information, drafting the paper, citing reference sources – writing striking introductions, discussing the methodology used, developing the argument, presentation style, language, presenting the paper and spontaneously answering audience questions.

PRACTICES:

- Opening and closing a telephonic conversation.
- Making an appointment.
- Making a query.
- Offering/Passing on information.
- Communicating with superiors.
- Expressing agreement/objection.
- Opening bank account (combination of prepared and impromptu situations given to each student).
- Group Discussions on various topics.
- Preparing SoP and Resume.
- Mock interviews on the FAQs including feedback.
- Oral presentation with the help of technology (Preparing PPT and presenting).

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Have the ability to introspect on individual strengths and weaknesses, and emerge as a balanced personality with improved self-awareness and self-worth.	Apply	1	12
2	Observe gender sensitive language and workplace etiquette in his professional life.	Analyze	1	9
3	Be able to prepare a resume and gain the confidence to face an interview.	Create	1, 2	10
4	Possess the interpersonal skills to conduct himself/herself effectively in everyday professional and social contexts.	Apply	2	8
5	Bring professionalism into his/her daily activities.	Create	2	8

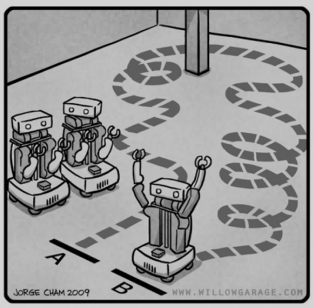
TEXT BOOKS:

1. Adrian Furnham, "Personality and intelligence at work", Psychology Press, 2008.
2. S. P. Dhanvel, "English and Soft skills", Orient Blackswan, 2011.

REFERENCE BOOKS:

1. Edward Holffman, "Ace the corporate personality", McGraw Hill, 2001.
2. John Adair Kegan Page, "Leadership for innovation", Kogan, 2007.
3. Krishna Mohan & NP Singh, "Speaking English effectively", Macmillan, 2008.
4. Rajiv K. Mishra, "Personality Development", Rupa & Co. 2004.

22RA302 PLANNING AND NAVIGATION



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Hours Per Week :

L	T	P	C
2	2	2	4

PREREQUISITE KNOWLEDGE: Basics of Mobile Robotics.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the planning and navigation concepts required for the field and service robotics working in real time environment. The main objective of this course is to make students familiarize with the algorithms and principles involved while developing navigation algorithms.

MODULE-1

UNIT-1 **6L+6T+6P=18 Hours**

Robot Planning and Navigation: Introduction, Competences for Navigation, Navigation Architectures – Modularity for code reuse and sharing, Control Localization, Decomposition Techniques, Localization and Mapping, Simultaneous Localization and Mapping (SLAM).

UNIT-2 **10L+10T+10P=30 Hours**

Decomposition Techniques - Case Studies, Chicken and Egg problem, Dealing with uncertainty, Exploring Unknown Environments, Goal Navigation, Adaptability to change – Learning and Coping.

PRACTICES:

- Path Integration Calibration.
- Localization and Mapping in 1D.
- Localization and Mapping in 2D.
- SLAM with Artificial Landmarks.
- SLAM in a Loop Environment.
- SLAM in an Office Building.

MODULE-2

UNIT-1 **6L+6T+6P=18 Hours**

Advanced Navigation Programming: Probabilistic Mapping Methods – Kalman Filter Method, Expectization Maximization Method, Particle Filter Method, Topological Mapping Methods, Dealing with Dynamic Environments – Exploration, Goal Navigation, Coping to Change, Biological Navigation Systems, Head Direction and Place Cells – State of the Art, Attractor Networks, Path Integration, Head Direction Correction, Place Cells, Robustness vs Accuracy, Sensory Difference.

UNIT-2 **10L+10T+10P=30 Hours**

Real World Environments Capability, Pilot Study Hippocampal Model. RatSLAM - Model for Spatial Pose, Generation of Local View, Visualization of SLAM – Hippocampal Model, RatSLAM requirements and representation.

PRACTICES:

- SLAM in an Outdoor Environment.
- Small Environment Goal Recall.
- Large Environment Goal Recall.
- Small Pose Cell Representation.
- Large Pose Cell Representation.
- Outdoor Experience Mapping..

SKILLS:

- ✓ *Explain the basics involved in planning and navigation of mobile robots.*
- ✓ *Apply SLAM algorithms for localization and mapping of mobile robots in real time environments.*
- ✓ *Suggest suitable type of SLAM algorithm for indoor and outdoor environments.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Distinguish the localization and Mapping features	Apply	1	1, 5, 9, 10, 12
2	Perform Simultaneous Localization and Mapping	Analyze	1	1, 2, 3, 5, 9, 10, 12
3	Demonstrate SLAM for indoor and outdoor environments	Apply	2	1, 2, 4, 5, 9, 10, 12
4	Develop algorithms to perform SLAM for dynamic environments.	Evaluate	2	1, 2, 5, 9, 10, 11, 12

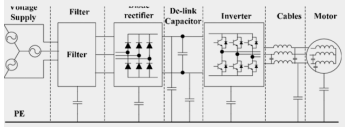
TEXT BOOKS:

1. Alonzo Kelly, “Mobile Robotics”, Cambridge University Press, 1st Edition, 2013.
2. Roland Siegwart, Illa R Nourbakhsh, Davida Scaramuzza, Introduction to Autonomous Mobile Robots, MIT Press, 2nd Edition, 2011.
3. Marco Hutter, Roland Siegwart, “Field and Service Robotics: Springer, Results of 11th International Conference”, 2018.

REFERENCE BOOKS:

1. Volkan Sezer, “Service Robotics”, Intech Open, 1st Edition, 2020.
2. John M Holland, “Designing Autonomous Mobile Robots”, Elsevier, 1st Edition, 2004.
3. Michael John Milford, Howard, Andrew, “Robot Navigation from Nature”, Springer, 1st Edition, 2008.

22EE304 POWER ELECTRONICS AND DRIVES



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Hours Per Week :

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Basics of electrical and electronics engineering, Analog electronics..

COURSE DESCRIPTION AND OBJECTIVES:

Power electronics involves the study of electronic circuits intended to control the flow of electrical energy. It deals with the processing and control of 'raw' electrical power from an electrical source such as an AC mains supply, a battery bank, a photovoltaic array, or a wind turbine into a form quality suitable for a particular electrical load. It is an enabling technology with a very wide range of applications, such as military/avionic products, industrial products, transportation system, telecom products, medical equipment etc.

MODULE-1

UNIT-1 **15L+0T+10P=25 Hours**

Power Semi-Conductor Devices: Introduction, operation, and characteristics of power devices (SCR, MOSFET, IGBT and GTO); Snubber Protection, Triggering and commutation of SCR.

Single Phase Controlled Converters: Study of semi and full bridge converters for R and RL loads; Analysis of load voltage - derivations of form factor and ripple factor; effect of the source impedance. Performance parameters.

UNIT-2 **09L+0T+06P=15 Hours**

Three Phase: Study of semi and full bridge converters for R and RL loads, Load voltage and current waveforms. Performance parameters.

PRACTICES:

- Study of characteristics of SCR, MOSFET & IGBT.
- Gate firing circuits for SCR's.
- Forced commutation circuits (Class A, Class B, Class C, Class D & Class e).
- Single phase fully controlled bridge converter with R and RL loads (MATLAB Simulation & Hardware).
- Single phase half controlled converter with R load (MATLAB Simulation & Hardware).

MODULE-2

UNIT-1 **15L+0T+10P=25 Hours**

Choppers: Analysis of step-down (Buck Converter) and step-up (Boost Converter), Control strategies - time ratio and current limit control; Analysis of fly-back, forward converters for SMPS.

AC-AC Converters: Single phase AC voltage regulators with R and RL loads, Sequence control of AC voltage regulators; Single phase to single phase cyclo converter - step up and step down with R and RL loads.

UNIT-2 **09L+0T+06P=15 Hours**

Inverters: Principle of operation of single phase full bridge square wave, Quasi-square wave, PWM inverters and comparison of their performance; Three phase inverters (120 & 180 degree); voltage control of single and three phase inverters.

SKILLS:

- ✓ *Understand the switching characteristics of various power semi-conductor devices.*
- ✓ *Design the commutation circuits for SCRs based on application.*
- ✓ *Design a SCR based controlled converter for given specifications.*

PRACTICES:

- DC-DC non isolated converters (Buck , boost) (MATLAB Simulation & Hardware).
- Single phase cyclo-converter with R and RL loads.
- Single phase series inverter with R and RL loads.
- Single phase parallel inverter with R and RL loads.
- Single phase AC Voltage Controller with R and RL Loads (MATLAB Simulation & Hardware).

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Selection of Power Semiconductor device as per application of converter.	Apply	1	1, 2, 6, 9
2	Compare the operation of two, three and six pulse converters and draw output waveforms with / without source and load inductance.	Analyse	1	1, 2, 9, 12
3	Classify choppers and outline the applications of SmPS.	Analyse	2	1, 2, 3, 9, 12
4	Design and analysis of DC/AC, AC/DC and AC/AC converters through experimentation.	Create	1, 2	1, 2, 9, 12
5	Illustrate the operation of AC voltage controller, cyclo-converter and its application.	Create	2	1, 2, 3, 9, 12

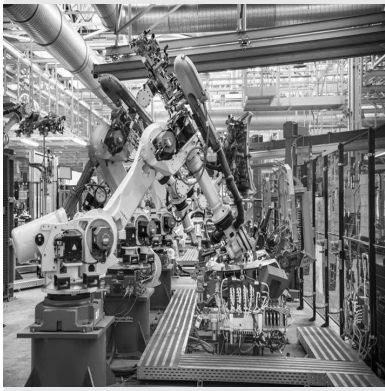
TEXT BOOKS:

1. Dr. P.S. Bimbra, “Power electronics” 4th Edition, Khanna publishers, 2021.
2. M.D. Singh and K.B. Khanchandani, “Power electronics”, 2nd Edition, Tata mc-Graw Hill, 2017.

REFERENCE BOOKS:

1. Vedam Subrahmanyam, “Power electronics Devices, Converters, Application”, 1st Edition, New Age International, 2015.
2. Ned Mohan, Tore M. Undeland and William P. Robbins, “Power Electronics Converters, Applications and Design”, 3rd Edition, Wiley, 2022.

22RA301 AUTOMATION IN MANUFACTURING



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Hours Per Week :

L	T	P	C
2	2	2	4

PREREQUISITE KNOWLEDGE: Basic of Automation.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the principles, concepts and techniques of automated material handling systems, inspection systems and flexible manufacturing systems. The objective of this course is to develop the real time interface of computers in manufacturing automation.

MODULE-1

UNIT-1 **6L+6T+6P=18 Hours**

Automation: Definition of automation, Reasons for automation, Types, Principles and strategies of automation, Current trends and Industrial application of automation, Information technology concepts – IOT, Introduction to Numerical Control Machines (NC), Computer Numerical Control Machines (CNC) and Direct Numerical Control (DNC) Machines - Components: Coordinate Systems, Motion Control and Part Programming.

UNIT-2 **10L+10T+10P=30 Hours**

Group Technology and Capp: Part families, Parts classification and coding, Opitz and MICLASS, Production flow analysis (PFA), Group technology machine cell design, Types and benefits of GT. Retrieval and Generative type systems, Current product manufacturing concepts like Lean and Agile Manufacturing.

Tension element, I - beam, shaft subjected to torsion, column.

PRACTICES:

- To prepare manual part program for facing, step turning, taper and finish turning using ordinary cycle.
- To prepare manual part program for facing, step turning, taper and finish turning using canned cycle.
- To prepare manual part program for grooving, threading and axial drilling using canned cycle.
- To prepare manual part program for linear and circular interpolation using milling operation.

MODULE-2

UNIT-1 **6L+6T+6P=18 Hours**

Flexible Manufacturing Systems and Automated Material Handling: Introduction to FMS, Components of FMS, Types of flexibilities, Applications and benefits, Layout Configurations, Implementation, Quantitative analysis of FMS, Simple problems. Automated material handling systems, Conveyor system, Automated guided vehicles, Pallets, Automated storage and retrieval systems, Carousel storage system and automated data capturing systems.

UNIT-2 **10L+10T+10P=30 Hours**

Automated Assembly Lines: Fundamentals, System configuration, Part delivery at workstation nd its applications, Design for automated assembly, Quantitative analysis of assembly systems, Line balancing algorithm, Largest candidate rule - simple problems; Kilbridge and Wester method - simple problems; Ranked positional weights method, Computerized techniques – simple problems.

SKILLS:

- ✓ *Design of industry specific automation layout.*
- ✓ *Develop part programming for automated process in modern manufacturing with CNC.*
- ✓ *Apply technology for capturing and storing the manufacturing information.*
- ✓ *Identify modern engineering tools necessary for Manufacturing.*

PRACTICES:

- To perform machining of components on CNC Turning and Milling Center.
- To generate the NC code for turning operation using cam software.
- To generate the NC code for milling operation using cam software.
- To generate a profile for turning and milling operations and verify the tool path using cam software.
- To develop GT code for engine components.
- To model FMS layout for car assembly line.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Enumerate the principle, strategies and advantages of automation.	Apply	1	1, 2, 9, 11
2	Develop CNC programs to manufacturing industrial components.	Develop	1	1, 2,9, 11
3	Design elements in FMS using simulation and analytical techniques.	Create	2	1,2,9
4	Demonstrate the different automated material handling, storage, retrieval and inspection systems.	Analyze	2	1,2,9

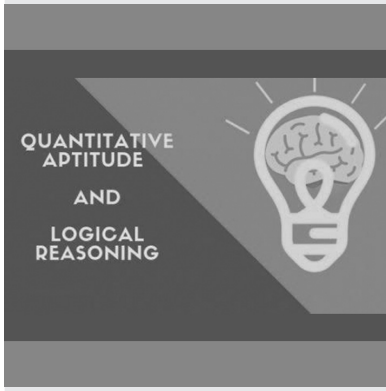
TEXT BOOKS:

1. M.P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, PE/PHI, 3rd Edition, 2013.
2. Yoram Koren, Computer Control of Manufacturing Systems, Tata McGraw-Hill, 2nd Edition, 2008.

REFERENCE BOOKS:

1. Radhakrishnan, Subramanyan. S and Raju V, “CAD/CAM/CIM”, New Age International Publishers, 1st Edition, 2008.
2. W. Buekinsham, “Automation”, PHI Publications, 3rd Edition, 2004.
3. Bonetto R., “FMS in Practice”, North Oxford Academic Publisher, 1st Edition, 2012.

22TP302 QUANTITATIVE APTITUDE AND LOGICAL REASONING



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Hours Per Week :

L	T	P	C
1	2	0	2

PREREQUISITE KNOWLEDGE: Basic Logical Thinking and Problem Solving Ability.

COURSE DESCRIPTION AND OBJECTIVES:

The Students will be introduced to various Arithmetic and Reasoning Problems. The students will have acquaintance with various problems like Time & Work, Time & distance, Percentages, Profit & Loss etc. besides solving puzzles and Critical Reasoning.

MODULE-1

UNIT-1 **4L+8T+0P=12 Hours**

Number system, LCM & HCF of numbers, Percentage, Ratio and proportion, Profit, loss and discount, Average & Mixtures, Simple Interest & Compound interest.

UNIT-2 **4L+8T+0P=12 Hours**

Time and work, Time & distance, Problems on trains, Problems on ages, Permutation & Combinations, Probability.

PRACTICES:

- Each concept would be taught in detail in the class followed by 10 problems solved in the class.
- Students would have to solve 10 additional problems as a homework assignment in each concept.

MODULE-2

UNIT-1 **4L+8T+0P=12 Hours**

Number series, Letter series, Analogy, Odd man out, Coding and decoding, Syllogisms- Statement & Conclusions, Puzzle test.

UNIT-2 **4L+8T+0P=12 Hours**

Blood relations, Direction sense test, Order & Ranking, Seating Arrangements, Calendar & Clocks.

PRACTICES:

Each concept would be taught in detail in the class followed by 10 problems solved in the class. Students would have to solve 10 additional problems as homework assignments in each concept.

SKILLS:

- ✓ *Helps in developing and improving problem-solving skills.*
- ✓ *Flexing and honing logical abilities.*
- ✓ *Allow students to develop critical thinking skills.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Meet the demands of current job market besides equipping them higher studies like CAT, GMAT etc.	Apply	1	2, 5
2	Solve Arithmetic and Reasoning Problems within shortest possible time without paper work.	Apply	1	2, 5
3	Exhibit better analytical skills and aptitude skills.	Analyse	2	2, 4
4	Develop interpretational skills.	Evaluation	2	2, 4

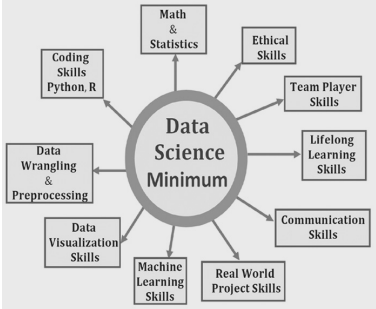
TEXT BOOKS:

1. R. S. Aggarwal, “Quantitative Aptitude for Competitive Examinations”, S. CHAND Publications Revised Edition, 2017.
2. ARIHANT, “A New Approach to Verbal & Non-Verbal Reasoning”, Arihant Publication - Revised Edition, 2021.

REFERENCE BOOKS:

1. Trishna Knowledge Systems, “Quantitative Aptitude for Competitive Examinations”, Pearson Publication, 2013.
2. R. S. Aggarwal, “A Modern Approach to Verbal & Non-Verbal Reasoning”, Revised Edition, S. CHAND Publications, 2018.

22RA305 DATA SCIENCE FOR ENGINEERS



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Hours Per Week :

L	T	P	C
2	2	2	4

PREREQUISITE KNOWLEDGE: Basic Mathematics and Programming.

COURSE DESCRIPTION AND OBJECTIVES:

This course mainly deals with univariate data analysis methods. It provides basic knowledge about random variables, common discrete and continuous distributions, sampling distributions. It also deals with descriptive statistics and data visualization methods. The overview of sampling techniques for data collection, and introduction to statistical inference methods for decision making and hypothesis testing also provided in this course.

MODULE-1

UNIT-1 **6L+6T+6P=18 Hours**

Inferential Statistics: Discrete Probability Distributions; Continuous Probability Distributions; Central Limit Theorem. Basic Concepts of Inference; Concepts of Hypothesis Testing-I: Null and Alternate Hypothesis, Making a Decision and Critical Value Method; Concepts of Hypothesis Testing-II: p-Value Method and Types of Errors; Permutation & Randomization Test.

UNIT-2 **10L+10T+10P=30 Hours**

Data Visualization: Understanding Data Visualization; Importance of Data Visualization; Common Visualizations - Frequency Distribution plot, Swarm Plot; Data Visualization Tools; Languages and Libraries in Data Visualization.

