NATIONAL ENGINEERING COLLEGE

(An Autonomous Institution Affiliated to Anna University Chennai)

K.R.NAGAR, KOVILPATTI

www.nec.edu.in

REGULATIONS – 2023

CURRICULUM & SYLLABUS

B. E. – MECHANICAL ENGINEERING

(Outcome Based Education & Choice Based Credit System)

DEPARTMENT OF MECHANICAL ENGINEERING

I. VISION

Producing globally competitive Mechanical Engineers with social responsibilities

II. MISSION

- Imparting quality education by providing excellent Teaching-Learning environment.
- Inculcating qualities of continuous learning, professionalism, team spirit, communication skill and leadership with social responsibilities.
- Promoting leading-edge research and development through collaboration with academia and industry.

III. PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 1: Graduates will have successful profession in Mechanical/allied Industries or Research /Academics or business enterprise.

PEO 2: Graduates will broaden their horizons beyond Mechanical Engineering to address the societal and environmental concerns.

PEO 3: Graduates will have the attitudes and abilities of leaders to adapt the changing global scenario.

IV. PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 1: Apply the concepts of Engineering Design to design, analyze and develop the Mechanical components and systems using the different analytical/CAD/experimental tools.

PSO 2: Apply the concepts of Thermal Engineering to design, analyze and develop the flow and energy systems using the different analytical/experimental/software tools.

PSO 3: Apply the concepts of Production and Industrial Engineering for analysis, optimization and development of mechanical systems.

V. PROGRAM OUTCOMES (POs)

PO 1: **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: **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.

PO 3: **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.

PO 4: **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.

PO 5: **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.

PO 6: **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.

PO 7: **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.

PO 8: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: **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.

PO 11: **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.

PO 12: **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.

REGULATIONS 2023

Curriculum and Syllabus

SEMESTER – I

S. No	Course Code	Course Title	Category	Periods Per Week				Total Contact Periods	Credits
				L	T	P	E		
Induction Programme – 2 weeks									**0**
Theory Courses									
1.	23SH11C	தமிழர்மரபு/ Heritage of Tamils	HSMC	1	0	0	0	1	1
2.	23SH12C	Mathematical Foundations for Engineers	BSC	3	1	0	0	4	4
3.	23SH13C	Introduction to Engineering	ESC	1	0	0	0	1	1
4.	23GN01C	Aptitude Essentials	EEC	1	0	0	0	1	1
Integrated Courses									
5.	23SH14C	Technical English	HSMC	1	0	2	0	3	2
6.	23SH15C	Engineering Physics	BSC	2	0	2	0	4	3
7.	23SH16C	Engineering Chemistry	BSC	2	0	2	0	4	3
8.	23ME11C	Engineering Graphics	ESC	2	0	4	0	6	4
			TOTAL	**13**	**1**	**10**	**0**	**24**	**19**

SEMESTER - II

S. No	Course Code	Course Title	Category	Periods Per Week				Total Contact Periods	Credits
				L	T	P	E		
Theory Courses									
1.	23SH21C	தமிழரும்தொழில்நுட்பமும் /Tamils and Technology	HSMC	1	0	0	0	1	1
2.	23GN05C	Professional Ethics and Human Values	HSMC	2	0	0	0	2	2
3.	23ME21C	Fourier Series, Complex Analysis and Calculus	BSC	3	1	0	0	4	4
4.	23ME22C	Materials Science	ESC	2	0	0	0	2	2
5.	23ME23C	Engineering Mechanics	ESC	3	1	0	0	4	4
Integrated Courses									
6.	23SH22C	Professional English	HSMC	1	0	2	0	3	2
7.	23CS11C	Problem Solving Techniques	ESC	3	0	2	0	5	4
8.	23EE13C	Fundamentals of Electrical and Electronics Engineering	ESC	3	0	2	0	5	4
Practical Courses									
9.	23GN02C	Innovation through Design Thinking	EEC	0	0	0	4	4	2
			TOTAL	**18**	**2**	**6**	**4**	**30**	**25**

SEMESTER – III

S. No	Course Code	Course Title	Category	Periods Per Week				Total Contact Periods	Credits
				L	T	P	E		
Theory Courses									
1.	23ME31C	Engineering Thermodynamics	ESC	3	1	0	0	4	4
2.	23ME32C	Statistics and Numerical Methods	BSC	3	1	0	0	4	4
3.	23MC02C	Environmental Science and Engineering	MC	2	0	0	0	2	0
Integrated Courses									
4.	23ME33C	Basic Manufacturing Processes	PCC	3	0	2	0	5	4
5.	23ME34C	Fluid Mechanics and Hydraulic Machines	PCC	2	1	2	0	5	4
6.	23ME35C	Materials Engineering	PCC	2	0	2	0	4	3
7.	23ME36C	Kinematics of Machinery	PCC	3	0	0	2	5	4
Practical Courses									
8.	23GN03C	Intellectual Property Rights Study	EEC	0	0	0	4	4	2
9.	23GN04C	Aptitude Excellence	EEC	0	0	2	0	2	1
			TOTAL	**18**	**3**	**8**	**6**	**35**	**26**

SEMESTER – IV

S. No	Course Code	Course Title	Category	Periods Per Week				Total Contact Periods	Credits
				L	T	P	E		
Theory Courses									
1.	23GN06C	Project Management and Finance	HSMC	2	0	0	0	2	2
2.	E1	Open Elective Course – I	OEC	3	0	0	0	3	3
3.	E2	Elective – Science Stream	OEC	3	0	0	0	3	3
4.	23MC01C	Constitution of India	MC	2	0	0	0	2	0
Integrated Courses									
5.	23ME41C	Machining Processes	PCC	3	0	2	0	5	4
6.	23ME42C	Thermal Engineering	PCC	3	0	2	0	5	4
7.	23ME43C	Strength of Materials	PCC	3	0	2	0	5	4
8.	23ME44C	Machine Drawing	PCC	1	0	2	0	3	2
Practical Courses									
9.	23ME45C	System Modeling	EEC	0	0	2	2	4	2
			TOTAL	**20**	**0**	**10**	**2**	**32**	**24**

SEMESTER – V

S. No	Course Code	Course Title	Category	Periods Per Week				Total Contact Periods	Credits
				L	T	P	E		
Theory Courses									
1.	E3	Program Elective Course - I	PEC	3	0	0	0	3	3
Integrated Courses									
2.	23ME51C	Heat and Mass Transfer	PCC	2	1	2	0	5	4
3.	23ME52C	Dynamics of Machinery	PCC	2	1	2	0	5	4
4.	23ME53C	Mechatronics, Robotics & Control	PCC	2	0	0	2	4	3
5.	23ME54C	CAD/CAM	PCC	2	0	2	2	6	4
6.	E4	Program Elective Course - II	PEC	2	0	0	2	4	3
Practical Courses									
7.	23ME55C	IoT Laboratory	PCC	0	0	2	0	2	1
8.	23ME56C	Simulation using Modern tool	EEC	0	0	2	2	4	2
			TOTAL	**13**	**2**	**10**	**8**	**33**	**24**