PRACTICES:

- Application of central limit theorem for probability distribution functions.
- Demonstration of Hypothesis testing – I & II.
- Validation of Permutation & Randomization Test.
- Performing the Data Visualization for a given dataset.

MODULE-2

UNIT-1 **6L+6T+6P=18 Hours**

Data Analytics with Python-I: Introduction to Data Analysis with Python; Python Packages for Data Science; Data Wrangling – Binning, Formatting, Normalization, Pre-processing of Data in Python.

UNIT-2 **10L+10T+10P=30 Hours**

Data Analytics with Python-II: Supervised and Unsupervised Learning, Linear and Logistic Regression Techniques, Dimensionality Reduction, SVM, Decision Trees.

PRACTICES:

- Application of Data Wrangling using Python
- Demonstration of Supervised learning method using Python
- Demonstration of Unsupervised learning method using Python
- Performing the Data Reduction using Python.

SKILLS:

- ✓ *Able to apply Probability Distributions to discrete and continuous variables.*
- ✓ *Able to evaluate the appropriateness of statistical analyses, results, and inferences to understand and interpret data in applied settings.*
- ✓ *Able to correctly interpret the results, and use those results as part of a larger critical thinking process.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply Probability Distributions to discrete and continuous variables.	Applying	1	1, 2, 9, 11
2	Evaluate the appropriateness of statistical analyses, results, and inferences to understand and interpret data in applied settings.	Evaluating	1	1, 2, 9, 11
3	Develop the basic numerical and graphical techniques by using python programming	Creating	2	1, 2, 9
4	Interpret the results, and use those results as part of a larger critical thinking process.	Analyzing	2	1, 2, 9

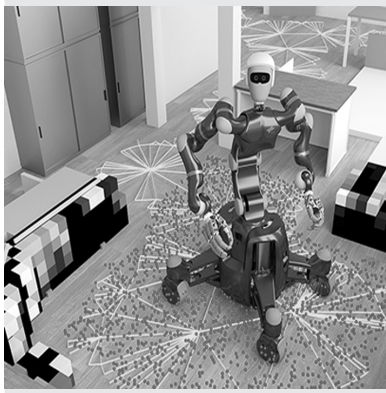
TEXT BOOKS:

1. Alberto Leon-Garcia ,"Probability, Statistics, and Random Processes for Electrical Engi-neering", 3rd Edition.
2. D.S. Moore, G.P. McCabe and B. Craig ,"Introduction to the Practice of Statistics", 7th Edition, 2010.

REFERENCE BOOKS:

1. Tamhane, A. C. and Dunlop, D. D. (2000) "Statistics and Data Analysis: From Elementary to Intermediate", Prentice Hall: Upper Saddle River, NJ. ISBN: 0-1374-4426-5.
2. Hayter, A. J. "Probability and Statistics for Engineers and Scientists", ISBN: 1111827044, 4th Edition, 2012.

22RA306 ROBOT PERCEPTION



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Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basics Robotic Components.

COURSE DESCRIPTION AND OBJECTIVES:

This course mainly deals with the features of robotic perception capabilities. It provides basic knowledge about working principles involved in the sensing of environment of which robot is working. It also deals with the importance of data acquisition. The main objective of this course is to impart knowledge to the students regarding the applicability of algorithms for robotic perception for industrial needs.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

Introduction: Robotic Perception, Mathematical Foundation – Coordinate Frames- Homogeneous Transformations, 3D Orientation; Sensor Models – Pin Hole Camera Model, Radial Distortion, Active Stereo Camera Head, Rectilinear Stereo and Projective Rectification; Image to Perception, Perception to Control.

UNIT-2 **10L+10T+0P=20 Hours**

Shape Recovery: Conventional Light Stripe Ranging, Robust Stereoscopic Light Stripe Sensing, Active Calibration of Parameters, Implementation – Measurement of Light Stripe; Gaussian Image in Computer Vision, Segmentation Algorithm, Non Parametric Surfaces, Fitting Geometric primitives, Object Modelling and Classification – Box, Cup, Bowl, Can, Ball, Multi Cue 3D Model, Kalman Filter Framework, Feature Measurement – Color, Edges, Texture.

PRACTICES:

- Demonstration of Robot Perception.
- Implementation of Image Segmentation Algorithm
- Feature Extraction from Image Analysis
- Application of feature extraction using Kalman Filter

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

Hybrid Positioning: Visual Servo Controller, Visual Feedback, Kinematic Feedback, Fusion of Visual and Kinematic Feedback, Implementation.

UNIT-2 **10L+10T+0P=20 Hours**

System Integration: Hand Eye Robot Platform – Hardware Configuration, Software Architecture; Task Specification and Planning – Grasping an unknown object, Pouring, Multi sensor Synergy, Answering the Challenges of Service Robots, Future Scope.

PRACTICES:

- Demonstration of Visual Servo Controller.
- Implementation of kinematic feedback
- Feature Extraction from Image Analysis for object grasping task
- Developing Hand Eye Robot Platform for a given task.

SKILLS:

- ✓ *Explain the working principles of visual perception.*
- ✓ *Select appropriate technique for the activities involved in robotic perception.*
- ✓ *Demonstrate confidently the fusion of visual and kinematic feedback in perception process.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Specify the features needed for visual sensors.	Apply	1	1, 2, 9, 11
2	Interpret the shape recovery features from visual inspection.	Analyze	1	1, 2, 9, 11
3	Perform the fusion of Visual and Kinematic feedback.	Create	2	1, 2, 9
4	Demonstrate the system configurations for robotic perception needed towards simple tasks.	Evaluate	2	1, 2, 9

TEXT BOOKS:

1. Geoffrey Taylor and Lindsay Kleeman, “Visual Perception and Robotic Manipulation “, Springer, 1st Edition, 2006.
2. Nicholas J. Wade and Michael T. Swanston, “Visual Perception: An Introduction”, Psychology Press, 3rd Edition, 2012.

REFERENCE BOOKS:

1. Rudolph Triebel, “Three Dimensional Perception for Mobile Robotics”, VDM Verlag Dr. Mueller E.K., 1st Edition, 2008.

IV

YEAR

ROBOTICS AND AUTOMATION ENGINEERING

B.Tech.

I SEMESTER

- 22RA401 - Artificial Intelligence for Robotics
- 22RA402 - Industry 5.0

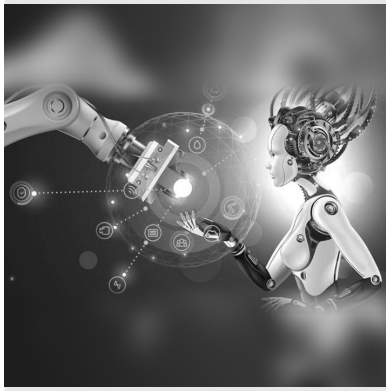
II SEMESTER

- 22RA403 - Internship/Project Work

COURSE CONTENTS

I SEM & II SEM

22RA401 ARTIFICIAL INTELLIGENCE FOR ROBOTICS



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Hours Per Week :

L	T	P	C
2	2	2	4

PREREQUISITE KNOWLEDGE: Basics of Programming.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the fundamentals of AI techniques and their applications in Robotics

Engineering. The main objective of this course is to make students conversant with the vari-ous artificial intelligence algorithms and their application in context with Robotics and Automation Engineering.

MODULE-1

UNIT-1 **6L+6T+6P=18 Hours**

Introduction and Problem Solving: History, state of the art, Need for AI in Robotics. Thinking and acting humanly, intelligent agents, structure of agents.

PROBLEM SOLVING: Solving problems by searching - Informed and Uninformed search - Constraint satisfaction problems.

UNIT-2 **10L+10T+10P=30 Hours**

Planning: Planning with forward and backward State space search - Partial order planning – Planning graphs - Planning with propositional logic - Planning and acting in real world.

PRACTICES:

- Solving problems by Informed Searching
- Solving problems by Uninformed Searching
- Solving problems by Constrained Satisfaction Problem
- Programming intelligent agents

MODULE-2

UNIT-1 **6L+6T+6P=18 Hours**

Reasoning: Uncertainty - Probabilistic reasoning–Filtering and prediction - Hidden Markov models - Kalman filters - Dynamic Bayesian Networks, Speech recognition, making decisions.

UNIT-2 **10L+10T+10P=30 Hours**

Forms of learning - Knowledge in learning - Statistical learning methods - reinforcement learning, communication, perceiving and acting, Probabilistic language processing, Robotic perception, localization, mapping - configuring space, planning uncertain movements, dynamics and control of movement, Ethics and risks of artificial intelligence in robotics.

PRACTICES:

- Solving problems by Probabilistic Reasoning
- Uncertainty estimation using Markov Modeling and HMM
- Evaluation of Uncertainty in Planning through Bayesian Networks
- NLP using N-gram method.

SKILLS:

- ✓ *Explain the concepts of Artificial Intelligence.*
- ✓ *Apply the methods of solving problems using Artificial Intelligence.*
- ✓ *Analyze the output parameters of Expert Systems using AI algorithms.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Identify appropriate AI methods to solve a given problem.	Apply	1	1, 2, 9, 11
2	Implement basic planning AI algorithms.	Develop	1	1, 2, 9, 11
3	Formalize a given problem in the language/ framework of different AI methods.	Create	2	1, 2, 9
4	Evaluation of different algorithms on a problem formalization, and state the conclusions that the evaluation supports.	Analyze	2	1, 2, 9

TEXT BOOKS:

1. Stuart Russell, Peter Norvig, “Artificial Intelligence: A modern approach”, Pearson Education, India, 4th Edition, Paperback, 2022.
2. Ovidiu Vermasen, “Artificial Intelligence for Digitising Industry- Applications”, River Publishers, 1st Edition, 2022.

REFERENCE BOOKS:

1. Ela Kumar, “Artificial Intelligence”, Wiley, 2020.
2. Negnevitsky, M, “Artificial Intelligence: A guide to Intelligent Systems”, Harlow: Addison-Wesley, 3rd Edition, 2011.
3. David Jefferis, “Artificial Intelligence: Robotics and Machine Evolution”, Crabtree Publishing Company, 1999.

22RA402 INDUSTRY 5.0

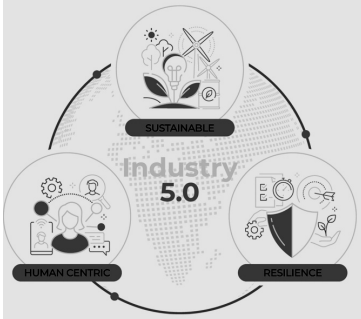
Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Fundamentals of Automation.

COURSE DESCRIPTION AND OBJECTIVES:

This course mainly deals with the concepts of Industrial Internet of Things and its architecture. It provides basic knowledge about IoT, Smart Manufacturing and Social impact of Industry 5.0. It also deals with the technical aspects and architecture of IIoT. The overview of intelligent manufacturing and process planning 4.0, risk management framework are also provided in this course.



Source: https://www.momenta.one/hubfs/m21images/industry%205%20-%20landingpage/Industry-5.png

MODULE-1

UNIT-1 **9L+6T+0P=18 Hours**

Industry 5.0: Introduction to Industry revolution; Evolution of Industry 1.0 to Industry 5.0; Industry Internet of Things; Power of 1%; Key IoT technologies; Cobots, Human Factors involved; Innovation in IIoT intelligent devices; Challenges and benefits of Industry 5.0; IIoT applications – health care, Oil and Gas Industry, Smart Office, Logistics.

UNIT-2 **15L+10T+0P= 25 Hours**

IIoT Technical Aspects: Miniaturization; Cyber Physical Systems (CPS); Wireless technology; IP technology; Network Functional Virtualization (NFV); Network Virtualization (NV); Software defined network (SDN); NFV vs SDN; smart phones; cloud and fog; big data analytics; M2M learning and AI; Augmented Reality and Virtual Reality; 3D Printing; People vs Automation.

MODULE-2

UNIT-1 **9L+6T+0P=18 Hours**

IIoT Architecture: IIC reference architecture; Industrial Internet Architecture Framework (IIAF); Implementation; architecture topology; Three – tier topology: edge tier, platform tier, enterprise tier, gateway mediated edge, connectivity, key system characteristics, data management.

UNIT-2 **15L+10T+0P= 25 Hours**

Intelligent Manufacturing: Introduction; Cloud manufacturing; IIoT enabled manufacturing; intelligent manufacturing; intelligent manufacturing platforms – GE predix, PTC thingworx, SIEMENS: smart factory; predictive analytics – Google Cloud ML platform, Microsoft Azure.

PRACTICES:

- Predict the risks and social implications in adaptation of Industry 4.0.
- Analyze the risks involved in IIoT and social implications in implementation of IIoT.

SKILLS:

- ✓ *Communicate the basic concepts of technologies involved in Smart Manufacturing.*
- ✓ *Distinguish the technical aspects and architectures involved in IIoT.*
- ✓ *Perform the predictive analytics using Google Cloud ML platform and Microsoft Azure.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Demonstrate the concepts and technologies involved in Internet of Things, Intelligent Manufacturing, Process Planning 4.0	Apply	1	1, 2
2	List out the technical aspects and architecture of Industrial Internet of Things	Apply	1	1, 2
3	Differentiate between the networks and architectures of IIoT.	Analyze	2	1, 2
4	Evaluate the predictive analytics involved in intelligent manufacturing.	Evaluate	2	1, 2

TEXT BOOKS:

1. Uthayan Elangovan, “Industry 5.0:The Future of Industrial Economy”, 1st Edition, CRC Press, 2022.
2. Alasdar Gilchrist, “Industry 4.0: The Industrial Internet of Things”, 1st Edition, Apress, 2016.

REFERENCE BOOKS:

1. Bruno Salgues, “Society 5.0:Industry of the future,Technologies, Methods and Tools”, Volume 1, Wiley, 1st Edition, 2018.
2. Kaushik Kumar, Divya Zindani and J Paulo Davim, “Industry 4.0: Developments towards the Fourth Industrial revolution”, Springer, 1st Edition,2019.

DEPT. ELECTIVES

B.Tech.

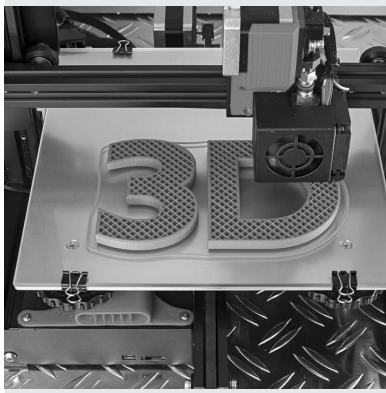
ROBOTICS AND AUTOMATION ENGINEERING

- 22ME801 - 3D Printing and Design
- 22ME804 - Asset Management
- 22ME805 - Automation and Advanced Manufacturing Processes
- 22ME806 - Biomechanics
- 22ME807 - Ceramics, Polymers and Smart Materials
- 22ME808 - Composite Materials
- 22ME811 - Computational Multibody Dynamics
- 22ME813 - Design and Fabrication of Composite Materials
- 22ME814 - Design of Smart Actuators
- 22ME815 - Digital Manufacturing
- 22ME816 - Electronics and Aerospace Materials
- 22ME818 - Environmental Degradation and Bio Materials
- 22ME819 - Failure Analysis
- 22ME821 - Industrial Economics
- 22ME822 - Industrial Engineering and Estimating & Costing
- 22ME823 - Industrial Engineering and Production Management
- 22ME824 - IOT and Smart Manufacturing
- 22RA802 - Legged Robots
- 22ME826 - Metrology and Surface Engineering
- 22ME827 - Modelling and Simulation of Manufacturing Systems
- 22ME828 - Nano material synthesis and Characterization Techniques
- 22ME830 - Product Design for Manufacturing
- 22RA803 - RPA in Industry
- 22ME832 - Special Casting and Welding Technologies
- 22ME833 - Tribology
- 22ME834 - Value Engineering

COURSE CONTENTS

I SEM & II SEM

22ME801 3D PRINTING AND DESIGN



source: https://www.google.com/search?q=3d+printing&source=lnms&tbm=isch&sa=X&ved=2ahUKEwji1re11fr5AhUjBLcAHTDKBGkQ_AUoAnoECAIQBA&biw=1366&bih=657#imgrc=6nFgEYWWucC3NM&imgdii=1U_Y4dq90t4EzM

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Manufacturing Technology.

COURSE DESCRIPTION AND OBJECTIVES:

This course offers advanced concepts of additive manufacturing techniques in 3D printing. The objective of this course to make students understand various rapid prototyping technologies and to select appropriate technologies for product development purposes.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

Introduction: Need for the compression in product development, Comparison with conventional manufacturing, History of 3D printing technology, Applications, Classification of RP systems.

RP Process: (Liquid and Solid Type): Principle, product design and development, Process parameters, introduction to liquid and solid type processes.

UNIT-2 **10L+10T+0P=20 Hours**

RP Process (Liquid and Solid Type): Process details and applications of Stereolithography systems, Solid Ground Curing, Liquid Thermal Polymerization (LTP), Process details and applications of Laminated object Manufacturing, Fused Deposition Modeling (FDP), Product design for FDM and wire arc additive manufacturing (WAAM).

PRACTICES:

- Generating STL files from the CAD Models & Working on STL files.
- Processing the CAD data in Catalyst software (Selection of Orientation, Supports generation, Slicing, Tool path generation).
- Solid ground curing – significances & types.
- Fabricating the physical part on a RP machine.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

RP Process (Powder Type): Principle, Process parameters, Process details.

RP Process Optimization: Rapid manufacturing process, optimization, factors influencing accuracy, Data preparation errors, Part building errors, errors in finishing, influence of part build orientation.

UNIT-2 **10L+10T+0P=20 Hours**

RP Process Optimization: Applications of Laser Engineered Net Shaping, Selective Laser Sintering, Product design. Application of Different Parameters like Layer Thickness, Air Gap, Raster Orientation, Infill Density, Infill Pattern, Nozzle Temperature, Printing Speed, Raster angle, Application and Properties of different thermos- plastic materials: ABS, PLA.

PRACTICES:

- Analysis on data preparation errors in RP and its remedial actions.
- Case study on the product design.
- Raster orientation in RP process.
- Study the properties of RP product.