SEMESTER – VI

S. No	Course Code	Course Title	Category	Periods Per Week				Total Contact Periods	Credits
				L	T	P	E		
Theory Courses									
1.	23ME61C	Design for Manufacturing & Assembly	PCC	3	0	0	0	3	3
2.	23ME62C	Industrial Engineering	PCC	3	0	0	0	3	3
3.	E5	Open Elective Course - II	OEC	3	0	0	0	3	3
Integrated Courses									
4.	23ME63C	Engineering Metrology and Measurements	PCC	2	0	2	0	4	3
5.	23ME64C	Machine Elements and system Design	PCC	3	1	0	2	6	5
6.	23ME65C	Computer Aided Analysis	PCC	2	0	2	2	6	4
7.	E6	Program Elective Course - III	PEC	2	0	0	2	4	3
Practical Courses									
8.	23ME66C	Product Development Practice	EEC	0	0	2	2	4	2
			TOTAL	**18**	**1**	**6**	**8**	**33**	**26**

SEMESTER – VII

S. No	Course Code	Course Title	Category	Periods Per Week				Total Contact Periods	Credits
				L	T	P	E		
Theory Courses									
1.	E7	Open Elective Course - III	OEC	3	0	0	0	3	3
Integrated Courses									
2.	E8	Program Elective Course - IV	PEC	3	0	0	0	3	3
3.	E9	Program Elective Course - V	PEC	3	0	0	0	3	3
4.	E10	Program Elective Course - VI	PEC	3	0	0	0	3	3
Practical Courses									
5.	23ME71C	Mini Project	EEC	0	0	0	6	6	3
6.	23ME72C	Internship	EEC	0	0	0	0	0	2
			TOTAL	**12**	**0**	**0**	**6**	**18**	**17**

SEMESTER – VIII

S. No	Course Code	Course Title	Category	Periods Per Week				Total Contact Periods	Credits
				L	T	P	E		
Practical Course									
1.	23ME81C	Capstone Project/Industry Practice	EEC	0	0	0	12	12	6
			TOTAL	**0**	**0**	**0**	**12**	**12**	**6**

TOTAL CREDITS: 167

Regulation 2023 - VERTICALS FOR HONOURS DEGREE / HONOURS DEGREE WITH SPECIALIZATION / MINOR DEGREE						
Department of Mechanical Engineering						
PROFESSIONAL ELECTIVE COURSES VERTICALS						
Sl No.	**Vertical 1**	**Vertical 2**	**Vertical 3**	**Vertical 4**	**Vertical 5**	**Vertical 6**
	CLEAN AND GREEN TECHNOLOGY	***MODERN MOBILITY SYSTEMS***	***ROBOTICS AND AUTOMATION***	***PRODUCT & PROCESS DEVELOPMENT***	***MATERIAS AND MODERN MANUFACTURING ENGINEERING***	***INDUSTRIAL MANAGEMENT***
1	Renewable Energy Sources	Automobile Engineering	Industrial Robotics	Product Design and Development Strategies	Advanced Machining Processes	Principles of Management
2	Solar Photovoltaic Energy Conversion	Vehicle Systems Design	Mechanics of Robots	Product Life Cycle Management	Quality Control of Welded Structures	Total Quality Management
3	Power Plant Engineering	Fundamentals of Digital Electronics	Control of Robotic Systems	Advanced Engineering Materials	Non-Destructive Evaluation	Operations Research
4	Cogeneration and Waste Heat Recovery	Automotive Electronics	Electrical Drives and Control	Computer Graphics and Virtual Reality	Additive Manufacturing	Marketing Management
5	Energy Conservation in Industries	Hybrid Electrical Vehicles	Mechatronics	Advanced Modeling Techniques	Lean Manufacturing	Production Planning and Control
6	Energy Storage Systems	Thermal Management of Batteries and Fuel Cells	Hydraulics and Pneumatics	Modelling and Simulation	Machine Tool Control	Process Planning and Cost Estimation
7	Energy Efficient Buildings	Automotive Materials Components Design and Testing	MEMS Devices – Design and Fabrication	Piping Design Engineering	Computer Integrated Manufacturing	Engineering Economics and Cost Analysis
8	Fuel Cells & Hydrogen Energy	Automated Guided Vehicles	Industry 4.0		Advanced Engineering Materials	Accounting for Engineers
9	Hybrid Electrical Vehicles		Microprocessor, Microcontroller and Applications			Industrial Safety Engineering

ELECTIVE COURSES (SCIENCE STREAM)

S. No	Course Category	Course Code	Course Name	L	T	P	E	C
MATHEMATICS								
1.	OEC	23SH01E	Linear Algebra, Mathematical Logic and Set Theory	2	1	0	0	3
2.	OEC	23SH02E	Linear Structures and Transformations	2	1	0	0	3
3.	OEC	23SH03E	Number Theory	2	1	0	0	3
4.	OEC	23SH04E	Numerical Analysis	2	1	0	0	3
5.	OEC	23SH05E	Optimization Techniques	2	1	0	0	3
6.	OEC	23SH06E	Principles of Discrete Mathematics	2	1	0	0	3
7.	OEC	23SH07E	Random Processes and Queuing Theory	2	1	0	0	3
8.	OEC	23SH08E	Statistical Techniques and Numerical Methods	2	1	0	0	3
9.	OEC	23SH09E	Transforms, Mathematical Logic and Set Theory	2	1	0	0	3
PHYSICS								
10.	OEC	23SH10E	Fundamentals of Laser Technology	3	0	0	0	3
11.	OEC	23SH11E	Nanomaterials for Engineers	3	0	0	0	3
12.	OEC	23SH12E	Photonics	3	0	0	0	3
CHEMISTRY								
13.	OEC	23SH13E	Biology for Computing	3	0	0	0	3
14.	OEC	23SH14E	Biology for Engineers	3	0	0	0	3
15.	OEC	23SH15E	Polymer Science and Technology	3	0	0	0	3
16.	OEC	23SH16E	Sensors for Engineering Applications	3	0	0	0	3

Course Code	**தமிழர் மரபு (HERITAGE OF TAMILS)**	**L**	**T**	**P**	**E**	**C**
23SH11C	(Common to all B.E. / B.Tech. Degree Programmes)	**1**	**0**	**0**	**0**	**1**

COURSE OUTCOMES

இப்பாடம் முடிந்ததும் மாணவர்களிடம் வளரும் திறன்

CO1:தமிழ் மொழியின் இலக்கிய வளம்,ஓவிய,சிற்பக் கலையின் பரிணாம வளர்ச்சி நாட்டுப்புறக் கலை மற்றும் வீர விளையாட்டுக்கள் பற்றிய அறிவு மற்றும் விளக்கும் திறன்

CO2:தமிழர்களின் திணைசார் கோட்பாடுகள் மற்றும் இந்திய பண்பாட்டில் தமிழர்களின் பங்கு பற்றிய அறிவு மற்றும் விளக்கும் திறன்

Upon the successful completion of the course, the student will be able to

Theory Component

CO1: know and explain about Tamil literary resources, Dimensional growth of painting and sculpture arts, folk art and martial arts.