SKILLS:

- ✓ *Develop rapid prototypes to reduce product development time.*
- ✓ *Evaluate effect of process parameters in additive manufacturing.*
- ✓ *Design models using 3D printing technology.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Select appropriate 3D printing technique for a desired end-product.	Apply	1	1
2	Evaluate effect of process parameters in additive manufacturing.	Evaluate	1	1, 2
3	Evaluate various 3D printing techniques with respect to quality of product.	Evaluate	2	2
4	Design and produce models using 3D printing technology.	Analyze	2	2

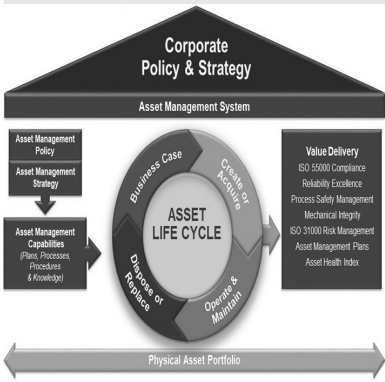
TEXT BOOKS:

1. Chua Chee Kai, Leong Kah Fai, 3D Printing and Additive Manufacturing: Principles & Applications, World Scientific, 4th Edition, 2015.
2. Ian Gibson, Davin Rosen, Brent Stucker “Additive Manufacturing Technologies, Springer, 2nd Edition, 2014.

REFERENCE BOOKS:

1. Additive Manufacturing: Principles, Technologies and Applications, C.P Paul, A.N Junoop, McGrawHill, 1st Edition, 2021.
2. Additive Manufacturing, Amit Bandyopadhyay Susmita Bose, CRC Press Taylor & Francis Group, 2nd Edition, 2020.
3. The 3D Printing Handbook: Technologies, Design and Applications, Redwood, Ben, Filemon Schoffer, and Brian Garret, 3D Hubs, 1st Edition, 2017.
4. William H Philips, “Additive manufacturing: opportunities, challenges, implications” Nova science publishers, 1st Edition, 2016.

22ME804 ASSET MANAGEMENT



source: https://www.lce.com/ Asset-Management-Systems-and-Capabilities-1766.html

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basics of Management Science and design.

COURSE DESCRIPTION AND OBJECTIVES:

This course offers fundamentals of Asset Management for an engineering system to focus on maintenance, renewal and enhancement activities, with an integrating mechanism, on delivering sustainable outputs valued by customers. The objective of this course is to make right decisions and optimizing processes, minimize the total life cost of assets.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

ASSET

Asset Knowledge Management: Present industrial situations and relevance of Asset Management, Theory and principles of Asset Management, Asset Management methodology Tools and Techniques, Implementation Framework for Asset Management in an organization.

UNIT-2 **10L+10T+0P=16 Hours**

Pertinent Issues of Asset Management in Indian industries, Life Cycle Cost, Analysis for Asset Management, ISO 55000 Standards: Recent Trends in Asset Management.

PRACTICES:

- Refine maintenance scheduling to cut maintenance costs.
- Determine how asset management improves the asset performance.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

Risk Management & Failure Mode Effect Analysis: Risk Management & Performance Improvement- overview of Risk Management tools and techniques- applications in the planning, decision-making and operational phases. Holistic Asset Management and classes of assets - physical assets/equipment, knowledge/information assets, human resources and strategic assets.

UNIT-2 **10L+10T+0P=16 Hours**

Failure Mode and Effects Analysis for Specific Assets, Application of Lean Engineering Principles for Asset Management, Asset Design and Maintenance Issues.

PRACTICES:

- Apply the FMEA to the industrial system to find bottlenecks.
- Develop the process sheet for lean manufacturing.

SKILLS:

- ✓ *Identify the role of the asset manager in a manufacturing industry.*
- ✓ *Find the challenges faced by an asset manager in the food industry.*
- ✓ *Develop the Asset management strategies in oil and gas asset.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Explore the fundamentals and systems approach to the asset management of physical systems.	Apply	1	1
2	Map the organizational activities and problems in terms of Asset Management framework.	Apply	2	1
3	Apply the asset management tools and techniques to improve asset and maintenance performance.	Evaluate	1	1, 2
4	Develop and document a maintenance plan for a technical system.	Create	2	1, 2

TEXT BOOKS:

1. Joe E. Amadi-Echendu, Roger Wilett, Kerry Brown, Joseph Mathew “Asset Condition, Information Systems and Decision Models” Springer, 2012.
2. Mitchell, J. S. “Physical Asset Management Handbook “, 4th Edition, British Standards Institution, Publicly Available Specification (PAS) 55-1 & 55-2, 2006.

REFERENCE BOOKS:

1. Gilberto Francisco Martha de Souza, “Reliability Analysis and Asset Management of Engineering Systems”, Springer, 1st Edition, 2022.
2. Peter W. Tse, “Engineering Asset Management - Systems, Professional Practices and Certification”, Springer, 1st Edition, 2015.

22ME805 AUTOMATION AND ADVANCED MANUFACTURING PROCESSES

source: https://welderpoint.com/types-of-welding-processes/

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Manufacturing Processes and Machining Technology.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the principles, concepts and techniques of automation and advanced manufacturing techniques which includes automated assembly lines and advanced techniques in manufacturing process. One of the objectives of this course is to develop the real time interface of computers in manufacturing automation. The second objective is to impart sound knowledge of high hardness material manufacturing techniques with high precision.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

Introduction to Automation: Definition of automation, Reasons for automation, Types, Principles and strategies of automation, Current trends and Industrial application of automation, Information technology concepts – IOT.

UNIT-2 **10L+10T+0P=20 Hours**

Automated Assembly Lines: Fundamentals, System configuration, Part delivery at the workstation and its applications, Design for automated assembly, Quantitative analysis of assembly systems, Line balancing algorithm, Largest candidate rule - simple problems; Kilbridge and Wester method - simple problems; Ranked positional weights method, Computerized techniques - simple problems.

PRACTICES:

- Functioning of home appliances with IOT concepts.
- Cases studies on automated assembly lines.
- Line balancing algorithms.
- Machine & part logical arrangements.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

Unconventional Forming Processes: Explosive forming, Electro-hydraulic forming, Electromagnetic forming, Laser Bending, Powder rolling, Spray rolling, Hydroforming, Hydrostatic, and Powder extrusion, and rotary forming.

UNIT-2 **10L+10T+0P=20 Hours**

Unconventional Welding Processes: Laser Beam Welding, Electron Beam Welding, Ultra-Sonic Welding, Plasma Arc Welding, Explosive Welding, Under Water Welding, Friction stir welding.

PRACTICES:

- Powder preparation & fabrication of the powder products.
- Simulations of extrusion and forming process.
- Friction stir welding process – process parameters optimization.
- Simulation of welding process.

SKILLS:

- ✓ *Design of industry-specific automation layout.*
- ✓ *Balance the automated assembly lines for maximum utilization of equipment.*
- ✓ *Apply high-quality forming techniques to fabricate complex shapes with optimum cost.*
- ✓ *Identify the type of advanced welding technique suitable for different materials.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Enumerate the principle, strategies and advantages of automation.	Understand	1, 2	1, 2, 10
2	Analyse and design the automated assembly lines.	Analyze	1, 2	1, 2, 4, 10
3	Adopt advanced techniques like explosive, electro-hydraulic, magnetic forming and extrusion.	Apply	1, 2	1, 2, 3, 9, 12
4	Implement ultrasonic and thermal energy for metal joining.	Apply	1, 2	1, 2, 3, 10, 11

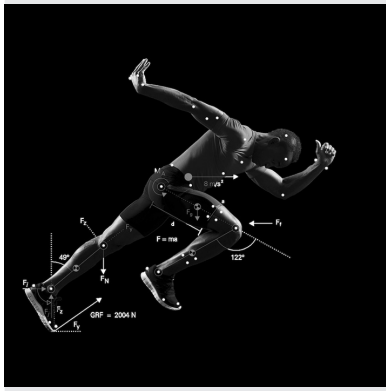
TEXT BOOKS:

1. M.P. Groover, “Automation, Production Systems and Computer Integrated Manufacturing”, PE/PHI, 3rd Edition, 2013.
2. P.C. Sharma, “A Text book of Production Technology (Manufacturing Processes)”, Revised edition., S. Chand & Company Ltd, 1st Edition, 2009.

REFERENCE BOOKS:

1. W. Buekinsham, “Automation”, 3rd edition, PHI Publications, 2004.
2. Bonetto R., “FMS in Practice”, 1st edition, North Oxford Academic Publisher, 2012.

22ME806 BIOMECHANICS



source: https://www.patcash.co.uk/2011/09/biomechanics-what-it-is-and-why-it-is-important-for-tennis/

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basic knowledge of human anatomy and analogy with physical systems.

COURSE DESCRIPTION AND OBJECTIVES:

The course provides an overview of musculoskeletal anatomy, the mechanical properties and structural behaviour of biological tissues, and bio dynamics. The course is meant to provide basic background in biomechanics for engineering students considering medical school, industrial positions in the biomedical field.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

Introduction to Biomechanics: Introduction to biomechanics, Fundamentals of biomechanics and qualitative analysis, Anatomical description and its limitations.

UNIT-2 **10L+10T+0P=20 Hours**

Multiaxial Deformations and Stress Analyses: Poisson's ratio, biaxial and triaxial stresses, stress transformation, principal stresses, Mohr's circle, failure theories, allowable stress and factor of safety, factors affecting strength of materials, fatigue and endurance, stress concentrations, torsion, bending and combined loading-problems.

PRACTICES:

- To analyse of laws of mechanics for bio mechanics.
- To analyse the forces on bicycle pedals during pedalling
- To locate the centre of gravity of an individual using the reaction board and the segmental method.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

Applications of Statics to Biomechanics: Skeletal joints and muscles, basics considerations, basic assumptions and limitations, mechanics of the elbow, shoulder, spinal column, hip, knee and ankle.

Mechanical properties of biological tissues: viscoelasticity, analogies based on springs and dashpots, empirical models of viscoelasticity, time-dependent material response, comparison of elasticity and viscoelasticity, common characteristics of biological tissues, biomechanics of bone, tendons and ligaments, skeletal muscles and articular cartilage.

UNIT-2 **10L+10T+0P=20 Hours**

Biomechanics of Human Movement: Linear and angular kinematics of human movement, linear kinetics of human movement, equilibrium and human movement, and angular kinetics of human movement.

PRACTICES:

- To measure the range of motion of upper and lower limbs using Goniometer.
- To simulate the blood flow through arteries using equivalent experimental setup.
- Analysis of movement and other motion in humans using OpenSim software.

SKILLS:

- ✓ *Able to understand the basic anatomy and its functioning.*
- ✓ *Able to apply mathematical formulation to the human analogous links*
- ✓ *Analyses the physiological systems specifically in orthopaedic system.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Design valid and efficient studies to address public health and clinical problems.	Apply	1	1, 2, 9
2	Apply the mechanics of physiological systems.	Apply	1	1, 2
3	Analyze the biomechanical systems.	Analyze	2	1, 2
4	Examine the mechanics of physiological systems specifically in orthopaedic system.	Analyze	2	1, 2

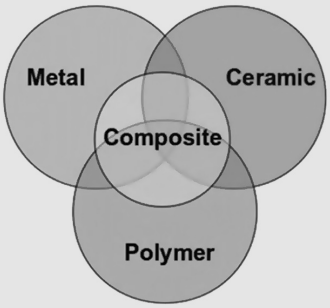
TEXT BOOKS:

1. Duane Knudson, “Fundamentals of Biomechanics”, Springer Science and Business Media, 2nd Edition, 2007.
2. Nihat ozkaya and Margareta Nordin,“Fundamentals of biomechanics-equilibrium, motion and deformation”, Springer, 4th Edition, 2016.
3. Susan .J. Hall, “Basic biomechanics”, Tata McGraw Hill, 6th Edition, 2011.

REFERENCE BOOKS:

1. D. J. Schneck and J. D. Bronzino, “Biomechanics- Principles and Applications”, CRC Press, 2nd Edition, 2000.
2. Jay D. Humphrey and Sherry De Lange, “An Introduction to Biomechanics: Solids and Fluids, Analysis and Design”, Springer Science and Business Media, 2004.

22ME807 CERAMICS, POLYMERS AND SMART MATERIALS



source: https://www.researchgate.net/figure/The-Combination-for-composites-among-metals-ceramics-polymers-5_fig1_341162791

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basics in material science Engineering.

COURSE DESCRIPTION AND OBJECTIVES:

This course demonstrates the most important classes of materials. The curriculum of the programme comprises advanced courses concerned with polymeric materials, composites and applications. The course 'Fundamentals of Polymer Science' is intended to give thorough understanding about polymers and their properties to those students who did not study polymer science during their undergraduate courses. The course contents include basic concepts, including mechanical properties and characterizations. The course is intended to give the student a broad scope preparation in selecting and using materials for engineering applications.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

Ceramics: Introduction to ceramics, general properties of ceramics and applications. crystal structure, bonding in ceramics, defects in ceramics structures, classification of ceramics-oxides ceramics, nonoxide ceramics, production of ceramic powders through various techniques- sol gel, co-precipitation, solvent vaporization. Fabrication of ceramics, porous ceramics, glasses, glass ceramics, super plasticity in ceramics, bio ceramics, creep mechanism in ceramics, toughening mechanism in ceramics, applications of ceramics

UNIT-2 **10L+10T+0P=20 Hours**

Polymers: Basic concepts, General mechanisms of polymerization reactions- synthesis, kinetics, techniques, Structure- property relationships of polymers. Copolymerization-mechanism-kinetics. Thermodynamics of polymer solutions, Crystal morphologies-Thermal transitions in polymers--Characterization and Testing Molecular weight determination- Spectroscopy techniques, Thermal properties. Polymer degradation. Production, properties and applications of industrial polymers and general purpose rubbers. Applications of polymers in materials processing (ceramic, semiconductors and metals).

PRACTICES:

- To prepare a mould for a given single piece pattern, to melting of metals to prepare the hand-layup technique.
- Topics related to sol gel, co-precipitation, solvent vaporization, toughening mechanism in ceramics Spectroscopy techniques.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

Energy Materials: Battery materials: Electrochemical fundamentals, electrochemical cell, charging and discharging, phase transition, order-disorder transition, electrode processes at equilibrium, energy efficiency, cycle life, Materials for electrode (e.g., LiCoO2, LiFePO4, graphite), Materials for non-rechargeable batteries (e.g., alkaline battery), Materials for rechargeable batteries (e.g., aluminium-ion battery, lithium-ion battery). Photovoltaic (PV) materials: Electrodynamic basics, electromagnetic waves, optics of flat interfaces, light absorption, Solar radiation, solar spectra, solar energy concentration, solar cell parameters, losses and efficiency limits, Crystalline silicon solar cells, thin-film solar cells, and other types, PV modules and systems (components, design, and fabrication), PV system economics and ecology.

SKILLS:

- ✓ *Will acquire engineering philosophies involve in ceramics, polymer and energy materials.*
- ✓ *Will propose the suitable materials for the demanded engineering applications.*
- ✓ *Will apply the gained skills for the development of fuel cells and energy materials.*

UNIT-2 **10L+10T+0P=20 Hours**

Fuel Cell: Overview of fuel cell types, charge transfer and mass transport in fuel cells, Thermodynamics and reaction kinetics in Fuel cell, Proton exchange membrane and solid oxide fuel cell materials, Fuel cell system design and characterization. Materials for hydrogen technology: Hydrogen production, hydrogen from the decomposition of materials containing hydride anions, Hydrogen storage in solids: metal hydrides, ammonia and related materials, reversible organic liquids

PRACTICES:

- Topics related to electrochemical cell, charging and discharging.
- Electro-dynamic basics.
- PV modules and systems.
- Hydrogen production (e.g., electrolytic production, thermal decomposition of water, chemical extraction).

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Learn and apply materials by properties and application based selection, with special attentions to applications in ceramics, polymers and energy engineering.	Apply	1, 2	1, 2, 4, 5, 9, 10, 12
2	Be able to identify and select appropriate materials for specific applications.	Apply	1, 2	1, 2, 5, 9, 10
3	Student should be able to demonstrate and analyze about the chemistry of polymers and concepts of degree of polymerisation.	Analyze	1, 2	1, 2, 3, 5, 9, 10
4	Solve complex exercises and computations dealing with materials performance in selected energy related.	Analyze	1, 2	1, 2, 5, 9, 10, 12

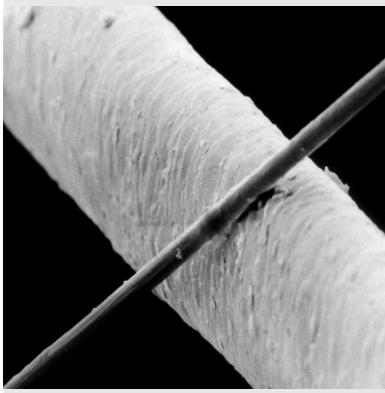
TEXT BOOKS:

1. R. Abbaschian, R.E. Reed-Hill, “Physical Metallurgy Principles”, Cengage Learning, 4th Edition, 2009.
2. D.R. Askeland, P.P. Phule, W.J. Wright, “The Science and Engineering of Materials”, Cengage Learning, 6th Edition, 2010.
3. W.D. Callister, D.G. Rethwisch, “Materials science and Engineering: An Introduction”, Wiley, 8th Edition, 2010.

REFERENCE BOOKS:.

1. L D. W. Bruce, D. O’Hare, R. I. Walton, “Energy Materials”, Wiley, 2011.
2. Malcolm P. Stevens , “Polymer Chemistry”, Oxford University Press, Inc, 1990.
3. Bahadur and Sastry , “Principles of Polymer Science”, Narosa Publishing House 2002.

22ME808 COMPOSITE MATERIAL



source: https://en.wikipedia.org/wiki/Composite_material#/media/File:Cfaser_haarrp.jpg

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basics of materials, Material properties.

COURSE DESCRIPTION AND OBJECTIVES:

This course introduces the basics of composite materials, their components and classification. manufacturing and characterisation. The objective of this course is to impart knowledge on composite materials and its applications.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

COMPOSITES:

Introduction: Definitions, Composites, Reinforcements and matrices, Types of reinforcements, Types of matrices, Types of composites, Carbon Fibre composites, Properties of composites in comparison with standard materials.

Constituents: Role and Selection of reinforcement materials, Types of fibers, Multiphase fibers, Mechanical properties of fibers. Metal matrix, Ceramic matrix, Carbon Matrix, Polymer Matrix.

UNIT-2 **10L+10T+0P=20 Hours**

Applications of Various Forms of Reinforcements: Glass fibers, Carbon fibers, Aramid fibers, Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers, Quartz and Silica fibers, Whiskers, Flakes, Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Laminated composites, Lamina and Laminate Lay-up, Ply-orientation.

PRACTICES:

- Examination of different synthetic fibres.
- Case study on fibres in day to day life.
- Evaluation of fibre properties.
- Collection and presentation of natural fibres and synthetic fibres.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

PMC's Manufacturing Methods: Hand Lay-up, Autoclave molding, Fiber-only performs, Wet Lay-up and Spray-up, Filament winding, Pultrusion, Resin Transfer Molding (RTM), Compounding, Injection molding.

MMC's Manufacturing Methods: Powder metallurgy technique, Liquid metallurgy technique, Diffusion bonding, Squeeze technique and secondary processing.

CMC's Manufacturing Methods: Cold-Pressing and Sintering, Slurry Impregnation and Hot-Pressing, Melt Infiltration, Reactive Liquid Infiltration, Chemical Vapor Infiltration (CVI).

Joining of Composites: Adhesives, Mechanical, Welding, Friction-fit integral joints. Various joining processes of FRP laminated composites.

SKILLS:

- ✓ *Identify the basic constituents of composite materials.*
- ✓ *Select suitable manufacturing process any composite product.*
- ✓ *Characterize composite materials using various tools.*
- ✓ *Choose the appropriate composite material for a given application.*

UNIT-2 **10L+10T+0P=20 Hours**

CHARACTERIZATION AND APPLICATIONS:

Mechanical Characterization of Composites: Mechanical testing of composites - Tensile testing, Compressive testing, Intra laminar shear testing, Inter laminar shear testing, Fracture testing, Thermal testing; Environmental Effects on composite.

Recycling of Composites: Categories of scrap composites, Recycling methods for thermoplastic matrix composites and thermoset matrix composites.

PRACTICES:

- Fabrication of MMC.
- Fabrication of PMC.
- Tensile test.
- Compression test.
- Flexural test.
- Impact test.
- Hardness.
- Recycling of composites.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Identify the suitable constituents for composite material.	Apply	1	1, 2, 3, 4, 12
2	Evaluate properties of reinforcements.	Apply	1	1, 2, 3, 4, 5, 11, 12
3	Select appropriate manufacturing method for PMC/MMC/CMCs.	Analyze	2	1, 2, 3, 4, 5, 9, 11, 12
4	Characterize a given composite material.	Analyze	2	1, 2, 3, 4, 5, 9, 11, 12

TEXT BOOKS:

1. Ronald F. Gibron, “Principles of composite Material mechanics”, McGraw-Hill international, 3rd Edition, 2011.
2. P. K. Mallick, “Fiber Reinforced Composites, Materials, Manufacturing, and Design”, CRC Press, 3rd Edition, 2007.

REFERENCE BOOKS:

1. Autar K. Kaw, “Mechanics of composite materials”, CRC Press New York, 2nd Edition, 2005.
2. K. K. Chawla, “Composite Science and Engineering”, Springer Verlag, 3rd Edition, 2012.

22ME811 COMPUTATIONAL MULTI-BODY DYNAMICS

source: https://www.cae-sim-sol.com/en/services/multibody-system-dynamics

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Fundamental Physics, Mathematics, Statics & Dynamics.

COURSE DESCRIPTION AND OBJECTIVES:

This course reviews and reinforces the student's understanding Kinematics and Dynamics of multibody systems with immediate application to the dynamics of systems of rigid bodies. The course will place equal emphasis on gaining both an analytical understanding and insight/intuition on the subject.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

Basic Concepts in 3D Rigid - Body Mechanics: Degrees-of-freedom; Rigid body vs flexible body; Spatial kinematics (3-Drotation and transformations) Euler theorem, rotation parameterization, Rodrigue's formula; Moments and products of inertia; Newton-Euler equations of motion; Lagrange Equation; Generalized forces.

UNIT-2 **10L+10T+0P=20 Hours**

Inter - Connected Rigid Bodies: Kinematic pairs(joints) with classification of constraints; holonomic and non-holonomic constraints; Springs, dampers, actuators and controllers with brief introduction of controls theory. Flexible Multibody Systems: Dynamic analyses using classical approximation, FEM.

PRACTICES:

- Demonstration of Spatial Kinematics of a Mechanism.
- Evaluation of moments and products of inertia.
- Estimation of Generalized forces in a given machine operation.
- Performance of Body motion using Lagrangian Equations.
- Identification of kinematic pairs in a mechanism.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

Formulation of Equations of Motion for Inter - Connected Bodies: Relative coordinates, generalized coordinates, Cartesianco-ordinates; Lagrange's equations and other approaches; Differential equations (ODE) and differential algebraic equations (DAE); Co-ordinate partitioning and Lagrange multipliers; Types of analyses(kinematic, static, quasi-static, kineto-static, dynamic and linear dynamic), various numerical methods.

UNIT-2 **10L+10T+0P=20 Hours**

Application of Numerical Methods: NR method, Jacobian, ODE integrators (Euler methods and Implicit methods); Stability, accuracy and Dahlquist's trade off criteria; Stiffness and damping-physicalvs numerical; Lock-up, bifurcation and singularities.

SKILLS:

- ✓ *Able to perform dynamic calculations.*
- ✓ *Able to estimate suitable mathematical model.*
- ✓ *Apply the dynamics analysis of the model.*

PRACTICES:

- Formulation of Spatial Coordinates of the tool body motion.
- Evaluation of body dynamics using different approaches.
- Estimation of stability and accuracy in positioning.
- Identification of singularities in a damping system.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply basic particle dynamics and 2-dimensional rigidbodymechanicsto3-dimensionalrigidbodies.	Applying	1	1, 2
2	Analyze interconnected bodies in a multi-body system.	Analyzing	1	1, 2, 9
3	Use numerical methods for the analysis of multi- body system.	Analyzing	2	1, 2, 9
4	Formulate the mathematical models of engineering systems.	Creating	2	1, 2, 3, 12

TEXT BOOKS:

1. A. A. Shabana, Computational dynamics, Cambridge University Press, 5th Edition, 2020.
2. Roberson R.E., and Richard S.,Dynamics of Multibody Systems, reprint, Springer-Verlag, 1st Edition, 2012.

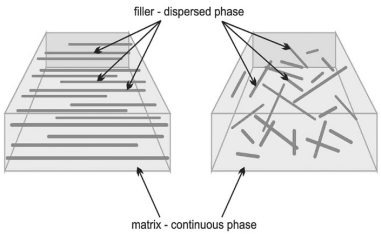
REFERENCE BOOKS:

1. Bauchau O.A.,Flexible Multibody Dynamics, Springer, 11th Edition, 2010.
2. Chaudhary H., and SKSaha, Dynamics and Balancing of Multibody Systems, Springer – Berlin, 1st Edition, 2009.

22ME813 DESIGN AND FABRICATION OF COMPOSITE MATERIALS

Hours Per Week :

L	T	P	C
2	2	0	3



source: https://www.essentialchemicalindustry.org/materials-and-applications/composites.html

PREREQUISITE KNOWLEDGE: Basics of Materials.

COURSE DESCRIPTION AND OBJECTIVES:

The course provides an overview of design and fabrication of composite materials. The course is meant to provide basic background in basics of types of composite materials, design aspects and various fabrication methods of fabrication of composites for several industrial and medical applications.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

Design process, composite design methods, fracture mechanics, Fabrication methods: Hand Layup, Prepreg Layup, Bag Molding Autoclave Processing, Compression Moldingc Resin Transfer Molding, Vacuum-Assisted Resin Transfer Molding, Pultrusion, Filament Winding.

UNIT-2 **10L+10T+0P=20 Hours**

Determination of stresses at critical points, and Strain energy method, Fabrication methods Hand lay technique in making of composites, drum winding.

PRACTICES:

- List the components replaced by composites in aerospace and automobile industry, justify.
- Develop a component using hand layup technique.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

Ply mechanics, Macromechanics, common laminate types, strength of laminates.

UNIT-2 **10L+10T+0P=20 Hours**

Simply Supported Sandwich Beam, helicopter blade, automotive drive shafts, carbon/epoxy-flywheel, aero plane wing tip.

PRACTICES:

- Fabricate the dog bone shaped composite specimens using drum winding technique.
- Prepare a detailed report on the analysis of composite drive shaft.

SKILLS:

- ✓ *Able to identify the mode of fracture.*
- ✓ *Able to estimate the stress involved in failure.*
- ✓ *Able to Select alternative metals that of light weight.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Design the composites based on mode of fracture.	Applying	1	1, 2
2	Analyse the failure stresses in composites.	Evaluating	2	1, 2, 5
3	Fabricate the composites using various types of fabrication methods.	Applying	1	1, 2, 6, 9
4	Develop innovative composites to replace metals by light weight composites.	Creating	2	1, 2, 3, 6, 9

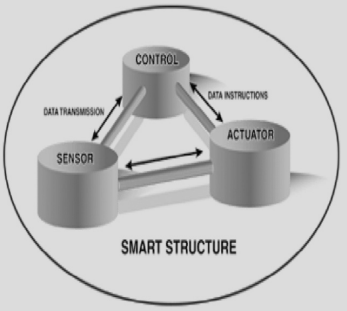
TEXT BOOKS:

1. Ever J.Barbero, “Introduction to composite Design”, CRC Press, T&F group, 3rd Edition, 2017.
2. Daniel Gay, “Composite Materials Design and Applications, CRC Press, T&F group, 3rd Edition, 2015.

REFERENCE BOOKS:

1. MohdNasirTamin, “Damage and Fracture of composite Materials and Structures, Springer-Verlag Berlin Heidelberg 1st Edition, 2012.
2. Chung Deborah D. L., “Composite Materials: Science and Applications”, Second edition, Springer-Verlag London Limited 2010
3. Kamal K. Kar “Composite Materials – Processing, Applications, Characterizations”, Springer-Verlag Berlin Heidelberg 2017.

22ME814 DESIGN OF SMART ACTUATORS



source: https://www.researchgate.net/profile/Ashraf-Beshr/publication/280297590/figure/fig1/AS:813281094684686@1570912731905/Figure-5-The-basic-five-components-of-the-smart-structures.png

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basics of Material Properties.

COURSE DESCRIPTION AND OBJECTIVES:

The purpose of this course is to introduce graduate students seeks to provide an accessible account of smart materials behavior together with examples of preliminary design of smart actuators.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

Introduction to Shape Memory Alloys: Over - view, system level response of smart structures, temperature induced transformations in SMA, shape memory effect, super/pseudo-elasticity, common types of SMAs and applications of SMAs, Fabrication methods and post treatment of SMA components.

UNIT-2 **10L+10T+0P=20 Hours**

Functionality Analysis of SMAs: Design process, semantics in design of SMAs, identification of functionality, basic SMA components and geometries for tension, torsion, spring response, Influencing factors for SMA actuators design.

PRACTICES:

- Temperature Transformation Prediction for a given shape memory alloy.
- Functional Feature Computation for SMAs.
- Identification of influencing factors for SMA design.

MODULE-2

UNIT-1 **6L+6T+0P=12Hours**

Smart Actuators: SMA wire – Bias spring arrangement, graphical design approach for stroke estimation, linear to rotary arrangement, linearized loading and unloading, Hysteretic loading and unloading response.

Constant force mode, constant deflection mode, simultaneous load and deflection mode, design of SMA wires and Ti – Ni SMA Springs, design of remote controlled flow control valve, heating and cooling of SMA wires.

UNIT-2 **10L+10T+0P=20 Hours**

Coupling of SMAs: Principle of Virtual work, need for mechanisms, loading curve and SMA response, 3-D design, bias forces, Structural and functional fatigue, Reporting Fatigue.

PRACTICES:

- Stroke Estimation of SMA wire spring for linearized loading.
- Deflection of SMA Spring under constant deflection mode.
- Developing the loading response of SMA mechanism.

SKILLS:

- ✓ *Smart Structure properties evaluation.*
- ✓ *Functional Analysis of Smart Structures.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Identify the basic geometries and components of SMA for simple applications.	Apply	1	1, 2, 9, 11
2	Predict the concepts, fabrication techniques and benefits of Shape Memory Alloys.	Evaluate	1	1, 2, 9, 11
3	Design the temperature controlled and preliminary SMA actuators.	Develop	2	1, 2, 9
4	Analyze the coupling SMA actuators with mechanisms.	Analyze	2	1, 2, 9

TEXT BOOKS:

1. Mohammad H. Elahinia, “Shape Memory Alloy Actuators”, Wiley, 1st Edition, 2016.
2. Leonardo Lecce and Antonio Concilio, “Shape Memory Alloy Engineering for Aerospace, Structural and Biomedical Applications”, Elsevier, 1st Edition, 2015.

REFERENCE BOOKS:

1. Ashwin Rao, A R Srinivasa, J N Reddy, “Design of Shape Memory Alloy (SMA) Actuators”, Springer, 1st Edition, 2015.
2. Dimitris C. Lagoudas, “Shape Memory Alloys”, Springer, 1st Edition, 2008.

22ME815 DIGITAL MANUFACTURING

source: https://epictool.ca/why-carbide-remains-one-of-the-most-popular-tool-materials/

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basics in the conventional manufacturing process.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with applications of computers in various aspects of the manufacturing process such as in design, process planning, scheduling, manufacturing, etc. The objective of this course is to provide knowledge on concepts of computer representation of geometry, part programming, group technology, and flexible manufacturing systems.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

Introduction to CAD/CAM & NC: Introduction to CAD/CAM: Definitions; Applications; product life cycle; CAD/CAM basic structure, Advantages of CAD/CAM. Introduction to Numerical Control (NC) Machine; NC components; NC procedure; NC coordinates systems and NC motion control Systems; Applications of NC.

UNIT-2 **10L+10T+0P=20 Hours**

CNC Machines & Programming: Introduction to Computer Numerical Machines (CNC), & Direct Numerical Control (DNC); Part- programming fundamentals; CNC programming (G- codes and M-codes), Fusion 360 – modelling & manufacturing practices.

PRACTICES:

- 2D drawings using CREO / Fusion 360 sketcher.
- 3D solid models using CREO / Fusion 360 modeling package.
- Manual CNC part programming for milling machine.
- Manual CNC part programming for milling machine.
- Computer generated CNC programming using Fusion 360.

MODULE-2

UNIT-1 **6L+4T+0P=10 Hours**

Introduction to GT & FMS: Introduction to Group Technology (GT); part families; parts classifications and Coding systems; design and manufacturing attributes. Flexible Manufacturing- In-line layout, loop layout, ladder layout & robot-centered cell.

UNIT-2 **10L+10T+0P=20 Hours**

Gt Coding & Product Flow Analysis: Part coding as per International Standards Optiz coding system. Multiclass coding system. Production Flow Analysis - Rank order clustering technique.

PRACTICES:

- Case studies on existing industry layouts.
- Case studies on part coding & grouping of the components.
- Study the existing plant layouts & their plotting.
- Case studies on grouping of machines & products by using the PFA method.

SKILLS:

- ✓ *Identify various facets of CAD / CAM.*
- ✓ *Acquire a basic idea of the structure of computing system hardware.*
- ✓ *Learns the skill of Computer-aided drawings*
- ✓ *Generate automated part programming for CNC systems.*
- ✓ *Perform production flow analysis used in group technology for various manufacturing applications.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Differentiate between product life cycle in conventional and computer based manufacturing systems.	Analyze	1	1, 2, 6
2	Analyze different modeling techniques of geometrical transformations during CAD geometry generation and display.	Analyze	1	1, 2, 5, 10, 12
3	Explore various modes of numerically controlled operations.	Apply	1	1, 2, 3, 4
4	Appreciate different preparatory and miscellaneous functions in CNC part programming.	Analyze	2	1, 2, 3, 9
5	Learn part coding and classification methods in manufacturing.	Apply	2	1, 3, 4

TEXT BOOKS:

1. Ibrahim Zeid, “CAD/CAM Theory and Practice”, 2nd edition, T ata McGraw Hill, 2009.
2. M.P Groover, “Automation, Production Systems and Computer Integrated Manufacturing”, 3rd edition, Published by Pearson, Education, Inc, 2008.

REFERENCE BOOKS:

1. P .N.Rao, “CAD/CAM Principles and Applications” 3rd edition, T ata McGraw Hill, 2010.
2. David F Rogers and J.Alan Adams, “Computer Graphics”, 2nd edition, T ata McGraw Hill, 2002,
3. Kundra T .K, Rao P .N. and T ewari N.K, “Numerical Control and Computer Aided Manufacturing”, 1st edition, T ata McGraw Hill, 2004.
4. Koren, “Computer Control of Manufacturing Systems”,1st edition, T ata McGraw Hill, 2005.

22ME816 ELECTRONICS AND AEROSPACE MATERIALS

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basics in Electronics and Materials Engineering.

COURSE DESCRIPTION AND OBJECTIVES:

To train the students to be an expert in electronics and materials related to aerospace engineering by performing various tests on electrical drives, and materials.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

BASIC ELECTRONICS-1:

Transistors : Transistor operation, configurations, small signal analysis of Basic Transistor Amplifier, Stabilization, Essentials of a Biasing Network, Biasing Methods for Amplifiers. Field effect transistor, Junction Field effect transistor, MOSFET, and unijunction transistor. Integrated circuits. Amplifiers and Ocillators: Classification of Power Amplifiers, Push Pull Power amplifier, Voltage Amplifiers, Feedback in Amplifiers, different types of oscillators. Tuned collector oscillator, Hartley oscillator, Colpitt's oscillator, Phase shift and Wein Bridge oscillator. Modulation and Demodulation: Principles of Radio Transmission and Reception. Modulation, Types of Modulation Amplitude Frequency and Phase Modulation Demodulation.

UNIT-2 **10L+10T+0P=20 Hours**

BASIC ELECTRONICS-2:

Analog and Digital: Operational Amplifier, Scale changer, sign changer, integrator, Differentiator, phase shifter, Logrithmic Amplifier, Positive and Negative Logic Systems, Logic Gates, Binary Number system, Binary Arithmetic Binary Code, Half Adder, Full Adder, Binary Adder, Digital input - output devices.

Power Control Devices : Silicon Controlled Rectifier, Characteristics, Triac, Diac Shockley diode, Silicon Bilateral Switch, Unijunction Transistor, Choppers, Inverters and their Applications.

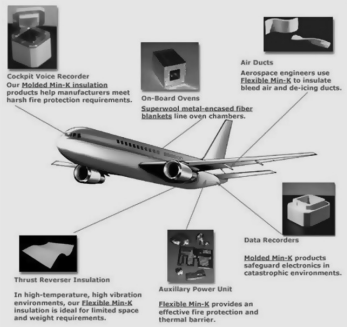
PRACTICES:

- Implementation of digital circuits.
- Design of electronic system using operational amplifiers– Device characteristic– Power supply design – Wave shaping circuits.
- clippers and clampers – Biasing of transistor.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

Aerospace Materials: Properties of materials: strength, hardness, fatigue, and creep – Ferrous alloys: stainless steels, maraging steel, aging treatments– Aluminum alloys: alloy designation and tempers, Al -Cu alloys, principles of age hardening, hardening mechanisms, Al-Li alloys, Al-Mg alloys, nanocrystalline aluminum alloys – Titanium alloys: α-β alloys, superplasticity, structural titanium alloys, intermetallics – Magnesium alloys: Mg-Al and Mg - Al - Zn alloys.



source: https://www.openpr.com/news/1377091/aerospace-materials-market-2018-analysis-by-growth-and-futuristic-trends-with-top-key-manufacturers-constellium-thyssenkrupp-hexcel-tencate-baosteel-alcoa.html

SKILLS:

- ✓ *Identify and propose suitable electronics components for aerospace applications.*
- ✓ *Able to process materials to enhance the safety and rigidity on aerospace materials.*
- ✓ *Ability to predict the materials failure problems.*

UNIT-2 **10L+10T+0P=20 Hours**

Superalloy: processing and properties of superalloys, single-crystal superalloys, environmental degradation and protective coatings - Composites: metal matrix composites, polymer based composites, ceramic based composites, carbon carbon composites.