CO2: know and explain about Tamils Thinai concepts, contribution of Tamils in Indian National Movements and Indian Culture

CO1:தமிழ் மொழியின் இலக்கிய வளம், ஓவிய,சிற்பக் கலையின் பரிணாம வளர்ச்சி நாட்டுப் புறக் கலை மற்றும் வீரவிளையாட்டுக்கள் பற்றிய அறிவு மற்றும் விளக்கும் திறன் **L:9**

இந்திய மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி –தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் - திருக்குறளில் மேலாண்மைக் கருத்துக்கள் - தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் - சிற்றிலக்கியங்கள் - தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி - தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு - நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள் - பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் - தேர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரிமுனையில் திருவள்ளுவர் சிலை - இசைக் கருவிகள் - மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் - தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு - தெருக் கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல் பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம்,தமிழர்களின் விளையாட்டுகள்.

CO1: know andexplain about Tamil literary resources, Dimensional growth of painting and sculpture arts, folk art and martial arts.

Language Families in India - Dravidian Languages – Tamil as a Classical Language – Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature- Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land- Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modernliterature in Tamil - Contribution of Bharathiyar and Bharathidhasan - Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple carmaking - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils - Therukoothu, Karagattam, VilluPattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam,Valari, Tiger dance - Sports and Games of Tamils.

CO2:தமிழர்களின் திணைசார் கோட்பாடுகள் மற்றும் இந்திய பண்பாட்டில் தமிழர்களின் பங்கு பற்றிய அறிவு மற்றும் விளக்கும் திறன் **L:6**

தமிழகத்தின் தாவரங்களும்,விலங்குகளும் - தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் - தமிழர்கள் போற்றிய அறக்கோட்பாடு–சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் - சங்ககால நகரங்களும் துறைமுகங்களும் - சங்க காலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி கடல் கடந்த நாடுகளில் சோழர்களின் வெற்றி - இந்திய விடுதலைப் போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப் படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

CO2: know andexplain about Tamils Thinaiconcepts, contribution of Tamils in Indian National Movements and Indian Culture

Flora and Fauna of Tamils &Aham and Puram Concept from Tholkappiyam and Sangam Literature -Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports ofSangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas - Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the otherparts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems ofMedicine – Inscriptions & Manuscripts – Print History of Tamil Books.

REFERENCES:

1. தமிழக வரலாறு–மக்களும் பண்பாடும் - கே.கே.பிள்ளை (வெளியீடு : தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் - முனைவர். இல.சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி–வைகை நதிக்கரையில் சங்ககால நகர நாகரீகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை–ஆற்றங்கரை நாகரீகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - ‘Sangam City Civilization on the banks of river Vaigai’ (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

L: 15; TOTAL: 15 PERIODS

Course Code	MATHEMATICAL FOUNDATIONS FOR ENGINEERS	L	T	P	E	C
23SH12C	(Common to all B.E. / B.Tech. Degree Programmes)	**3**	**1**	**0**	**0**	**4**

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Component

CO1: interpretthe nature of quadratic form by orthogonal transformation.
CO2: identify the maxima and minima of functions.
CO3: solve ordinary differential equations.
CO4: find the solution of partial differential equations.
CO5: evaluate integrals of multivariate calculus.

Soft skill Component

CO6 : develop communication, problem solving and interpersonal skills

L:9, T:3

CO1: interpret the nature of quadratic form by orthogonal transformation.

Characteristic equation – Eigen values and Eigen vectors of a real matrix – Properties of Eigen values and Eigen vectors – Diagonalisation of a matrix by orthogonal transformation – Quadratic forms – Reduction of quadratic form to canonical form by orthogonal transformation and its nature; Cayley – Hamilton theorem (excluding proof) - Application: Stretching of a elastic membrane.

CO2: identify the maxima and minima of functions. **L:9, T:3**

Functions of two variables: Limit, continuity and partial derivatives; Total derivative, Jacobian, Taylor series- Application :Linearization of Non Linear systems using Taylor Series - Maxima and minima - Method of Lagrange multipliers.

CO3: solve ordinary differential equations. **L:9, T:3**

Solutions of first order ordinary differential equations - Equations solvable for ‘p’, equations solvable for ‘y’, equations solvable for ‘x’ - Solutions of higher order linear differential equations with constant coefficients – Cauchy’s and Legendre’s linear equations - Method of variation of parameters – Solution of simultaneous linear differential equation. Application RCL – circuit and Mass Spring System.

CO4: find the solution of partial differential equations. **L:9, T:3**

Formation of partial differential equations – Solutions of standard types of first order partial differential equations - Lagrange’s linear equations - Solutions of homogeneous and Non homogeneous linear partial differential equations of second and higher order with constant coefficient – Application - Shallow wave equations of first order PDE.

CO5 : evaluate integrals of multivariate calculus **L:9, T:3**

Double integration – Cartesian and polar coordinates - Change of order of integration - Change of variables - Cartesian to polar coordinates - Area as double integral - Triple integration - Cartesian and polar coordinates – Change of Variables- Cartesian to spherical and cylindrical coordinates. Application – Moments and centers of mass.

TEXT BOOKS:

1. Grewal.B.S., Higher Engineering Mathematics, Khanna Publications, 44th Edition, 2021.
2. James E. Gentle, Matrix Algebra, Springer International Publishing, 2nd Edition, 2017
3. ShankerRao.G., Linear Albebra, WileyIndia, 1st Edition , 2017

REFERENCES:

1. Bali.N.P. and Manish Goyal, A Textbook of Engineering Mathematics, Laxmi Publications Private Limited, 10th Edition, 2016.
2. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India, 10th Edition, 2017.
3. Kenneth B. Howell, Ordinary Differential Equations, CRC Press, 2020.
4. James Strewart, Daniel Clegg, Saleem Watson, Essential Calculus Early Trancendentals, Cengage Learning, 9th Edition, 2021.
5. Nanda Kumar A.K, P.S.Datti: Raju .K.George , Ordinary Differential Equations, Cambridge University press, 2017.

L: 45; T: 15; TOTAL: 60 PERIODS

Course Code	INTRODUCTION TO ENGINEERING	L	T	P	E	C
23SH13C	(Common to all B.E. / B.Tech. Degree Programmes)	**1**	**0**	**0**	**0**	**1**

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Component

CO1: articulate the importance of Engineering and its role in society through OBE framework
CO2: identify and describe academic pathways towards career settlement

CO1: articulate the importance of Engineering and its role in society through OBE framework **L:9**

Engineering – An introduction, Classification of different Engineering Disciplines, Role of Engineers in Society. Graduate Attributes (GA), Program Specific Criteria (PSC)- Program Educational Objectives (PEO), Program Outcomes (PO), Course Outcomes (CO), Choice Based Credit System (CBCS), course categories, teaching and learning process, active and passive learning, project / problem based learning, different assessments process.

CO2: identify and describe academic pathways towards career settlement **L:6**

Curriculum, cafeteria curriculum and self learning big picture of the Program and the significance of each course in the undergraduate Engineering Program, Discuss the different career paths for an engineering graduate. Career objective, competency requirement.

Case study: Each student has to interact with alumni mentors/seniors/faculty members/surf the internet and present a career path that inspires him/her at the end of the course

REFERENCES:

1. Quamrul H. MazumderIntroduction to Engineering, An Assessment and Problem Solving Approach, CRC Press, 1st Edition, 2016.
2. Saeed Moaveni, "Engineering Fundamentals an Introduction to Engineering", Cengage Learning, USA, 4th Edition, 2011.

L: 15; TOTAL: 15 PERIODS

Course Code	APTITUDE ESSENTIALS	L	T	P	E	C
23GN01C	(Common to all B.E. / B.Tech. Degree Programmes)	**1**	**0**	**0**	**0**	**1**

COURSE OUTCOMES:

Upon the completion of the course the students will be able to

CO1: Recall the fundamentals in quantitative techniques and solve Number series problems quickly
CO2: Develop problem solving skills on Numbers and enhance arithmetic ability
CO3: Infer appropriate comparison and distribution methods using ratio and to form equations
CO4: Improve quantitative skills and solve problems on percentages and profit loss
CO5: Calculate data interpretation and data sufficiency in quantitative aptitude

CO1: Recall the fundamentals in quantitative techniques and solve Number series problems quickly **L : 3**

Numeric series – Finding missing numbers – Odd number out series - Letter series – Symbol series - Alphanumeric series

CO2: Develop problem solving skills on Numbers and enhance arithmetic ability **L : 3**

Number Types - HCF & LCM – Square root- Cubic root - divisibility criteria- Unit digit calculation- Prime factors

CO3: Infer appropriate comparison and distribution methods using ratio and to form equations **L : 3**

Ratio & Proportion: Comparison of Ratios - Variations: Direct and indirect proportionAges: Present Age, Past Age & Future calculation

CO4: Improve quantitative skills and solve problems on percentage and profit loss **L : 3**

Concept of Percentage – Percentage calculation - Calculation of Percentage on Population Results on Depreciation .Profit and Loss –Percentage of Profit and Loss – Discount

CO5: Calculate data interpretation and data sufficiency in quantitative aptitude **L : 3**

Data Interpretation – Pie Chart – Bar Chart – Table Chart .Data Sufficiency in Logical Reasoning : Numbers, Ratio, Ages, Percentage and Profit Loss

REFERENCES:

1. Dr.R.Aggarwal, " Quantitative Aptitude", S Chand Publishing, Revised Edition 2017
2. R.V.Praveen, "Quantitative Aptitude and Reasoning" , 3rd Edition , Eastern Economy Edition, PHI Learning 2016

Video Materials
Profit Loss
https://youtu.be/PpVO7I8dx6U
https://youtu.be/_cW7_BUDYcw
Number series
https://youtu.be/_4ZJFkFE2XU
https://youtu.be/83nJmniFmNk
Numbers
https://youtu.be/81pwuMJ8OIU
https://youtu.be/VT_N9cacgl4
Square root and Cube root
https://youtu.be/nJSqsaT0AgU
https://youtu.be/_HyhwS8P9KY
Problems on Ages
https://youtu.be/6PCTRVmu-ek
https://youtu.be/eAl3BvO_Ipw
Data Interpretation
https://youtu.be/s99rda8e0vc

L: 15; TOTAL: 15 PERIODS

Course Code	TECHNICAL ENGLISH	L	T	P	E	C
23SH14C	(Common to all B.E. / B.Tech. Degree Programmes)	**1**	**0**	**2**	**0**	**2**

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Component

CO1: apply the fundamental grammar rules in writing
CO2: utilizing phonetic transcription for pronunciation

Practical Component

CO3: apply the basic language skills in various aspects of communication
CO4: utilize technical terms and phrases in specific contexts
CO5: develop the pronunciation skill through various language components
CO6: distinguish different writing forms and interpret text through divergent thinking
CO7: develop effective reports with grammatical and language components

Soft skill Component

CO8: develop communication, team spirit, creativity and time management

CO1: apply the fundamental grammar rules in writing **L:13, P:26**

Parts of Speech - Word Formation using Prefix and Suffix - Sentence formation (Kinds of Sentences) - Tenses (Present, Past & Future tense) – Concord

CO3: apply the basic language skills in various aspects of communication

Diary Writing - Greeting and Self Introduction

CO4: utilize technical terms and phrases in specific contexts

Technical terms and extended definition - Essay Writing (Argumentative Essay and Analytical Essay) - Situational phrases & Conversation - Formal Letter Writing (Permission & Requisition letters)

CO6: distinguish different writing forms and interpret text through divergent thinking

Picture Description, Introduction to Reading Techniques (Skimming, scanning, inferring, predicting, Reading and Reviewing a book (Sci – Fi), E Mail Writing

CO7: develop effective reports with grammatical and language components
Listening and responding to general information (Business context) - Report Writing (Types, Structure, and Stages of report writing) - Checklist

CO2:utilizing phonetic transcription for pronunciation **L:2, P:4**

Phonetics (Vowels & Consonants)

CO5: develop the pronunciation skill through various language components

Word Transformation from one form to another - Letter Writing (Informal) - Listening and responding to general information (General context)

TEXT BOOKS:

1. Paul V. Anderson, Technical Communication: A Reader - Centered Approach, Cengage Learning, 9th Edition, 2017.
2. RavindraNath Tiwari, Technical English-II, Shashwat Publication, 1st Edition, 2020.
3. Stephen D. Krashen, Principles and Practice in Second LanguageAcquisition. Pergamon, 1987.
4. Lester Kaufman and Jane Straus, The Blue Book of Grammar and Punctuation: An Easy-to Use Guide with Clear Rules, Real-World Examples, and Reproducible Quizzes, Wiley, 2021.
5. Wells H. G., The Time Machine, Penguin Classics, 2012.

REFERENCES:

1. Michael McCarthy, English Grammar: The Basics, Taylor & Francis, 2021.
2. Peter Lucantoni and Lydia Kellas, Cambridge IGCSE(TM) English as a Second Language Workbook, Cambridge University Press, 6th Edition, 2022.

L: 15; P: 30; TOTAL: 45 PERIODS

Course Code	ENGINEERING PHYSICS	L	T	P	E	C
23SH15C	(Common to all B.E. / B.Tech. Degree Programmes)	**2**	**0**	**2**	**0**	**3**

COURSE OUTCOMES:

Upon the successful completion of the course, the student will be able to

Theory Components:

CO1: identify the structural properties of crystalline materials
CO2: comprehend and apply the concepts of centre of mass and elasticity
CO3: explain thermodynamic parameters and fundamental laws and their application in various processes
CO4: illustrate the applications of different lasers and optical fibers
CO5:interpret the quantum concepts, to illustrate the quantization of energy, and computation

Practical Components:

CO6: compare the mechanical properties of the materials due to bending and torsion
CO7: analyze thermal conductivity of different bad conducting materials
CO8: explore the light-matter interaction by the phenomenon of interference and diffraction and photoelectric effect

Soft skill Component:

CO9: develop the team spirit and communication skill through group activities

CO1: identify the structural properties of crystalline materials **L:10**

Crystalline and amorphous materials - unit cell - primitive cell - crystal systems, Bravais lattices - Miller indices – interplanar distance – Characteristics of SC, BCC, FCC, HCP structures - Bragg's law - X-ray diffraction and its applications - Synthesis of crystalline materials

CO2: comprehend and apply the concepts of centre of mass and elasticity **L:6,**

CO6: compare the mechanical properties of the materials due to bending and torsion **P:10**

Multi-particle dynamics - Introduction - Center of mass (CM) – CM of continuous bodies - Introduction to rigid bodies - translation - rotation – moment of inertia – theorems of moment of inertia – Torsional pendulum.