PRACTICES:

- Identify the types of materials used for Aerospace applications.
- Develop coatings to protect from degradation.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Understand and trouble shoot electric circuits and working principles of electrical machines.	Apply	1, 2	1, 2, 4, 5, 9, 10, 12
2	Identify and propose suitable electronics components for aerospace applications.	Apply	1, 2	1, 2, 5, 9, 10
3	Able to process materials to enhance the safety and rigidity on aerospace materials.	Apply	1, 2	1, 2, 3, 5, 9, 10
4	Ability to predict the materials failure problems.	Apply	1, 2	1, 2, 5, 9, 10, 12

TEXT BOOKS:

1. Bapat, “Electronics Circuits and Systems Analog and Digital”, Tata Mc-GrawHill, Delhi.
2. H C Rai and Mahesh Popli, “Fundamentals of Electronics”, Dhapat Rai & Sons, Naisarak, Delhi.
3. Polmear, I. J., “Light Alloys: From Traditional Alloys to Nanocrystals”, Elsevier, 4th Edition, 2005.

REFERENCE BOOKS:.

1. Cantor, B., Assender, H., and Grant, P. (Eds.), Aerospace Materials, CRC Press, 1st Edition, 2001.
2. Campbell, F. C., Manufacturing Technology for Aerospace Structural Materials, Elsevier, 1st Edition, 2006.
3. Kainer, K. U. (Ed.), Metal Matrix Composites, Wiley-VCH, 1st Edition, 2006.

22ME818 ENVIRONMENTAL DEGRADATION AND BIO MATERIALS

source: https://www.conserve-energy-future.com/causes-and-effects-of-environmental-degradation.php

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basics in Environmental and material science Engineering .

COURSE DESCRIPTION AND OBJECTIVES:

The students can bale to review on

- Degradation of advanced materials (metal or non-metal).
- Degradation of materials under extreme conditions (pH, radiation-exposure).
- High-temperature oxidation and hot corrosion.
- Corrosion of materials in industrial media or service environments.
- Biodegradation and biocompatibility of implants.
- Learn characteristics and classification of Biomaterials.
- Understand different metals, ceramics and its nanomaterials characteristics as biomaterials.
- Get familiarized with the concepts of Nano Science and Technology.
- Understand the concept of biocompatibility and the methods for biomaterials testing.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

Environmental Degradation: Degradation economics, types of degradation: electrochemical, high-temperature corrosion and oxidation, chemical and physical ageing of plastics, degradation of reinforced concrete, biofouling, biodegradation, erosion corrosion – environmental variables, cavitation, fretting corrosion, erosive and corrosive wear, corrosion of ceramics, laboratory assessment of corrosion: linear polarisation techniques, Tafelextrapolation, oxidation, free energy- temperature diagrams, corrosion control: materials selection and design, protective coatings, inhibitors, passivators, electrical methods.

UNIT-2 **10L+10T+0P=20Hours**

Effect of Materials in Environmental Degradation: The effects of environmental degradation on a wide range of materials, including metals, plastics, concrete, wood and textiles, the kind of degradation and its effects, To measure, analyse, and control environmental degradation for a wide range of industrial materials including metals, polymers, ceramics, concrete, wood and textiles exposed to environmental factors such as weather, seawater, and fire.

PRACTICES:

- Study of sampling and preservation methods.
- Study on significance of characterization of water and waste water.
- Determination of Available Chlorine in Bleaching Powder.

SKILLS:

- ✓ *Will able to demonstrate some novel degradable techniques suitable with eco-friendly.*
- ✓ *Provide awareness on the materials towards environment.*
- ✓ *Ability to fabricate and propose suitable materials in Bio-materials applications.*

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

Biomaterials: Overview: Historical development; Materials in Medical Applications; Materials Properties for Bio-applications Biomaterials Classification and Processing: Metallic implants – Stainless steels, co-based alloys, Ti-based alloys, shape memory alloy, nanostructured metallic implants, degradation and corrosion, ceramic implant – bio inert, biodegradable or bioresorbable, bioactive ceramics, nanostructured bio ceramics. Polymerization, factors influencing the properties of polymers, polymers as biomaterials, biodegradable polymers, Bio polymers: Collagen, Elastin and chitin. Medical Textiles. Case studies on use of functional and biomaterials for various applications.

UNIT-2 **10L+10T+0P=20 Hours**

Characterization of Biomaterials: Characterization and use of biomaterials in medical applications. Concepts of biocompatibility in terms of structure and properties of materials and interactions between materials. Issues related to the design of biomaterials. Design of biomaterials to meet specific medical needs.

PRACTICES:

- Study on special materials related to Medical Applications.
- Alternate materials for biomaterials.
- Novel design procedure and proposal on design of biomaterials to meet specific medical needs.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Identify the parameter to be analyzed for the student project work in environmental stream.	Apply	1, 2	1, 2, 4, 5, 9, 10, 12
2	Analyze different types of Biomaterials and its classification and apply the concept of nanotechnology towards biomaterials use.	Analyze	1, 2	1, 2, 5, 9, 10
3	Identify significant gap required to overcome challenges and further development in metallic and ceramic materials.	Apply	1, 2	1, 2, 3, 5, 9, 10
4	Identify significant gap required to overcome challenges and further development in polymeric materials.	Apply	1, 2	1, 2, 5, 9, 10, 12

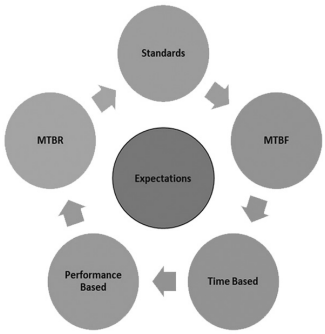
TEXT BOOKS:

1. Myer Kutz, “Handbook of Environmental Degradation of Materials”, William Andrew Publishing, 2005.
2. Denny A Jones, “Principles and Prevention of Corrosion”, 2nd Edition, Pearson, 2014
3. Sreeram Ramakrishna, MuruganRamalingam, T. S. Sampath Kumar, and Winston O. Soboyejo, “Biomaterials: A Nano Approach”, CRC Press, 2010.

REFERENCE BOOKS:

1. S. V. Bhat, “Biomaterials”, 2nd Edition, Narosa Publishing House, 2006.
2. Ed. R. D. Ratner, A. S. Hoffman, F. J. Schoen and J. E. Lemons, “Biomaterials Science, An Introduction to Materials in Medicine”, 2013.
3. John Enderle, Joseph D. Bronzino, Susan M.Blanchard, “Introduction to Biomedical Engineering”, Elsevier, 2005.

22ME819 FAILURE ANALYSIS



source: https://www.sciencedirect.com/science/article/pii/S1874694299800030

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basics of Integration, differentiation and complex numbers.

COURSE DESCRIPTION AND OBJECTIVES:

To course deals with the concept of mode of failures, fractures and procedure of various failure analysis. The objective of this course is to identify the nature of failure and analyze the fractured surfaces of a component.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

Failure, Fracture, and Fatigue: Identification of failure, Types of failure, modes of fracture, Fundamentals of fracture mechanics, characteristics of ductile and brittle fracture., Fatigue, Factors affecting fatigue life, Elevated temperature fatigue.

UNIT-2 **10L+10T+0P=20 Hours**

Analysis of Fractured Surface: Procedure for the analysis of Mechanical failures, Methodology of fractographic examination, Inference of the fractured surface of components subjected to mechanical loading, Writing and presentation of reports.

PRACTICES:

- To study the behavior and estimate the fatigue life of cracked shaft.
- To determine the critical crack length of a failed components in fatigue.
- To study the fractured surface of components in tension.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

Wear, Corrosion and Forming: Wear, factors influencing wear failures, Corrosion, factors influencing corrosion failures, hydrogen embrittlement, Failure in castings, Failure due to improper heat treatment, Failure in weldments.

UNIT-2 **10L+10T+0P=20 Hours**

Procedure of Various Failure Analysis: Procedure of wear failure analysis , Two body and three body wear mechanisms, Procedure of corrosion failure analysis, Procedure for cast and weld failure analysis.

PRACTICES:

- To study the fractured surface of components in torsion.
- To estimate the wear resistance of a material.
- To study the corrosion resistance of materials in different environment.

SKILLS:

- ✓ *To study the fractured surface of components in impact.*
- ✓ *To Analyze the remaining life of a defected/ damaged component.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Evaluate the basic modes of failures and their analysis procedure.	Apply	1	1, 2, 3
2	Estimate the life of a component in corrosive environment.	Evaluate	2	1, 2, 9
3	Analyze the wear resistance of different materials in contact with other solids.	Analyze	1	1, 2, 6
4	Integrate various factors causing fatigue failure of components.	Create	2	1, 2, 6, 9

TEXT BOOKS:

1. Jose Luis Otegui, Failure Analysis: Fundamentals and Applications in Mechanical Components, Springer, 1st Edition, 2013.
2. Jorge Luis González, Fractography and Failure Analysis, Springer, Volume 3, Structural Integrity, 2017.

22ME821 INDUSTRIAL ECONOMICS

source: https://www.google.com/search?q=INDUSTRIAL+ECONOMICS&tbm=isch&ved=2ahUKEwignebXsdX6AhUAgGMGHcajCUcQ2-cCegQIABAA&oq=INDUSTRIAL+ECONOMICS&gs_

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basics of Management Science .

COURSE DESCRIPTION AND OBJECTIVES:

This course aims to develop student's capacity to analyse the economic environment in which business entities operate and understand how managerial decisions can vary under different constraints that each economic environment places on a manager's pursuit of its goals, focusing on analysing the functioning of markets and the economic behaviour of firms and other economic agents.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

DEMAND ANALYSIS, THEORY OF PRODUCTION:

Demand Analysis: Types of Demand, Demand determination Concept of Elasticity and measurement, Demand forecasting, Survey & Statistical methods.

Theory of Production: Production function, Marginal rate of technical substitution, Iso-quants and Iso-costs, Law of Variable Proportions and law of returns to scale.

Break Even Analysis: Introduction; Assumptions in break-even analysis; Important terms and definitions; Calculations of break-even point; Effect of changes in volume, selling price, fixed cost and variable cost; Cost concepts.

UNIT-2 **10L+10T+0P=20 Hours**

Case Studies: Estimation of demand for the practical data (Case Study) by using Moving average method; Estimation of demand for the practical data (Case Study) by using Exponential Smoothing Method; Calculations and analysis of elasticity of demand for the practical case problems (Case Study); Determination of BEP for the practical problems.

PRACTICES:

- Determination of BEP for the practical situation problems.
- Estimation and analysis of elasticity of demand for the practical case situations.
- Construction of BEA Chart.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

DEPRECIATION & MARKETS:

Depreciation: Introduction, Purpose, Methods for calculating depreciation - straight line method, sum of year digit method, sinking fund method, machine hour basis method.

Introduction to Markets and price-output determination: Features and types of different competitive situations – Perfect competition, Monopoly, Monopolistic competition & their price output determination.

Capital Budgeting: Methods and Evaluation of Capital Budgeting Projects – Pay Back Method – Accounting Rate of Return (ARR) – Net Present Value (NPV).

SKILLS:

- ✓ *Identify the factors of production and output-cost relationship.*
- ✓ *Apply break-even analysis to study the volume-profit relationship.*
- ✓ *Select the suitable pricing methods for various objectives.*
- ✓ *Evaluate the market structure for profit maximization criteria.*
- ✓ *Make use of suitable depreciation methods.*

UNIT-2 **10L+10T+0P=20 Hours**

Capital Budgeting: Calculations and analysis of depreciation for the practical case problems using different methods (Case Studies); Draw the cost curves under-price-output determination in each market; Solving capital budgeting problems for the practical data by using different methods.

PRACTICES:

- Estimation and analysis of depreciation methods.
- Solving capital budgeting problems for the practical data by using different methods.
- Draw the Cost-Output curves under 2 Markets.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the knowledge of the mechanics of supply and demand to explain working of markets.	Apply	1	1, 2, 12
2	Describe how changes in demand and supply affect markets.	Analyse	1	1, 2, 5, 12
3	Understand the choices made by a rational consumer.	Apply	1	1, 2, 3, 5, 12
4	Explain relationships between production and costs.	Analyse	2	1, 2, 12
5	Define key characteristics and consequences of different forms of markets.	Apply	2	1, 2

TEXT BOOKS:

1. A.R. Arya Sri, Managerial Economics and Financial Analysis, TMH, 2nd Edition, 2010.
2. Gupta: Managerial Economics, TMH, 1st Edition, 2005.

REFERENCE BOOKS:

1. Dominic Salvatore, Managerial Economics, Thomson, 2nd Edition, 2006.
2. Mote Paull, Managerial Economics, TMH, 1st Edition, 2004.

22ME822 INDUSTRIAL ENGINEERING AND ESTIMATING AND COSTING

source:
https://www.google.com

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basics of Management Science .

COURSE DESCRIPTION AND OBJECTIVES:

This course offers the application of principles and techniques for planning and control of the production and service systems to optimize/make best use of resources. The objective of this course is to emphasize the importance of various production planning control parameters and their applications used in industries.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

INDUSTRIAL ENGINEERING:

Method Study: Definition, Objectives, Procedure for conducting method study.

Time Study: Definition, Objectives, Procedure for conducting time study.

Elements of Cost: Material cost, Labour cost and expenses, Total cost, Allocation of overheads by different methods.

Fundamentals of Estimation: Purpose and Functions of estimating, Constituents of estimation.

Mensuration: Important formulae for various geometric shapes to calculate areas & volumes of components.

UNIT-2 **10L+10T+0P=12 Hours**

Case Studies: Conduct method study for Case Study problem; Conduct time study for Case Study problem; Estimation of total cost of the product for the real application problem; Estimation of areas and volumes for the practical products of complex geometry.

PRACTICES:

- Conduct Method study for any job in the organization.
- Conduct Time study for manufacturing of a component.
- Estimation of mensuration for real life products.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

ESTIMATION:

Estimation of The Weight and Cost of Material Required for a Product: Divide the component drawing into simple and smaller geometrical configurations-Simple problem.

Estimation of Machining Time: Estimation of time required for machining operations like turning, screw cutting, drilling, shaping, boring, grinding - Simple problems on every operation.

Estimation of Fabrication Cost: Use tables for obtaining consumption of gas, filler rods, and rate of welding for different types of welding, Steps involved to estimate the cost.

SKILLS:

- ✓ *Implement the procedure of cost estimation in practical situations.*
- ✓ *Estimate the production cost of a given component produced in foundry shop, forging shop & welding shop.*
- ✓ *Evaluate the machining time for different operations performed in lathe, shaping, drilling, boring & grinding.*

UNIT-2 **10L+10T+0P=12 Hours**

Estimation of weight and cost: Estimation of weight and cost for the practical products of complex geometry. Estimation of machining time required for the practical jobs; Estimation of fabrication cost of material for the practical jobs under welding operation.

PRACTICES:

- Estimation of weight and Fabrication cost for the practical products of complex geometry.
- Estimate the production cost of a given component produced in foundry shop, forging shop & welding shop.
- Calculate the machining time for different operations performed in lathe, shaping, drilling, boring & grinding.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Understand the fundamental concepts of work study such as method study and work measurement.	Apply	1	1, 2, 12
2	Apply various types of engineering work measurement techniques such as time study, work sampling in analysing time of tasks.	Apply	1	1, 2, 5, 12
3	Implement the fundamental concepts of cost & estimation to determine the selling price various components.	Apply	2	1, 2, 5, 12

TEXT BOOKS:

1. O.P. Khanna, “Industrial Engineering and Management”, Dhanpat Rai publishers, 1st Edition, 2016.
2. G.B.S. Narang and V. Kumar, “Production and Costing”, Khanna Publishers, 1st Edition, 2005.

REFERENCE BOOKS:

1. T.R. Banga and S. C. Sharma, “Mechanical Estimating and Costing”, Khanna Publishers, 20th Edition,, 2011.
2. N.K. Agarwal, S.C. Sharma, T.R. Banga, “Industrial Engineering & Management Science” .

22ME823 INDUSTRIAL ENGINEERING AND PRODUCTION MANAGEMENT

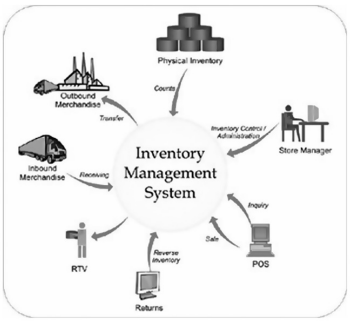
Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basics of Management Science .

COURSE DESCRIPTION AND OBJECTIVES:

This course offers the concepts of various types of manufacturing systems, productivity and various layouts used in shop floors. The objective of this course is to emphasize the importance of various production planning control parameters and their applications used in industries.



source: https://www.indiamart.com/proddetail/inventory-management-software-13521610462.html

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

Types of Manufacturing Systems: Types of Manufacturing Systems: Job Order Production; Batch Production; Mass Production; Characteristics, Advantages, Limitations.

Demand Forecasting: Need of forecasting; Forecasting Methods (Qualitative and Quantitative Methods)- Least square method; Moving average method; Exponential Smoothing Method; Forecasting Errors.

Introduction to inventory models: Deterministic models (i.e., EOQ and EBQ); Steps involved in purchase inventory models with one price break and multi price break when shortages are not allowed, Introduction to ABC analysis.

UNIT-2 **10L+10T+0P=20 Hours**

Demand Forecasting and Introduction to Inventory Models: Estimation of demand for the practical data (Case Study) by using Least square method; Estimation of demand for the practical data (Case Study) by using Moving average method; Estimation of demand for the practical data (Case Study) by using Exponential Smoothing Method; Calculations of different forecast errors in each method. Inventory problems solving relating practical application on EOQ; Inventory problems solving relating practical application on EBQ; Problems solving on Quantity discounts; Problems solving relating practical application on ABC analysis (Case Study).

PRACTICES:

- Estimation of demand forecasting under different methods. Also test the forecast accuracy in each method.
- Analyze the different inventory parameters for the practical inventory problem.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

ASSEMBLY LINE BALANCING:

Assembly Line Balancing: Definition; Advantages and RPW technique.