Elasticity – Stress - strain diagram and its applications - Moduli of elasticity and its relation - bending of beams - Bending moment – cantilever - theory and experiment - Uniform bending - theory and experiment – Non Uniform bending - I-shaped girders

CO3: explain thermodynamic parameters and fundamental laws and their application in various processes **L:6, P:8**

CO7: analyse thermal conductivity of different bad conducting materials.

Laws of thermodynamics –Thermo dynamical processes – Introduction to heat transfer – conduction - convection and radiation – thermal conductivity of good conductor –Radial flow of heat - Spherical shell method and cylindrical shell method – Thermal conductivity of poor conductor - Lee's disc method– Applications - heat exchangers - refrigerators and ovens

CO4: illustrate the applications of different lasers and optical fibers **L:6,**

CO8: explore the light-matter interaction by the phenomenon of Interference and diffraction and photoelectric effect **P:6**

Lasers: Interaction of light with matter - Einstein coefficients and their relations – characteristics of laser - components of laser – Lasing action – Pumping methods – Types of Laser - Nd-YAG laser -semiconductor laser- Applications

Fiber optics: principle and classification of optical fibers – propagation of light in optical fiber - Numerical aperture and Acceptance angle – losses associated with optical fibers (Qualitative) – Fiber optic communication system - Applications - Displacement and pressure sensors – Endoscopy

CO5: interpret the quantum concepts, to illustrate the quantization of energy, and computation **L:6, P:2**

CO8: explore the light-matter interaction by the phenomenon of interference and diffraction and photoelectric effect

Planck's radiation law - de-Broglie hypothesis – Matter waves - Heisenberg's uncertainty principle – elementary proof – applications – Schrödinger's time-dependent and time-independent wave equation – physical significance of wave function – Introduction to quantum tunneling - applications - particle in a one-dimensional box – tunneling microscope – quantum confinement in 0D, 1D, 2D systems - quantum computation

TEXT BOOKS:

1. AvadhanuluM. N., KshirsagarP.G and Arun MurthyT.V.S, A Text book of Engineering Physics, S.Chand& Co, 11th Edition, 2018.
2. Kleppner D and Kolenkow R. An Introduction to Mechanics. McGraw Hill Education (Indian Edition), 2017.
3. Kenneth S Krane, Modern Physics, Wiley, 4th Edition, 2021.

REFERENCES:

1. WolfsonR., Essential University Physics, Volume 1 & 2, Pearson Education, 2ndIndian Edition, 2009.
2. Hitendra K. Malik, A.K. Singh, Engineering Physics, McGraw Hill Education, 2nd Edition, 2017.
3. Kyungwon An, Fundamentals of Laser Physics, World Scientific Publishing Company, 2023
4. HallidayD, Resnick R andWalker J, Principles of Physics, Wiley, 12th Edition, 2021.

L: 30; P: 30; TOTAL: 60 PERIODS

Course Code	ENGINEERING CHEMISTRY	L	T	P	E	C
23SH16C	(Common to all B.E. / B.Tech. Degree Programmes)	2	0	2	0	3

COURSE OUTCOMES:

Upon the successful completion of the course, the student will be able to

Theory Component:

CO1: explain the suitable water treatment technologies for domestic and industrial applications

CO2: apply the knowledge of corrosion to solve the industrial problems

CO3: describe the preparation, properties and their applications of smart materials in various sectors

CO4: describe the basic components and performance analysis of batteries

CO5: predict the mechanical, electrical and electronics properties of materials using various instrumentation techniques

Practical Component:

CO6: estimate the amount of Ca^{2+}/ Mg^{2+}, alkalinity and Chloride ion present in the water sample.

CO7: quantify the amount of acid and metal ion in the given samples by different analytical techniques

Soft skill Component:

CO8: develop interpersonal, work ethics and communications skills for career settlement

CO1: explain the suitable water treatment technologies for domestic and industrial applications

CO6: estimate the amount of Ca^{2+}/ Mg^{2+}, alkalinity and Chloride ion present in the water sample.

L:6, P:12

Introduction, sources and impurities in water, potable water specifications (as per WHO and BIS) - hardness-types-estimation of $Ca^{2+}$and Mg^{2+} ion in water by EDTA method. Alkalinity-types-determination of alkalinity of water -chronic daily intake - incremental life time risk - hazard quotient, hazard index, contamination factor - determination of chloride ion in water using Argentometric method-municipal water treatment- physical

methods and chemical methods. Disinfection-internal conditioning - calgon and carbonate conditioning. Desalination-types-Reverse Osmosis (RO) process- Forward osmosis (FO) - electro dialysis - demineralization.

CO2: apply the knowledge of corrosion to solve the industrial problems.

CO7: quantify the amount of acid and metal ion in the given samples by different analytical techniques

Corrosion – mechanism of dry and wet corrosion-forms of corrosion– galvanic corrosion and differential aeration corrosion, crevice corrosion, pitting corrosion, microbial corrosion-stress corrosion, intergranular corrosion - determination of rate of corrosion by weight loss method. **L:6, P:6**

Protection: cathodic protection, surface coatings, corrosion inhibitors. Corrosion of industrial components: corrosion and its control in power industries, automotive industries, chemical processing industries and marine industries.

CO3: describe the preparation, properties and their applications of smart materials in various sectors

Polymers: introduction - classification - functional polymers: electroluminescence polymer, biodegradable polymers, fire retardant polymer, thermo responsive polymer - piezo, ferro and pyroelectric polymer - nanocomposites: introduction, synthesis, properties & applications- synthesis of nanocomposites using sol -gel process **L:6**

CO4: describe the basic components and performance analysis of batteries

Introduction - components - operation principle - Lead acid – Nickel metal hydride batteries- Lithium ions batteries: Lithium polymer battery, Lithium sulphur battery - fabrication and performance evaluation- safety issues - battery management system - recycling of lithium batteries. **L:6**

CO5: predict the mechanical, electrical and electronics properties of materials using various instrumentation techniques

CO7: quantify the amount of acid and metal ion in the given samples by different analytical techniques.

Spectroscopy methods: Beer-Lambert's law and its limitations– UV-visible spectroscopy and IR spectroscopy – principle - instrumentation– applications. Estimation of copper. Electro analytical methods: potentiometric titration - Estimation of Fe^{2+} ion by potentiotometric method. Conductometric method- estimation of HCl by conductometric titration- pH metric method-Estimation of HCl by pH metric titration-applications. Thermal analytical methods: Thermal Gravimetric Analysis (TGA) and Differential Thermal Analysis (DTA)- Thermo Mechanical Analysis (TMA) –principle - instrumentation - Thermo gravimetric analysis of $CuSO_4.5H_2O$- applications. **L:6, P:12**

TEXT BOOKS:

1. Jain P.C. and Jain M, Engineering Chemistry, DhanpatRai Publishing Company, New Delhi, 17th Edition, 2021.
2. Dara S.S and Umare S.S, A Text Book of Engineering Chemistry, S.Chand& Company Limited, 20th Edition, 2018.
3. Agarwal S, Engineering Chemistry, Cambridge Publishing Company, 2nd Edition, 2019

REFERENCES:

1. Benjamin M. M, Water Chemistry, Waveland Press, 2nd Edition, 2019.
2. Cicek V, Corrosion Engineering, Springer Publishing, 1st Edition, 2021.
3. Shahinpoor. M, Fundamentals of Smart Materials, Publisher: Royal Society of Chemistry, 1st Edition, 2020.

4. Berg H, Bernhardsson S, and Johansson P, Electric Vehicle Batteries: Moving from Research towards Innovation, Publisher: Springer, 1st Edition, 2019.
5. Crouch S, Skoog D, Holler F, Principles of Instrumental Analysis, 2017.

L: 30; P: 30; TOTAL: 60 PERIODS

Course Code	PROBLEM SOLVING TECHNIQUES	L	T	P	E	C
23CS11C	(Common to all B.E. / B.Tech. Degree Programmes)	3	0	2	0	4

COURSE OUTCOMES:

Upon the successful completion of the course, the student will be able to

Theroy Component:

CO1: apply fundamentals of problem solving techniques to develop simple algorithms for arithmetic and logical problems

CO2: apply fundamental, sequential, conditional logic statements and arrays for solving basic problems

CO3: implement modular programming concept using user defined functions

CO4: inscribe programs using pointers and to allocate memory for user defined data types using dynamic memory management functions

CO5: develop file processing application programs

Practical Component:

CO6: develop programs for simple algorithms using sequential and Control structures

CO7: inscribe programs using arrays, functions and pointers to work with multiple data items.

CO8: develop application programs using structures and files concept.

CO1: apply fundamentals of problem solving techniques to develop simple algorithms for arithmetic and logical problems **L:6**

Overview of programming: Problem Solving in Everyday Life, Types of Problem, Computer-based problem solving, Algorithms - Building blocks of algorithms (statements, control flow, functions) - Notation (pseudo code, flow chart) – Problem solving aspect – Top down design – Implementation of algorithms – Program Verification – Efficiency of algorithms – Analysis of algorithm.

CO2: apply fundamental, sequential, conditional logic statements and arrays for solving basic problems **L:12, P:10**

Data Types - Constants – Variables - Keywords – Operators– Problem Solving using fundamental algorithms. Control Statements: Branching and Looping - Algorithms Using Selection and Repetition - Summation of a set of numbers, Reversing Digits of an Integer - Implementation of fundamental algorithms and factoring methods - Array Techniques - Array order reversal, Array Counting, Finding maximum and the minimum value in a set

CO6: develop programs for simple algorithms using sequential and Control structures

Solve problems using control statements (Decision making and Looping)

CO7: inscribe programs using arrays, functions and pointers to work with

multiple data items.

Problem solving based on Array Handling(1D and 2D, Multi-dimensional arrays, traversal, rotation) - Solve problems to handle strings

CO3: implement modular programming concept using user defined functions **L:10, P:8**

Modular Programming approach: Modularization and recursion - Bubble Sort, Selection Sort, Linear Search, Binary Search, Implementation of sorting and searching

CO7: inscribe programs using arrays, functions and pointers to work with multiple data items.

Solve problems by using modular approach (Functions and Recursion)

CO4: inscribe programs using pointers and to allocate memory for user defined data types using dynamic memory management functions **L:12, P:10**

Pointer Concept – add numbers using call by reference – finding maximum number from list of numbers - permutations of a given string using pointers – Implementation of function returns a pointer;

Structures &Union - finding the largest element of an array using Dynamic Memory Allocation – Implementation of Student database in structure using Dynamic Memory Allocation;

CO7: inscribe programs using arrays, functions and pointers to work with multiple data items.

Build efficient solutions to manage memory efficiently through Pointers.

CO8: develop application programs using structures and files concept.

Develop appliactions using Structures

CO5: Develop file processing application programs **L:5, P:2**

File Handling: Files - Introduction, Types of file processing: Sequential access, Random access – Implementation of word count, copy file, Voter's age validation, Marks range validation

CO8: Develop application programs using structures and files concept.

Develop applications using Files

TEXT BOOKS:

1. Maureen Sprankle and Jim Hubbard, Problem Solving and Programming Concepts, Prentice Hall, 9th Edition, 2012.
2. R.G Dromey, How to solve it by Compute, Pearson education, Delhi, 2nd Edition, 2021.

REFERENCES:

1. Behrouz A. Forouzan, Richard F.Gilberg, P.GoldaJeyasheeli, G.Priyanka, S.T.Veena , Problem solving Using C A Structured Programming Approach, Volume I & II, 1st Edition, Cengage Publication, 2022
2. Karl Beecher, Computational Thinking: A Beginner's Guide to Problem Solving and Programming, BCS Learning & Development Limited, 1st Edition, 2017.
3. Byron S. Gottfried, Jitendar Kumar Chhabra, Programming with C, Tata McGraw Hill Publishing Company, New Delhi, 4th Edition, 2018.
4. Kernighan B.W., Ritchie D.M., C Programming Language (ANSI C), Prentice Hall of India Private Limited., New Delhi, 2nd Edition, 2010.

5. PradipDey and Manas Ghosh, Programming in C, Oxford University Press, New Delhi, 2018.
6. Yashavant P. Kanetkar, Let Us C, BPB Publications,16th Edition, 2020
7. H. M.Deitel, P. J. Deitel, C How to Program, Pearson Education., New Delhi, 7th Edition, 2016.

L: 45; P: 30; TOTAL: 75 PERIODS

Course Code	ENGINEERING GRAPHICS	L	T	P	E	C
23ME11C	(Common to MECH, CIVIL, AIDS, EEE, IT)	2	0	4	0	4

COURSE OUTCOMES:

Upon the successful completion of the course, the student will be able to
CO1: Construct the Engineering Curves and Perform Freehand Sketching.
CO2: Construct the Orthographic Projections of Points, Straight Lines and Lamina
CO3: Draw the Projections of Simple Solids in Different Positions.
CO4: Visualize the Sectional Views and Surface of Various Solids.
CO5: Draw the Isometric and Perspective Projections of Various Solids.

CO1: Construct the Engineering Curves and Perform Freehand Sketching. L:6, P:12

Principles of Engineering Graphics – significance. Usage of Drawing Instruments. Lettering and dimensioning exercise Construction of ellipse, parabola and hyperbola using eccentricity method– Construction of cycloids, Epi and Hypo-cycloids. Orthographic views of simple components by Free hand drawing - Transferring measurement from the given object to the free hand sketches.

CO2: Construct the Orthographic Projections of Points, Straight Lines and Lamina L:6, P:12

Principle of orthographic projections – Conventions - First angle and third angle projections. Projections of points placed in all quadrants – projections of straight lines – inclined to both reference planes - determination of true length and inclinations. Projections of regular polygonal surfaces and circular lamina inclined to both reference planes.

CO3: Draw the Projections of Simple Solids in Different Positions. L:6, P:12

Projections of simple solids like prisms, pyramids, cylinder and cone - axis inclined to one reference plane - change of position method.