Network Analysis: Activity analysis; Network construction; Critical Path Method (CPM); Programme Evaluation Review Technique (PERT).

Statistical Process Control: Control charts for variables (X Bar Chart; R Bar Chart); Attribute Control Charts (P Chart; C Chart).

SKILLS:

- ✓ *Describe and evaluate the social and economic environment of business.*
- ✓ *Implement decision support tools for the growth of an organization.*
- ✓ *Apply inventory management and its importance in organizations.*
- ✓ *To apply productivity techniques for achieving continuous improvement.*
- ✓ *Apply effective project management techniques.*

UNIT-2 **10L+10T+0P=20 Hours**

Network Analysis, Control Charts: Solving assembly line balancing for the given practical application problem(Case Study) by using RPW technique; Estimation and analysis of CPM network for the given practical application problem; Estimation and analysis of PERT network for the given practical application problem; Construction and analysis of X-Bar & R-Bar charts for the given practical statistical data; Construction and analysis of P-chart for the given practical statistical data; ; Construction and analysis of C-chart for the given practical statistical data.

PRACTICES:

- Design an assembly line balancing parameters for the given practical line balancing problem.
- Estimation and analysis of CPM/PERT network for the given practical application problem.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Understand the basics about managerial aspects of operations and production systems.	Apply	1	1, 11
2	Implement production planning activities in industries.	Apply	1	2, 3
3	Perform the concept of Assembly line balancing.	Apply	2	3, 2
4	Understand the types of inventory models.	Apply	1	1, 5

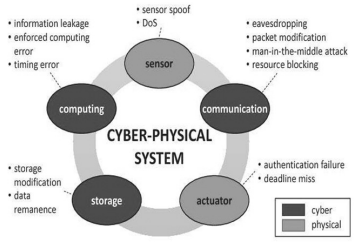
TEXT BOOKS:

1. William J Stevenson, “Operations Management”, Mc Graw Hill, 12th Edition, 2017.
2. S.N. Chary, “Production and Operations Management”, Tata McGraw Hill, 4th Edition, 2009.
3. Joseph Monks, “Operations Management”, Tata McGraw Hill, 3rd Edition, 2005.

REFERENCE BOOKS:

1. R. Panner Selvam, “Production and Operations Management”, 3rd edition, Prentice Hall of India, 2012.
2. R Dan Reid, and Nada R. Sanders, Operations Management, John wiley & Sons, 5th Edition, 2012.
3. Samuel Eilon, “Elements of Production Planning and Control”, 1st Edition, Universal Book Publishers, 2004.

22ME824 IOT AND SMART MANUFACTURING



source: https://www.researchgate.net/figure/Attack-surface-of-Cyber-Physical-System-CPS-24_fig1_332826219

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basics of Electronics and manufacturing process.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with necessity of internet of things (IoT) and its applications in smart manufacturing systems. The main objective of this course is to expose the requirements of the cyber- physical engineering system in manufacturing & its challenges.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

introduction to IOT: The Internet of Things: An overview; Design Principles for Connected Devices; Internet Principles – IP protocol suite. Prototype embedded devices & prototyping the online components.

UNIT-2 **10L+10T+0P=20 Hours**

Embedded Computing: Embedded Computing Basics, Arduino / Raspberry Pi, etc. Real Time Reactions, Other Protocols. Techniques for Writing Embedded Code – Memory Management & Performance. Automatic Storage Management in a Cloud World – Introduction to Cloud, Relational Databases in the cloud, Automatic Storage Management in the Cloud.

PRACTICES:

- Embedded Computing – Arduino.
- Prototype of physical design – case study.
- 3 Online prototyping - Getting started with an API.
- Online prototyping - Writing a New API.
- Smart Connected System Design Case Study.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

Smart Design & Smart Machines: Smart Design - Digital Tools, Product representation and exchange technologies and standards, Agile (Additive) Manufacturing Systems and standards. Mass customization, Smart Machine Tools, Robotics and Automation (perception, manipulation, mobility, autonomy).

UNIT-2 **10L+10T+0P=20 Hours**

Cyber-Physical Systems: Industrial Cyber-Physical System (CPS) - potential improvement for CPS. Smart manufacturing systems - design & Analysis, planning & control.

PRACTICES:

- Explore an industry with conventional & smart manufacturing- a case study.
- Practice on robotic programming to do a particular operation.
- Case studies on CPS & CPM.
- Proposal of a smart fabrication process on paper, project report.

SKILLS:

- ✓ *Learns the IoT tool kit, sensors & gateway & Arduino.*
- ✓ *Learns use of IP protocol, DNS, Cloud based design, API.*
- ✓ *Learns basic framework for smart manufacturing.*
- ✓ *Learns the working of Cyber physical manufacturing systems.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Address the underlying concepts and methods behind IoT & Smart Manufacturing.	Apply	1	1, 2, 4, 12
2	Develop the prototype embedded systems.	Analyze	1	1, 2, 3, 5, 12
3	Handle the cloud data by using APIs.	Analyze	1	1, 2, 5, 6, 8
4	Apply the automation tools required in manufacturing process.	Apply	2	1, 2, 5, 12
5	Create the cyber-physical system in manufacturing.	Analyze	2	1, 2, 3, 5

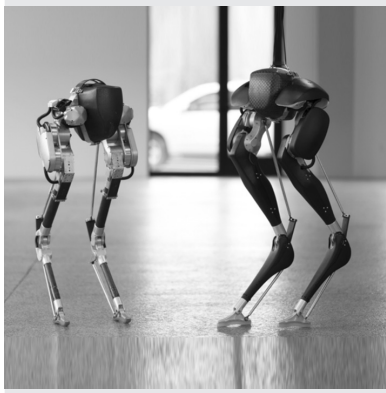
TEXT BOOKS:

1. A. McEwen and H. Cassimally, “Designing the Internet of Things”, Wiley, 1st Edition, 2013.
2. Jeschke S., Brecher C., Song H., and Rawat D. B., “Industrial Internet of Things Cyber manufacturing Systems”, Springer, 1st Edition, 2017.

REFERENCE BOOKS:

1. Tao F., Zhang M., and Nee A. Y. C., “Digital Twin Driven Smart Manufacturing”, Academic Press, 1st Edition, 2019.
2. M. Kuniavsky, “Smart Things: Ubiquitous Computing User Experience Design”, Morgan Kaufmann, 1st Edition, 2010.

22RA802 LEGGED ROBOTS



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Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basics of Robotics.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the fundamentals of legged robots in real time applications. The main objective of this course is to make students conversant with the various types of control and stability analysis methods of walking gaits.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

Introduction to Legged Robots: Advantages and Disadvantages of Walking Motion, Terminology, History of Legged Robots, Principles of Legged Motion - theory of land locomotion, soil mechanics of wheels, Locomotion using levers, Soil mechanics and the difference between feet and wheels, energetics of legged locomotion, Mechanisms other than legs, Aids to locomotion, Non-locomotory uses of appendages, Description and classification of gaits.

UNIT-2 **10L+10T+0P=20 Hours**

Mechanics: Animal structures and their applications to robots, Leg number and arrangement, Leg design, Structure, Actuation methods, Purpose of analysis and control, objectives of control in legged locomotion, Dynamics, Multi-pod Control.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

Stability: Static Stability Criteria, Dynamic Stability Criteria, Comparative Study Stability Margins, Stability Level Curves, Geometric Stability and Required Torques, Effects of Considering a Limited Motor Torque: Simulation Study Forms of learning, Effects of Limiting Motor Torque in Real Robots, Global-stability Criterion.

UNIT-2 **10L+10T+0P=20 Hours**

Gaits: PERIODIC GAITS: Introduction, Gait Generation, Continuous Gaits, Discontinuous Gaits, Two-phase Discontinuous Crab Gaits, Discontinuous Turning Gaits, Path Tracking with Discontinuous Gaits

NON - PERIODIC GAITS: Introduction, Free Crab Gaits, Free turning Gaits, Free Spinning Gaits.

PRACTICES:

- Simulation of Biped Robot motion for obstacle avoidance.
- Simulation of 6 – legged robot for obstacle avoidance.
- Evaluation of parameters for Geometric, Static and Dynamic Stability of Biped Robot.
- Performance analysis of Discontinuous Crab Gaits.
- Performance analysis of Free Crab Gaits.

SKILLS:

- ✓ *Explain the concepts of stability criteria of gaits.*
- ✓ *Apply the methods of control analysis of periodic and non - periodic gaits.*
- ✓ *Analyze the stability parameters of walking robots.*

COURSE OUTCOMES:

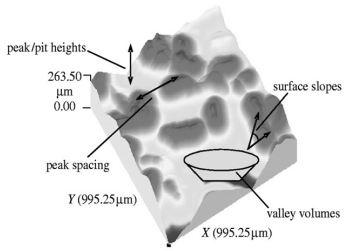
Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Implement basic system requirements for Gait development	Apply	1	1, 2, 9, 11
2	Formalize a control analysis method for gaits.	Evaluate	1	1, 2,9, 11
3	Analyze Path tracking in periodic and non - periodic gaits	Develop	2	1, 2, 9
4	Identify problems that are amenable to stability of Walking Robots.	Analyze	2	1, 2, 9

TEXT BOOKS:

1. D J Todd, “Walking Machines: An Introduction to Legged Robots”, Kogan Page, 1st Edition, 1985.
2. Pablo Gonzalez de Santos, Elena Garcia and Joaquin Estremera, “Quadrupedal Locomotion”, Springer, 2005.

22ME826 METROLOGY AND SURFACE ENGINEERING



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Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basics of Engineering Thermodynamics.

COURSE DESCRIPTION AND OBJECTIVES:

This course offers knowledge on limits, gauges, linear and angular measurements in engineering applications and also covers the aspects of surface engineering. The objective of this course is to develop knowledge of industrial measuring instruments and to select suitable surface treatment method to improve surface properties.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

INTRODUCTION TO METROLOGY: Product tolerance, Theory of limits, Fits and Tolerances, Fundamental deviation and types, Grades of tolerances, Fits - types of fits; Hole basis and shaft basis systems, Interchangeability and selective assembly, Limit Gauges, Taylor's principle, GO and NO GO gauges, Plug and Ring gauges.

UNIT-2 **10L+10T+0P=20 Hours**

Linear and Angular Measurements: Slip gauges, CMM, Angle and Taper measurement: Bevel protractor, Sine bar, Taper determination using Rollers and spheres, Optical Measurements: Optical flats, NPL Interferometer.

Comparators: Mechanical, Electrical, Pneumatic.

Surface roughness measurement: Surface roughness and surface texture, Numerical assessment of surface finish - CLA, RMS, Ten-point height of irregularity; Measuring Instruments - Profilograph, Talysurf.

PRACTICES:

- Performance on linear of measurements.
- Performance on angular measurements.
- Study on various types of fits as per standards.
- Surface roughness measurement and its analysis.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

Surface Engineering: Surface texture and properties, Surface cleaning techniques, Surface integrity, Wear and its measurement, Lubricants and its selection for reducing wear, Principles of corrosion and remedial measures, Laser applications for surface modifications.

UNIT-2 **10L+10T+0P=20 Hours**

Surface Treatment: Mechanical surface treatment and coating, Casehardening and surface coating, Thermal spraying, Vapour deposition, Diffusion coating, Electroplating, Electrolysis plating and Electro formatting, Ceramic, organic and diamond coating.

PRACTICES:

- Surface cleaning methods.
- Wear measurement under varying the process parameters.
- Electroplating & Electro formatting.

SKILLS:

- ✓ *Design limits, fits and tolerances for the two mating parts.*
- ✓ *Analyse the precision and accuracy various products.*
- ✓ *Develop a product that can able to withstand friction and wear for long time.*
- ✓ *Improve the life of machine components by selecting appropriate coatings.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Estimate the tolerances, fits and surface quality.	Apply	1	1, 2, 10
2	Select and use appropriate methods/instruments for inspection of various measurements.	Analyze	1	1, 2, 10
3	Evaluate various surface roughness parameters.	Evaluate	2	1, 2, 3, 12
4	Analyse quality of surface coating technologies in industry.	Analyze	2	1, 2, 3, 10, 11

TEXT BOOKS:

1. D. S. Kumar, “Mecahnical Measurements & Controls”, Metropolitan Book, 5th Edition, 2012.
2. R. K. Jain, ”Engineering Metrology”, Khanna Publishers, New Delhi, 20th Edition, 2009.
3. M. Mahajan, “A Textbook Of Metrology” Dhanpat Rai & Co., New Delhi, 2nd reprint Edition, 2014.

REFERENCE BOOKS:

1. R. K. Rajput, “Mechanical Measurements & Instrumentation”, S.K. Kataria & Sons, 3rd Edition, 2010.
2. E. O. Doebelin, “Measurement Systems”, Tata McGraw Hill, New Delhi, 6th Edition, 2011.

22ME827 MODELING AND SIMULATION OF MANUFACTURING SYSTEMS

source: https://www.google.com

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basics of Finite Element Methods.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with simulation of the manufacturing process of forming, casting, welding & metal removal operation. The main objective of the course is to elaborate on mathematical modeling of the manufacturing process.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

Basics of Sheet Metal and Casting Process: Basic tools used in simulation software - ANSYS Workbench, Abaqus, COMSOL, Deform or LS-Dyna - in geometry modeling, boundary conditions, Pre-processing & Post-processing elements.

Hydroforming – Introduction, Tube forming, Sheet metal hydroforming, plastic instabilities, Forming limit curve, Casting- Fundamentals of the casting process, Mathematical modeling of heat transfer.

UNIT-2 **10L+10T+0P=20 Hours**

Numerical Modelling of Hydro Forming & Casting Process: Material characterization in forming process, Analytical modeling & Numerical modeling of metal forming process. Solidification of casting phenomenon, Boundary conditions, Discretization of governing equation & Simulation software.

PRACTICES:

- Basic tools- geometry, BC, Pre & post-processing tools.
- Simulation of the hydroforming process.
- Compare the Analytical & Simulation results of a hydroforming process.
- Casting process simulation– Schematic diagram (include all stages of work).
- Mathematical modeling of casting.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

Welding & Metal Removal (M.R.) Operations: Welding - Introduction, Computation of welding process - framework, driving forces, Mathematical modeling of heat source, Machining - Introduction - Turning, Milling & Drilling, Cutting mechanics & Analytical modeling.

UNIT-2 **10L+10T+0P=20 Hours**

Simulation of Welding & M.R. Operation: Welding – Coupled physics- thermal & structural & Welding deformation. Finite element modeling of metal removal - Model formation, Mesh, Boundary conditions, Contact reference, Material modeling, Friction modeling, Chip separation, & Adaptive meshing.

PRACTICES:

- Mathematical modeling of the welding process.
- Develop the heat source model.
- Compare the experimental & simulation results on the thermal profile.
- Simulation of the welded process – deformation, thermal stress, etc.
- Modeling of Lathe operation.

SKILLS:

- ✓ *Learns the modeling of casting, and hydroforming process.*
- ✓ *Learned significance of material properties, and boundary conditions.*
- ✓ *Learns to model heat source development & coupled physics.*
- ✓ *Learns the coupled physics incorporation in the manufacturing process.*
- ✓ *Learns the various simulation tools & their post-processing elements.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Address the underlying concepts of simulation software in modeling & analysis.	Analyze	1	1, 2, 3, 12
2	Analysis the analytical methods on hydroforming process.	Analyze	1	1, 2, 3, 5, 12
3	Develop the mathematical models of casting, & welding process.	Apply	1	1, 2, 3, 5, 9
4	Apply simulation models on metal removal operations.	Analyze	2	1, 2, 3,5
5	Apply the various meshing technologies in simulation process.	Analyze	2	1, 2, 5

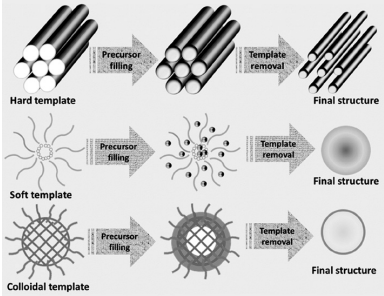
TEXT BOOKS:

1. Kuang-O (Oscar) Yu, “Modeling for Casting and Solidification Processing”, CRC Press, Taylor & Francis Group, 1St Edition, 2002.
2. Bouchaib Radi, Abdelkhalak El Hami, “Material Forming Processes - simulation, Drawing, Hydroforming and Additive Manufacturing”, John Wiley & Sons, Inc, 1St Edition, 2016.

REFERENCE BOOKS:

1. Lars-Erik Lindgren, “Computational welding mechanics_ Thermomechanical and microstructural simulations”, Woodhead Publishing Limited, 1St Edition, 2014.
2. Angelos P. Markopoulos, “Finite Element Method in Machining Processes”, Springer, 1St Edition, 2013.

22ME828 NANOMATERIALS SYNTHESIS AND CHARACTERIZATION TECHNIQUES



source: https://www.google.com/search?q=NANOMATERIALS+SYNTHESIS&tbm=isch&ved=2ahUKEwiS8_fssPj5AhWe_DgGHcXAC9oQ2-cCegQIABAA&oq=NANOMATERIALS+SYNTHESIS&gs_

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basics in Material Science Engineering.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with fundamentals of nanotechnology, domain applications, fabrication techniques and characterization. The objective of this course is to impart basics of nanotechnology in the integrated multidiscipline such as material science, medicine, electronics and space applications, etc.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

INTRODUCTION:

Genesis of Nanotechnology: Introduction, Nano Science, Nano technology, Nano materials, Scope of applications, Properties of Nano materials, Basic principles of Nano science and technology.

Fabrication of Nanomaterials: Introduction, Techniques used in Nano technology - top-down approach, bottoms-up approach;

UNIT-2 **10L+10T+0P=20 Hours**

NANOMATERIALS SYNTHESIS:

Physical Synthesis Techniques: Thermal evaporation, e-beam evaporation, Sputtering techniques, Pulse Laser Deposition, Atomic Layer Deposition, Mechanical milling.

Chemical Synthesis Methods: Chemical Vapor Deposition (CVD), Sol-gels techniques, Solvothermal and hydrothermal methods, Electroplating, Spin and Dip coating techniques, Flame and Spray pyrolysis.

PRACTICES:

- Synthesis of Metal Oxide Nanoparticle using chemical synthesis approach.
- Preparation of Nano particles using top-down approach.
- Fabrication of Polymeric Nanocomposite.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

Characterization Techniques: Tools used in Nano technology: Particle size analyses using - Scherer`s formula, X-ray diffraction, FTIR Spectroscopy, Scanning Electron Microscope, EDS, Atomic Force Microscope (AFM), Scanning Tunneling Microscopy (STM)– Transmission Electron Microscopy (TEM). Spectroscopic techniques: Infra-red spectroscopy (IR), Thermal Characterization Techniques.