CO4: Visualize the Sectional Views and Surface of Various Solids. L:6, P:12

Sectioning of simple solids – Axis perpendicular to horizontal plane- Drawing sectional views with true shape of the section. Development of lateral surfaces of truncated solids – Prisms, pyramids, cylinder and cone.

CO5: Draw the Isometric and Perspective Projections of Various Solids. L:6, P:12

Principles of isometric projection – Isometric scale – Isometric projections of simple solids like prism, pyramid, cone and cylinder – Combination of solids. Perspective projections of simple solids by visual-ray method

TEXT BOOKS:

1. Bhatt N.D, "Engineering Drawing", 54th Edition, Charotar Publishing House, 2023.
2. Shah M.B and Rana B.C, "Engineering Drawing", Pearson Education, 2nd Edition, 2009.

REFERENCES:

1. Natrajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2009.
2. Agrawal B. & Agrawal C.M., "Engineering Graphics", TMH Publication,2nd Edition, 2013
3. Narayana K.L. &Kannaiah P, "Text book on Engineering Drawing", Scitech Publishers, 2011.
4. Gopalakrishna K.R, "Engineering Drawing", Subhas Publications, 32nd Edition, 2017.

L: 30; P: 60; TOTAL: 90 PERIODS

Course Code	தமிழரும் தொழில்நுட்பமும் (TAMILS AND TECHNOLOGY)	L	T	P	E	C
23SH21C	(Common to all B.E. / B.Tech. Degree Programmes)	1	0	0	0	1

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

CO1: தமிழர்களின் நெசவு மற்றும் பானைத் தொழில்நுட்பம், வடிவமைப்பு மற்றும் தொழில்நுட்பம், உற்பத்தித் தொழில்நுட்பம் பற்றிய அறிவு மற்றும் விளக்கும் திறன்.

CO2: தமிழர்களின் வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம், அறிவியல் தமிழ் மற்றும் கணினித் தொழில்நுட்பம் பற்றிய அறிவு மற்றும் விளக்கும் திறன்.

Upon the successful completion of the course, the student will be able to

CO1: Know and explain about Tamils weaving and Pottery technology, Design and construction Technology and Manufacturing Technology.

CO2: Know and explain about Tamils Agriculture and irrigation technology, Scientific Tamil and Tamil computing

CO1: தமிழர்களின் நெசவு மற்றும் பானைத் தொழில்நுட்பம், வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம் மற்றும் உற்பத்தித் தொழில்நுட்பம் பற்றிய அறிவு மற்றும் விளக்கும் திறன் **L:9**

சங்க காலத்தில் நெசவுத் தொழில் - பானைத் தொழில்நுட்பம் - கருப்பு சிகப்பு பாண்டங்கள் - பாண்டங்களில் கீறல் குறியீடுகள்- சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு - சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் - சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும் கோவில்களும் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் - செட்டி நாடு வீடுகள் - பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக்கலை- கப்பல் கட்டும் கலை - உலோகவியல் - இரும்புத் தொழிற்சாலை - இரும்பை உருக்குதல், எஃகு - வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் - நாணயங்கள் அச்சடித்தல் - மணி உருவாக்கும் தொழிற்சாலைகள் - கல் மணிகள், கண்ணாடி மணிகள் - சுடுமண் மணிகள் - சங்கு மணிகள் - எலும்புத் துண்டுகள் - தொல்லியல் சான்றுகள் - சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

CO1: KNOW AND EXPLAIN ABOUT WEAVING AND CERAMIC TECHNOLOGY, DESIGN AND CONSTRUCTION TECHNOLOGY, MANUFACTURING TECHNOLOGY

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW)– Graffiti on Potteries- Designing and Structural construction House & Designs in household materials duringSangam Age - Building materials and Hero stones of Sangam age — Details of Stage Constructions in Silappathikaram- Sculptures and Temples of Mamallapuram- Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- ThirumalaiNayakarMahal - Chetti Nadu Houses, Indo –Saracenic architecture at Madras during British Period- Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold Coins as source of history - Minting of Coins — Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences – Gemstone types described in Silappathikaram.

CO2: தமிழர்களின் வேளாண்மை, நீர்ப்பாசனத் தொழில்நுட்பம், அறிவியல் தமிழ் மற்றும் கணினித் தமிழ் பற்றிய அறிவு மற்றும் விளக்கும் திறன். **L:6**

அணை, ஏரி, குளங்கள், மதகு - சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் - கால்நடை பராமரிப்பு - கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் - வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் - கடல்சார் அறிவு - மீன்வளம் - முத்து மற்றும் முத்துக்குளித்தல் - பெருங்கடல் குறித்த பண்டைய அறிவு - அறிவுசார் சமூகம்- அறிவியல் தமிழின் வளர்ச்சி - கணினித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் - தமிழ் மென்பொருட்கள் உருவாக்கம் - தமிழ் இணையக் கல்விக் கழகம் - தமிழ் மின் நூலகம் - இணையத்தில் தமிழ் அகராதிகள் - சொற்குவைத் திட்டம்.

CO2: KNOW AND EXPLAIN ABOUT AGRICULTURE TECHNOLOGY, IRRIGATION TECHNOLOGY, SCIENTIFIC TAMIL & TAMIL COMPUTING

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing – Knowledge of Sea - Fisheries — Pearl - Conche diving - Ancient Knowledge of Ocean – Knowledge Specific Society- Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books –Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries– Sorkuvai Project.

REFERENCE BOOKS:

1. தமிழக வரலாறு–மக்களும் பண்பாடும் - கே. கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2. கணினித் தமிழ் - முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்)
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils(Dr.K.K.Pillay)A joint publication of TNTB & ESC and RMRL
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International InstituteofTamilStudies.)
9. Keeladi-Sangam City Civilization on the banks of river Vaigai (JointlyPublishedby:Department of Archaeology &Tamil NaduText Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to TamilNadu (Dr.K.K.Pillay) (Published by: The Author)

L: 15; TOTAL: 15 PERIODS

23GN05C	PROFESSIONAL ETHICS AND HUMAN VALUES	L	T	P	E	C
	(Common to all B.E. / B.Tech. Degree Programmes)	2	0	0	0	2

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

CO1: Recognize and practice the core human values and theories related to ethical behavior.

CO2: Analyze the engineering ethical breach from past study.

CO3: Distinguish and apply safety, responsibility and rights in workplaces.

CO1: Recognize and practice the core human values and theories related to ethical behavior **L: 10**

Moral dilemmas and moral autonomy - Kohlberg's theory - Gilligan's theory - Consensus and controversy –Case studies: Vigil mechanism, Whistle blowing - Protected disclosures - Personal ethics, work ethics and human values - Governing Regulation.