UNIT-2 **10L+10T+0P=20 Hours**

ANALYSIS OF NANO MATERIALS: Particle size analyses using - Scherer`s formula, X-ray diffraction, powder diffraction, lattice parameters, structure analyses, strain analyses, phase identification, FTIR Spectroscopy, FTIR spectra of nanomaterials.

Thermal Characterization Techniques: Thermo gravimetric analysis; Differential thermal analysis, Differential scanning calorimetry, Dilatometry, Dynamic mechanical analysis, Thermo mechanical analysis, Dielectric thermal analysis, Thermo-optical analysis.

SKILLS:

- ✓ *Synthesize of nanomaterials using physical and chemical techniques.*
- ✓ *Recognize domain applications of nanotechnology in textiles, space, medicine,computers and electronics.*
- ✓ *Characterize nanomaterials using various tools.*

PRACTICES:

- Identification of range of Nano particles using Particle analyser.
- EDS analysis of Nano metal powders.
- Measurement of crystallinity through XRD.
- TGA analysis of nano composites.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Identify suitable nano material for desired applications.	Apply	1	1, 2, 3, 4, 5, 12
2	Select a suitable synthesize technique for Nano materials.	Apply	1, 2	1, 2, 3, 4, 5, 9, 11, 12
3	Analyze material properties with respect to its microstructural aspects.	Analyze	1, 2	1, 2, 3, 4, 5, 8, 11, 12
4	Evaluate the nano materials for defects using appropriate tools.	Apply	1, 2	1, 2, 3, 4, 5, 9, 11, 12

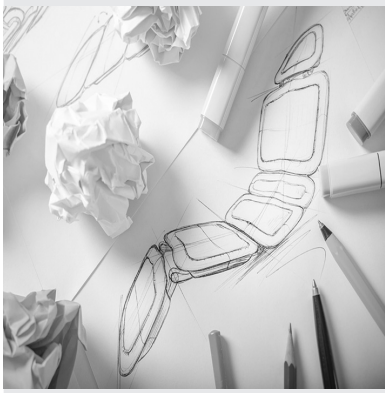
TEXT BOOKS:

1. Mark Ratner, “Nano technology”, Pearson Education, 3rd Edition, 2008.
2. Zhong Lin Wang, “Hand Book of Nano phase& Nanostructured materials (Vol. I&II)”, Springer, 2002.

REFERENCE BOOKS:

1. M. Ratner and D. Ratner, “Nanotechnology, A Gentle Introduction to the Next Big Idea”, Pearson, 1st Edition, 2009.
2. C.P. Poole and F.J. Owens, “Introduction to Nanotechnology”, Wiley, 1st Edition, 2009.
3. T. Pradeep, “NANO The Essential, understanding Nano science and Nanotechnology”, Tata McGraw – Hill Publishing Company Limited, 2007.

22ME830 PRODUCT DESIGN FOR MANUFACTURING



source: https://novaproductdesign.com/design-industrial-mechanical-engineering-manufacturing/

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basics of Computer Aided Manufacturing .

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the factors be taken into account when products are designed and developed at industries. The main objective of this course is to expose computer-aided technologies in product development from product ideas to physical products and in decision making.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

Product Strategies: Product strategies, Time to market, Analysis of the product, the three 'S', Procedures adopted by industrial designers – Clay studies, Mock-ups, Scale model, Prototypes.

UNIT-2 **10L+10T+0P=20 Hours**

Concurrent Engineering: Key concepts for product manufacturing, Conceptual design stages, Concurrent Engineering - Conceptual diagram of lifecycle design.

PRACTICES:

- Develop the list of factors to be considered for product development.
- Practice on industries product designers – clay studies, prototypes.
- Practice on a conceptual diagram of the lifecycle design of a product.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

Product Supporting Technologies: Technologies that support decision-making in product manufacturing- Supporting systems- Product shape description technologies, Analysis & Performance characteristics, Support generation of product ideas, Database technologies

UNIT-2 **10L+10T+0P=20 Hours**

Industrial Technologies in P.D.: Bottlenecks in Supply Chain Management, Design Incorporating Quality Engineering, Evaluation for Ease of Assembly, Group technology, Process planning, Module technology, Scheduling technology.

PRACTICES:

- Practice on Product shape description technologies- design tools.
- Case study on product idea and implementation.
- Case study on – assessment of the quality of the product.

SKILLS:

- ✓ *Learns the factors to be considered the product development.*
- ✓ *Learns industries design aspects of product development.*
- ✓ *Learns the concurrent engineering product lifecycle.*
- ✓ *Learns the analysis & performance characteristics of the products.*
- ✓ *Learns computer-integrated manufacturing product development.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analysis on product design strategies at industries.	Analyze	1	1, 2, 3, 4
2	Develop the conceptual diagram of lifecycle design.	Apply	1	1, 2, 3, 5, 11, 12
3	Apply the product shape description technologies.	Apply	2	1, 2, 3, 5, 12
4	Computer-aided analysis of product manufacturing.	Analyze	2	1, 2, 5,9, 12

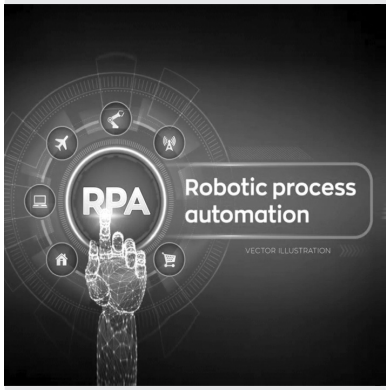
TEXT BOOKS:

1. A.K.Chitale, R.C. Gupta, Product Design and Manufacturing, PHI publications, 5th Edition, 2011.
2. Masataka Yoshimura, “System Design Optimization for Product Manufacturing”, Springer, 1st Edition, 2010.

REFERENCE BOOKS:

1. Karl.T.Ulrich, Steven D Eppinger, “Product Design and Development” – Irwin McGrawHill, 1st Edition, 2000.
2. Geoffery Boothroyd, Peter Dewhurst and Winston Knight, “Product Design for Manufacture and Assembly”, CRC Press, 3rd Edition, 2002.

22RA803 RPA IN INDUSTRY



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Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Basics of Robotics and Programming.

COURSE DESCRIPTION AND OBJECTIVES:

This course mainly deals with the concepts of process automation using robots. It provides basic knowledge about the required programming skills for robotic process automation.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

Introduction and RPA Skills: Introduction to RPA, History, Benefits, Downsides, Consumer Willingness, Comparison to BPO, BPA and BPM, On-Premise Vs. the Cloud, Web Technology, Programming Languages and Low Code, OCR (Optical Character Recognition), Databases, APIs (Application Programming Interfaces), AI (Artificial Intelligence), Cognitive Automation, Agile, Scrum, Kanban, and Waterfall, DevOps, Flowcharts.

UNIT-2 **10L+10T+0P=20 Hours**

Process Methodologies: Lean, Six Sigma, How to Implement Six Sigma, Six Sigma Roles and Levels, Lean Six Sigma, Finding the Right Balance, Applying Lean and Six Sigma to RPA.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

Vendor Evaluation: Be Realistic, Check Out Third Parties, Minimum Capabilities, Who Is the User? Funding, Ecosystem, Costs, Training and Education, Support, Best-of-Breed vs. End-to-End, Thought Leadership and Vision, Industry Expertise, Security, Monitoring, and Deployment, What Type of RPA? The Design, Next-Generation Technologies

UNIT-2 **10L+10T+0P=20 Hours**

Deployment and Monitoring: Testing, Going into Production, Monitoring, Security, Scaling, Types of Data, Big Data, The Issues with Big Data, The Data Process, Types of Algorithms, The Perils of the Moonshot, Bias.

SKILLS:

- ✓ *Illustarte the basic concepts of robotic process automation.*
- ✓ *Distinguish the technical aspects and methodologies involved in RPA.*
- ✓ *Perform the RPA for Monitoring and Vendor Evaluation.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Demonstrate the concepts and technologies involved in RPA.	Apply	1	1, 2
2	Propose the technical aspects and procedure of RPA to achieve Six Sigma in industry.	Create	1	1, 2
3	Evaluate the vendors using RPA.	Analyze	2	1, 2
4	Develop the RPA for process monitoring.	Develop	2	1, 2

TEXT BOOKS:

1. Tom Taulli, “The Robotic Process Automation Handbook”, APress, 1st Edition, 2020.
2. Richard Murdoch, “Robotics Process Automation: Guide to Building Software Robots, Automate Repititive Tasks & became an RPA Consultant”, Independently published, 1st Edition, 2018.

REFERENCE BOOKS:

1. Mary C. Lacity and Leslie P. Willcocks, “Robotic Process and Cognitive Automation”, ISBN: 978-0995682016, 2018.

22ME832 SPECIAL CASTING AND WELDING TECHNOLOGIES

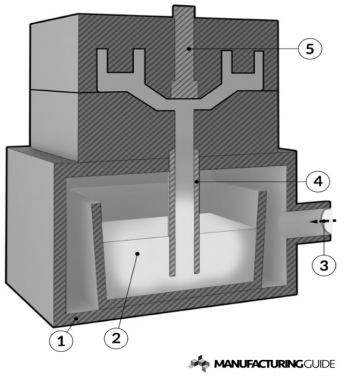
Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Manufacturing Processes .

COURSE DESCRIPTION AND OBJECTIVES:

This course offers knowledge on foundry practice, solidification of metals, metal casting and advanced welding processes. The objective of this course is to impart knowledge on special casting technologies, solidification routes, special welding technologies defects in casting and welding and finishing operations of casting and welding.



source: https://www.manufacturingguide.com/en/low-pressure-mold-casting

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

Introduction to Casting, Solidification and Defects: Introduction to casting process and the steps involved; Components produced by casting process, Comparison of metal casting with metal joining, Advantages and limitations of casting process; Freezing of pure metals; Nucleation and Growth, shrinkage, solidification of alloys. Defects in castings and its remedies; Cleaning and inspection of castings.

UNIT-2 **10L+10T+0P=20 Hours**

Special Molding Processes and Testing: Study of important molding processes, No bake molds, Flask less molds, CO2 mold, Metal Molds: Gravity die casting, Pressure die casting, Slush casting, Thixo-casting. Finishing processes: Fettling and cleaning of castings; removal of gates and risers, grinding. Non Destructive testing; Foundry automations-moulding machines-automation of sand plant.

PRACTICES:

- Preparation of sand mold cavities for casting process.
- Perform the casting operation & note the solidification timings with various cooling rates.
- Study the properties of the cast product.
- Case studies on CO2 mold & Metal molds.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

Physics of Welding Arc and Welding Defects: Welding as compared with other fabrication processes, Physics of welding Arc, Basic characteristics of power sources for various arc welding processes, Transformer, rectifier and generators, arc efficiency, Effect of shielding gas on arc, isotherms of arcs and arc blow. Welding defects – causes and remedies.

UNIT-2 **10L+10T+0P=20 Hours**

Weldability, Solidification and Testing: Effects of alloying elements on weld ability, welding of plain carbon steel, Cast Iron and aluminium, copper, nickel and titanium alloys. Epitaxial growth, weld pool shape and columnar grain structures. Mechanical, pressure and leak testing. Inspection methods – visual, penetrant, magnetic, ultrasonic, x-ray and gamma radiography. Use of imaging techniques for online monitoring.

SKILLS:

- ✓ *Manufacture components by metal casting processes.*
- ✓ *Design gates and risers for sand castings.*
- ✓ *Identify alloys for various applications.*
- ✓ *Recognize special casting techniques for intended applications.*

PRACTICES:

- Arc welding process on similar & dis-similar joints.
- Simulation of welding process- couples physics analysis.
- Welding joint properties study – metallurgical & mechanical properties.
- Case studies on adding alloy element at weld bead.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Select the molding material for molds and cores as well as the molding process.	Understand	1	1, 2, 4, 9, 10
2	Test quality of casting and welding by selecting a suitable testing method.	Analyze	1, 2	1, 2,4, 8, 9, 10
3	Analyse and evaluate quality and properties of castings and welding.	Apply	1, 2	1, 2, 3, 9, 12
4	Design gating and rising system for moulding.	Apply	1	1, 2, 3, 9, 10, 11

TEXT BOOKS:

1. P. N. Rao, “Manufacturing Technology: Foundry, forming and welding”, Tata McGraw Hill, 3rd Edition, 2003.
2. Khanna O. P. – ‘A Text Book on Welding Technology’ – Dhanpat Rai and Sons, New Delhi, 1st Edition, 2013.

REFERENCES:

1. R. A. Lindberg, “Processes and Materials for Manufacturing”, Pearson Education, 4th Edition, 2006.
2. “ASM Handbook: Volume 15: Casting” American Society of Metals, Ohio, 9th Edition, 2008.
3. Kou S. – ‘Welding Metallurgy’ – John Wiley Publications, New York, 2nd Edition, 2003.

22ME833 TRIBOLOGY

source: https://www.imeche.org/industry-sectors/tribology/tribology-group-information-and-resources/trib-design-guides

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Fundamental physics, Mathematics, Engineering mechanics.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the factors affecting tribological features by friction, wear and lubrication between contact surfaces. The objective of this course is to impart importance ofthe lubrication to overcome friction and wear for improving the over-all performance of the machines.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

Industrial Tribology: Tribology in design; tribology in industry; Viscosity; flow of fluids; viscosity and itsvariation -absolute and kinematic viscosity; temperature variation; different viscometers; Tribological considerations Nature of surfaces and their contact;Physic-mechanical properties of surface layer; Geometrical properties of surfaces.

Role of friction; causes of friction; theories of friction; Friction of metals and non-metals; Definition of wear; types and mechanism of wear; Wear of metals and non-metals.

UNIT-2 **10L+10T+0P=20 Hours**

Methods of measuring surface roughness; Friction measurements; Measurement of wear; Viscosity Index determination of Lubricants.

PRACTICES:

- Evaluation of Surface Roughness.
- Prediction and Validation of Viscosity Index of Lubricants.
- Friction co-efficient measurement under static and dynamic conditions.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

LUBRICATION AND BEARINGS: Lubrication; SAE Classification of Lubricants; lubricant additives; general properties and selection.

Principle of hydrostatic and Hydro-dynamic lubrication; Reynold's equation in two dimensions;Petroff's equation; Friction in sliding bearing; General requirements of bearing materials; types of bearing materials.

UNIT-2 **10L+10T+0P=20 Hours**

Hydrostatic step bearing; Hydrostatic lift; hydrostatic squeeze film Bearing.

Design of journal bearing; minimum oil film thickness; oil whip and whirl; anti – friction bearing; hydrodynamic thrust bearing.

PRACTICES:

- Sensitivity Analysis of design parameters for Thrust Bearing.
- Sensitivity Analysis of design parameters for Squeeze Bearing.
- Sensitivity Analysis of design parameters for Journal Bearing.

SKILLS:

- ✓ *Understand the nature of engineering surfaces and their topography.*
- ✓ *Identify the consequences of wear mechanisms.*
- ✓ *Analyze the principles of boundary lubrication and hydrodynamic theories.*
- ✓ *Apply the basic theories of friction, wear and lubrication to sliding and roller bearings.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Illustrate the tribological system and factors affecting tribological phenomenon.	Apply	1	1, 2, 6
2	Predict the performance and behavior of a tribological system.	Apply	1	1, 2, 3
3	Estimate the critical operating speeds for avoiding oil whip and oil whirl.	Evaluate	2	1, 2, 3, 6
4	Design efficient and robust tribological systems.	Create	2	1, 2, 6, 9

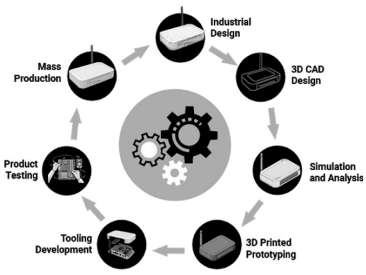
TEXT BOOKS:

1. Gwidon Stachowiak and Andrew W Batchelor, “Engineering Tribology”, Butterworth - Heinemann, 4th Edition, 2016.
2. Ming Qui, Long Chen, Yingchun Li, Jiafei Yan, “Bearing Tribology: Principles and Applications”, Springer, 1st Edition, 2018.

REFERENCE BOOKS:

1. Moore D.F and D.W. Hopkins, “Principles and Application of Tribology”, Pergamon, 1st Edition, 2013.
2. R. Arnell, “Tribology: Principles and Design Applications”, Reprint Edition, Springer Verlag, 1st Edition, 2012
3. Bowden F.P. and Tabor D., “The Friction and Lubrication of Solids”, Oxford University Press, 1st Edition, 2001.
4. Prasanta Sahoo, “Engineering Tribology”, PHI Learning Pvt. Ltd, New Delhi, 1st Edition, 2011.

22ME834 VALUE ENGINEERING



source: https://volansys.com/blog-how-product-design-engineering-services-add-value-to-iot-solutions/

Hours Per Week :

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Fundamental physics, Mathematics, Design of Machine Members.

COURSE DESCRIPTION AND OBJECTIVES:

The product development through engineering aspects is always remains challenges to engineers. The aim of present course is to introduce the students about the basic product design process based on mechanical aspects applying innovative thinking and fundamentals of mechanical engineering.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

Product Design: Introduction, Product life cycles, Characteristics of Successful Product development, Design and development of Products, Types of Design and Redesigns, Engineering Designs, Duration and cost of product development, the challenges of Product development.

UNIT-2 **10L+10T+0P=20 Hours**

Product Design for Manufacturing and Assembly: Methods for designing for manufacturing and assembly, design forMaintainability, Design for Environment, Legal factors and socialissues, Engineering Ethics and Issues of society related to design ofproducts, Design for safety, Vision and Illumination design: Climate,Noise, Motion, Sound and Vibration, Product Costing.

Product Development Processes and Product Planning: A Generic development process, concept development, the front endprocess, adopting the generic product development process, TheProduct Planning Process.

PRACTICES:

- Understanding the case study on Nike shoes during product development from concept to customer.
- Redesign of aero engine bearing housing to reduce manufacturing cost.
- Discuss the challenges in the design of an array of aluminum bronze bushings for a new bulldozer.
- Explore the case study in case of replacement of a flanged, split bearing in a new torque converter design.

MODULE-2

UNIT-1 **6L+6T+0P=12 Hours**

Identifying Customer Needs: Customer Satisfaction, Voice of customer, Customer Populations, Types of customer needs, Customer need models. Gathering Customer needs: Need Gathering Methods, Conducting Interviews: Like Dislike Method, Articulated-Use Method, Product feel and Industrial Design, Organizing and Prioritizing Needs: Grouping Interpreted needs, Affinity Diagram, Determining need Importance, Customer use patterns, Customers need Documentation.

UNIT-2 **10L+10T+0P=20 Hours**

Value Engineering: Definition, Value Engineering Function: Approach of Function, Evaluation of Function, Determining Function, Classifying Function, Evaluation of costs, Evaluation of Worth, Determining Worth, Evaluation of Value, FAST Diagramming, Case Studies on Product Design Development and Value Engineering.

SKILLS:

- ✓ *Able to solve open chain design problems.*
- ✓ *Able to design the socio-centric models.*
- ✓ *Able to estimate the value of existing model.*

PRACTICES:

- Methods for evaluating value for money.
- Estimation of elements of cost evaluation.
- Function Analysis and System Technique for Iron box using FAST diagram.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Solvethe open-ended design problems.	Applying	1	1, 2, 3
2	Design the engineering products as per industry/ society requirements.	Applying	1	1, 2, 5, 9
3	Develop new product based on mechanical design engineering.	Create	2	1, 2, 6, 9
4	Enhance the value of the product by modifying the existing design.	Analyze	2	1, 2 ,5, 9

TEXT BOOKS:

1. K.T. Ulrich and S.D., Product design and development, Eppinger, Tata McGraw Hill, 7th Edition, 2020.
2. Lawrence D. Miles, Techniques of Value Analysis and Engineering, Value Foundation, 3rd Edition, 2015.

REFERENCE BOOKS:

1. Chitale&Gupta,Product Development, Prentice Hall India Pvt. Ltd. 5th Edition, 2011.
2. S. S. Iyer, Value Engineering, New age International Publishers, 3rd Edition, 2019.

HONOURS

ROBOTICS AND AUTOMATION ENGINEERING

B.Tech.

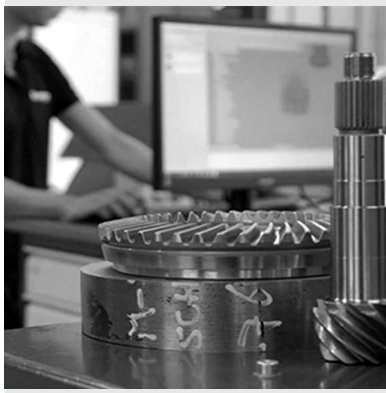
PRODUCTION DESIGN

- 22RA951 - Computer Aided Design and Manufacturing
- 22RA952 - Design of Machine Members
- 22RA953 - Finite Element Methods
- 22RA954 - Mechanics of Materials
- 22RA955 - Product Life Cycle Management

COURSE CONTENTS

I SEM & II SEM

22RA951 COMPUTER AIDED DESIGN AND MANUFACTURING



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Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Fundamental physics, Mathematics, Engineering mechanics.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with applications of computers in various aspects of manufacturing such as design and drafting, process planning, scheduling, manufacturing, etc. The objective of this course is to provide knowledge on concepts of computer compatible mathematical representation of geometry, Computer Aided Process Planning and Production Planning Control.

MODULE-1

UNIT-1 **9L+6T+0P=15 Hours**

Introduction to CAD/CAM: Definitions, Applications, Product life cycle, Automation, Types of automation, Advantages of CAD/CAM, Basic structure, Input and output devices, CAD procedure, DDA algorithm.

UNIT-2 **15L+10T+0P=25 Hours**

GEOMETRIC MODELING:

Transformation Of Geometry: 2-D and 3-D transformation, Translation, Scaling, Reflection, Rotation and Homogenous Coordinate systems.

Geometric Modeling: Curve representation, Synthetic Curves, Cubic Splines, B-splines, Bezier- Curves, Wireframe model, Surface model and Solid model - Requirements, Primitives and Boolean operators; Boundary Representation (B-Rep), Constructive Solid geometry (CSG).

PRACTICES:

- 2D drawings using Creo sketcher
- 3D solid models using Creo modeling package
- Assembly models:
- Cotter joint
- Knuckle Joint
- Bush-pin coupling
- Screw jack
- Journal bearing

MODULE-2

UNIT-1 **9L+6T+0P=15 Hours**

Process Planning And Concurrent Engineering: Process Planning, CAPP, Concurrent Engineering, Design For Manufacturing, Advanced Manufacturing Planning.

UNIT-2 **15L+10T+0P=25 Hours**

Production Planning and Control: Aggregate Production Planning, Master Production Schedule, Materials Requirement Planning, Capacity Planning, Shop Floor Control, Inventory Control, Manufacturing Resource Planning.

SKILLS:

- ✓ *Identify various facets of CAD / CAM.*
- ✓ *Convert vector straight lines to raster images utilizing the pixel information.*
- ✓ *Develop Production Planning Charts.*
- ✓ *Generate automated process planning.*

PRACTICES:

- Process Planning.
- Aggregate Production Planning.
- Shop Floor Control.
- Inventory Control.

COURSE OUTCOMES:

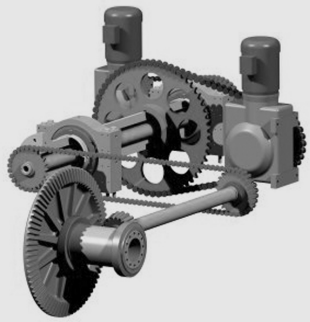
Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Differentiate between product life cycle in conventional and computer-based manufacturing systems.	Apply	1	1, 2, 3, 5
2	Develop various methodologies used for geometric construction.	Create	1	1, 2, 3, 5
3	Explore various vendors for Materials Requirement Planning	Analyze	2	1, 2, 3, 5
4	Generate Process Planning Charts for a given product manufacturing	Develop	2	1, 2, 3, 5

TEXT BOOKS:

1. Mikell P. Groover, “Automation, Production Systems, and Computer-Integrated Manufacturing”, Pearson, 4th Edition, 2015.
2. Jianbin Xue, “Integration of CAD/CAPP/CAM”, De Gruyter, 1st Edition, 2018.

22RA952 DESIGN OF MACHINE MEMBERS



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Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Fundamental physics, Mathematics, Engineering Mechanics.

COURSE DESCRIPTION AND OBJECTIVES:

The objective of this course is to enrich fundamental concepts required for the design of machine components when subjected to various types of loading and operating conditions.

MODULE-1

UNIT-1 **9L+6T+0P=15 Hours**

Design for Static & Fatigue Strength: Selection of Materials, Phases of design, Theories of failure and its applications in static design, Stress concentration, Fluctuating stresses, design for low cycle and high cycle fatigue, Design for finite and infinite life, Strength of transverse and parallel fillet welds; Design of bolted joints, Design of helical springs.

UNIT-2 **15L+10T+0P=25 Hours**

Design Tasks: Selection of materials using Ashby charts, Modeling of knuckle joint, cotter joint, Experimental determination of endurance limit, Measurement and assembly of machine parts, estimation stress concentration and factor of safety, solving numerical problems using design data book.

PRACTICES:

- To create wire frame and surface models using Creo/CATIA.
- To model machine components using Creo/CATIA.
- To design the shafts based on various theories of failure using C/MATLAB.
- To determine the finite or infinite life of shafts subjected to fatigue load using MATLAB.
- Modeling and assembly of Cotter/Knuckle Joints.

MODULE-2

UNIT-1 **9L+6T+0P=15 Hours**

Design of Transmission Elements: Shafts and keys, flat belt drives, spur gears, journal bearings, antifriction bearings.

UNIT-2 **15L+10T+0P=25 Hours**

Design Tasks: Selection of v- belt drives, estimation of module, Computer aided design of shafts and keys, Selection of antifriction bearings from catalogue, Fitment and alignment of Bearing, Modeling of gear drive.

PRACTICES:

- To design and modeling of spur gear using MATLAB/Creo.
- To design and modeling of helical gear using MATLAB/Creo.
- Modeling and assembly of Plummer block.
- To estimate the rating life of ball bearing using MATLAB.
- To estimate the rating life of taper roller bearing using MATLAB.

SKILLS:

- ✓ *Problem solving skills.*
- ✓ *Programming/ Modeling/Analysis skills.*
- ✓ *Creative skills.*
- ✓ *Teamwork.*
- ✓ *Communication skills.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply suitable failure theory for design of various machine elements subjected to static loading or cyclic loading.	Apply	1	1, 2
2	Evaluate the strength and the rating life of mechanical elements.	Evaluate	1	1, 2, 3
3	Construct machine components using modeling software.	Apply	2	1, 2, 3
4	Conceptualize a machine in terms of geometrical requirements and synthesize an Assembly of machine components.	Create	2	1, 2,9

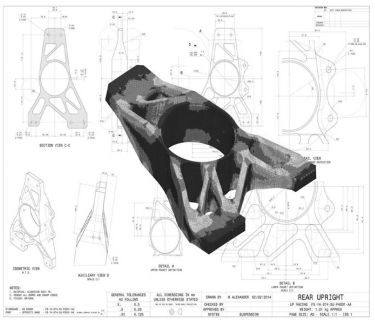
TEXT BOOKS:

1. Robert L. Norton, Machine Design: An Integrated Approach, Pearson, 6th Edition, 2020.
2. Keith J Nisbett and Richard G Budynas, Mechanical Engineering Design, McGraw-Hill Education, 10th Edition, 2014.

REFERENCE BOOKS:

1. George Dieter and Linda Schmidt , Engineering Design, 6th Edition, 2021.
2. Ashby M F, Material Selection in Mechanical Design, Elsevier, 5th Edition, 2016.

22RA953 FINITE ELEMENT METHODS



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Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Fundamentals of Mathematics, Material Properties.

COURSE DESCRIPTION AND OBJECTIVES:

This course explores the fundamental concepts of finite element methods(FEM) & basics of analysis package. It is a numerical method used to find the approximate solutions of various real time field problems. The objective of this course is to provide solutions using FEM for static structural and steady state heat transfer problems.

MODULE-1

UNIT-1 **9L+6T+0P=15 Hours**

Rudimentary Concepts of FEM: Energy methods, Minimum Potential energy method, Rayleigh-Ritz and Weighted residual methods, Galerkin method, 1D structural analysis.

UNIT-2 **15L+10T+0P=25 Hours**

Structural Analysis: Problems on simple bars, trusses and beams

PRACTICES:

- To perform static structural analysis of 1D problems.
- To perform structural analysis of trusses.
- To determine Nodal solution and Von-mises stress distribution for plane stress and
- Plane strain structural problems using manual meshing procedure.
- To determine Nodal solution and Von-mises stress distribution for plane stress and
- Plane strain structural problems using automatic meshing procedure.
- To analyze the different types of beams subjected to UDL, UVL, Bending moment, and point load.

MODULE-2

UNIT-1 **9L+6T+0P=15 Hours**

2D Structural & Modal Analysis: Shape functions, Eigen value and Eigen vector analysis

UNIT-2 **15L+10T+0P=25 Hours**

Analysis of Structural and Machine Members: Plane stress, plane strain, and axisymmetric components, Engine components: Piston, Biomedical Applications – Dental and Bone Crack propagation.

PRACTICES:

- To study the buckling behavior of connecting rod.
- To find natural frequencies and mode shapes of single rotor system.
- To determine the contact stresses during indentation.
- To simulate the mode shapes of I.C engine block in Ansys workbench.
- To carry out coupled field analysis of boiler/pressure vessel Ansys workbench.

SKILLS:

- ✓ *Formulate and apply FEM for linear Partial Differential Equation problems.*
- ✓ *Solve the system of equations using numerical method.*
- ✓ *Acquire the use of analysis packages and programming.*
- ✓ *Interpret the results obtained and prepare report.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Identify appropriate elements for structural & heat transfer problems.	Apply	1	1, 2
2	Apply suitable element equations for given application.	Apply	2	1, 2
3	Evaluate nodal solution for structural & heat transfer problems.	Evaluate	1	1, 2, 4
4	Solve structural/thermal field problems using analysis package.	Analyze	2	1, 2, 4

TEXT BOOKS:

1. Gang Li, “Introduction to Finite Element Method and Implementation with MATLAB”, Cambridge University Press, 1st Edition, 2021.
2. Daryl L Logan, “A First Course in the Finite Element method”, Cengage Learning, 6th Edition, 2017.

REFERENCE BOOKS:

1. J.N. Reddy, Introduction to Finite Element Method, McGraw Hill, 4th Edition, 2020.
2. Z. Yang, “Finite Element Analysis for Biomedical Applications”, Taylor & Francis, 1st Edition, 2018.
3. Ashok D. Belegundu, Chandrupatla, Introduction to Finite Elements in Engineering, Pearson 4th Edition, 2015.

22RA954 MECHANICS OF MATERIALS

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Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Fundamental physics, Mathematics, Engineering mechanics.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the fundamental concepts of mechanics of deformable solids, stress analysis and deflections. The objective of this course is to determine the effect of forces and moments on engineering structures like beams, shafts subjected to various loads.

MODULE-1

UNIT-1 **9L+6T+0P=15 Hours**

Simple Stresses and Strains: Classification of Stresses and Strains, Elastic Constants, Thermal Stresses, Principal stresses. Beams, supports and their reactions, Shear force and bending moment at a section.

UNIT-2 **15L+10T+0P=25 Hours**

Stress Analysis, SFD and BMD: Stress-strain diagrams in tension, True vs Engineering stress-strain, Stresses on simple bars, stepped bars, compound bars due to forces applied and temperature change, Stresses on inclined planes, Principal stress, Mohr's circle, Shear force and bending moment diagrams.

PRACTICES:

- To study the behavior of beams subjected to bending loads.
- To determine the Modulus of elasticity of a material subjected to tension.
- To determine the hardness of a material.
- To determine the impact strength of material.

MODULE-2

UNIT-1 **9L+6T+0P=15 Hours**

Bending and Torsion: Theory of simple bending, Flexure formula, Bending and shear stresses distribution in various beam sections, unsymmetrical bending. Torsional shear stresses in circular and non-circular shafts, power transmission capacity of shafts,

UNIT-2 **15L+10T+0P=25 Hours**

Bending and Torsion Stresses in Machine Member: Application of area moment of inertia in the estimation of stresses in beams, Determination of maximum slope and deflection of beams. Shear stresses in shafts due to twisting moment, material saving in the design of hollow and solid shafts for same strength and rigidity.

PRACTICES:

- To estimate the bending stress of beams subjected to point loads.
- To estimate the deflection of beams subjected to transverse loads.
- To determine the Modulus of rigidity of a material subjected to torsion.
- To estimate the torsional shear stress and angle of twist of shafts subjected to twisting moment.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Determine the stress, strain due to external force, temperature change.	Apply	1	1, 2
2	Plot shear force and bending moment diagrams for different beams and loading.	Apply	1	1, 2
3	Estimate the bending stresses, shear stresses for beam sections subjected to different boundary and loading.	Analyze	2	1, 2
4	Calculate torsional shear stress, modulus of rigidity of shaft materials subjected to twisting moment.	Evaluate	2	1, 2

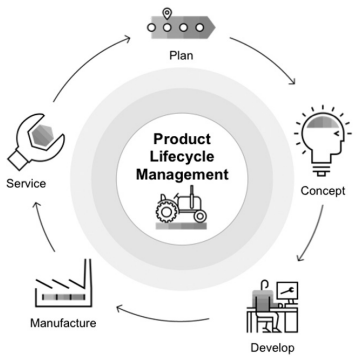
TEXT BOOKS:

1. Timoshenko S. P., Elements of Strength of Materials,East-West Press, 5th e, 2021
2. Ferdinand Beer, Mechanics of Materials, McGraw Hill Education, 8th Edition, 2020

REFERENCE BOOKS:

1. Robert L. Mott and Joseph A.Applied Strength of Materials, CRC Press, 6th e, 2017
2. S S. Rattan, “Strength of Materials”, 3rd edition, Mc.Graw Hill, 2016.

22RA955 PRODUCT LIFE CYCLE MANAGEMENT



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Hours Per Week :

L	T	P	C
3	2	0	4

PREREQUISITE KNOWLEDGE: Basics of Management Concepts.

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with in-depth concepts of product development through its life cycle at various stages. The objective of this course is to enable the students to develop an optimal product life cycle designs.

MODULE-1

UNIT-1 **9L+6T+0P=15 Hours**

Introduction: Background, Overview, Need, Benefits, Concept of Product Life Cycle. Components / Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement.

UNIT-2 **15L+10T+0P=25 Hours**

Product Life Cycle Environment: Product Data and Product Workflow, Company's PLM vision, The PLM Strategy, Principles for PLM strategy, Preparing for the PLM strategy, Developing a PLM strategy, Strategy identification and selection, Change Management for PLM.

PRACTICES:

- Design a life cycle chart of any engineering product.
- Create suitable PLM strategy with respect to customer requirement.
- Identify tools required and work process flow for a given product.

MODULE-2

UNIT-1 **9L+6T+0P=15 Hours**

Product Development Process & Methodologies: Integrated Product development process - Conceive - Specification, Concept design, Design - Detailed design, Validation and analysis (simulation), Tool design, Realize – Plan manufacturing , Manufacture, Build/Assemble , Test (quality check) , Service - Sell and Deliver , Use , Maintain and Support, Dispose. Bottom-up design, Top-down design, Front loading design workflow, Design in context, Modular design.

UNIT-2 **15L+10T+0P=25 Hours**

Product Development Methodologies & Analysis Tools: Concurrent engineering - work structuring and team Deployment - Product and process systemization - problem, identification and solving methodologies. Product Reliability, Mortality Curve. Design for Manufacturing, Design for Assembly. Design for Six Sigma.

Probabilistic design concepts-FMEA-QFD-Taguchi Method for design of experiments - Design for product life cycle. Estimation of Manufacturing costs, Reducing the component costs and assembly costs, Minimize system complexity.

PRACTICES:

- Analyze process control using SPC Charts.
- Perform failure mode effect analysis of a product.
- Develop appropriate soft computing algorithms in product development process.

SKILLS:

- ✓ *Formulate a process plan for production of Gear Box.*
- ✓ *Identify the non-conformance of washers in a given lot.*
- ✓ *Perform failure mode analysis of a rotor system.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Develop suitable strategic plan in accordance with customer requirements and company policy.	Analyze	1	1, 2
2	Build optimal process plans and work flow from start to end of product manufacturing.	Apply	1	1, 2
3	Evaluate process controllability charts to monitor outliers of process parameters.	Analyze	2	1, 2
4	Create minimal cost base product life cycle designs with higher reliability.	Analyze	2	1, 2

TEXT BOOKS:

1. Grieves, Michael. Product Lifecycle Management, McGraw-Hill, ISBN 0071452303, 1st Edition, 2006.

REFERENCE BOOKS:

1. Antti Saaksvuori, Anselmi Immonen, “Product Life Cycle Management”, Springer, (Nov.5, 2003), 1st Edition, 2003.
2. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realisation, Springer-Verlag, ISBN 1852338105, 1st Edition, 2004.
3. Product Design & Process Engineering, McGraw Hill – Kogalkusha Ltd., Tokyo, 1st Edition, 1974.