CO2 : Analyze the engineering ethical breach from past study **L: 10**

Engineering as experimentation - engineers as responsible experimenters - codes of ethics - a balanced outlook on law - Case study: The challenger disaster

CO3 : Distinguish and apply safety, responsibility and rights in workplaces **L: 10**

Safety and risk - assessment of safety and risk - risk benefit analysis and reducing risk - Collegiality and loyalty - respect for authority – confidentiality; Collective bargaining, Conflicts of interest - Case study; Occupational crime - professional rights - employee rights - Intellectual Property Rights (IPR) - discrimination. Case studies: The Three mile island and Chernobyl disaster

TEXT BOOK

1. Mike W Martin and Roland Schinzinger, “Ethics in Engineering”, McGraw Hill, New York, 5th Edition, 2022

REFERENCES

1. Behnam Taebi, “Ethics and Engineering: An Introduction”, Cambridge University Press, 2021
2. Ajesh Faizal, Aswathy S U, Roy V I, “Professional Ethics in Engineering: an Industry Perspective”, Noor Publishing, 2021
3. R.S.Naagarazan, “A Textbook on Professional Ethics and Human Values”, New age International Pvt. Ltd; 3rd Edition, 2022
4. Dr.P.Elamurugan, “Professional Ethics in Engineering”, Notion Press, 2021

L:30; TOTAL:30 PERIODS

Course Code	FOURIER SERIES, COMPLEX ANALYSIS AND	L	T	P	E	C
23ME21C	CALCULUS	3	1	0	0	4

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Component

CO1: perform Fourier series expansion of the functions.
CO2: calculate the Fourier series solution of Wave and Heat equation.
CO3: interpret analytic function in transformations.
CO4: evaluate complex integration over contour.
CO5: analyze the concepts related to vector field.

CO 1 : perform Fourier series expansion of functions

Dirichlet's conditions – General Fourier series – Half range series – Complex form of Fourier series – Parseval's identity – Harmonic analysis – Identification of frequencies. **L:9,T:3**

CO2 : calculate Fourier series solution of Wave and Heat equation

Fundamentals of Fourier series - Half range Fourier series - Classification of Partial Differential Equations - Fourier series solutions of one dimensional wave equation - One dimensional heat equation - Steady state solution of two dimensional heat equation (Insulated edges excluded). **L:9,T:3**

CO3 : interpret analytic function in transformations

Analytic functions - Necessary and Sufficient conditions (excluding proofs) - Harmonic and orthogonal properties of analytic functions - Harmonic conjugate - Construction of analytic functions- fluid flow problems-Conformal mapping: w= z+c, cz, 1/z and bilinear transformation. **L:9,T:3**

CO4 : evaluate complex integration over contour

Statement and applications of Cauchy's integral theorem and Cauchy's integral formula (excluding proofs) – Taylor's and Laurent's expansions - Singular points - Residues - Residue theorem (excluding proof) - Application of residue theorem to evaluate real integrals - Unit circle and semi - circular contour (excluding poles on boundaries). **L:9,T:3**

CO5 : analyze the concepts of calculus in vector fields

Differentiation of vectors : Gradient, Divergence, Curl and Directional derivatives – Line, Surface and Volume Integrals - Statement of Green's, Gauss divergence and Stokes' theorem - Simple applications involving rectangular parallelepiped and cubes. **L:9,T:3**

TEXT BOOKS:

1. Grewal.B.S., Higher Engineering Mathematics, 44th Edition, Khanna Publications, Delhi, 2021.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2017.

REFERENCE BOOKS:

1. Bali.N.P. and Manish Goyal, A Textbook of Engineering Mathematics, 10th Edition, Laxmi Publications Private Limited, 2016.
2. Jain.R.K. and Iyengar.S.R.K., Advanced Engineering Mathematics, 5th Edition, Narosa Publishing House Private Limited, 2016
3. Ramana B.V, Higher Engineering Mathematics, Tata Mc-Graw Hill Publishing Company, New Delhi, 2017.
4. Michael D .Greenberg, Advanced Engineering Mathematics, 2nd Edition, Pearson Education, 2021.

L: 45; T: 15; TOTAL: 60 PERIODS

Course Code	**MATERIALS SCIENCE**	**L**	**T**	**P**	**E**	**C**
23ME22C		**2**	**0**	**0**	**0**	**2**

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Component

CO1: describe the preparation, properties, and applications of glass, ceramics and nanomaterials.

CO2: qualitatively analyze different materials based on their magnetic properties and explain the applications of magnetic materials in various sectors.

CO3: interpret the properties of the various solar materials and their role in the energy production.

CO1: describe the preparation, properties, and applications of glass, ceramics and nanomaterials.

Glass: Introduction - classifications - manufacturing process – commercial and Industrial applications. Glass durability: controlling factors, Improvement of durability, durability measurements, and mechanism of reactions of solutions with glass surfaces. Effect of temperature and composition on the physical properties. Colours in glasses: role of transition metal ions in glass manufacturing - application of redox reactions. Decolorization and refining of glasses, methods of testing of glass quality. **L:18**

Engineering Ceramics: Introduction - Classification – Preparation, properties and applications of Boron carbide, Silicon carbide, Nitrides: Boron, Silicon and aluminium nitrides. Refractories: Introduction - types; acidic, basic and neutral refractories. properties, manufacturing process and applications.

Nanomaterials: Introduction - size dependence of properties –classification. Synthesis; laser ablation method and hydrothermal methods. Characterization techniques: Scanning and Transmission Electron Microscopy – Principle-Instrumentation (Block diagramme only).

CO2: qualitatively analyze different materials based on their magnetic properties and explain the applications of magnetic materials in various sectors. **L-6**

Magnetic materials: Introduction - types - Soft, hard and Ferrite magnetic materials: properties, and applications. Applications of magnetic materials in spintronics, magnetic information storage, magneto resistance in thin film structures, sensors, and memory elements in computers.

CO3: interpret the properties of the various solar materials and their role in the energy production. **L-6**

Solar collector materials – Glazing materials – Absorber materials - Insulation materials - Reflecting materials – Phase change materials. Photovoltaic materials: Direct and indirect band-gap materials. Solar grade silicon: Mono and multi crystalline silicon solar cells. CIGS – Dye sensitised solar cells-Pervoskite solar cells

REFERENCES:

1. William J Callister, Introduction to Materials Science and Engineering, John Wiley & Sons, Inc. 12th Edition, Reprint 2021.
2. Vijayamohanan K Pillai, Meera Parthasarathy, Functional Materials: A Chemist's Perspective,

Universities Press, 2013.
3. Smith, Foundations for material science and engineering McGraw-Hill, 4th Edition, 2019.
4. Master, IES, Basics of material science & engineering, 7th Edition, Ies Master Publication, 2022.
5. David Kingery.W, Introduction to Ceramics, Wiley & Sons, 2013.
6. Duffie, J.A., and Beckman, W.A. Solar Energy Thermal Process, John Wiley and Sons, NewYork, Jui Sheng Hsieh, Solar Energy Engineering, Prentice Hall, 2017.
7. Barry Carter.C, Grant Norton. M., Ceramic Materials: Science and Engineering, Springer Verlag New York Inc., 5th Edition 2021.

L : 30; TOTAL : 30 PERIODS

Course Code	**ENGINEERING MECHANICS**	**L**	**T**	**P**	**E**	**C**
23ME23C		**3**	**1**	**0**	**0**	**4**

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Component

CO1: Apply laws of mechanics to analyze the system of forces acting on particles and rigid bodies.
CO2: Evaluate the reactions in supports and perform force analysis on structures.
CO3: Compute the centroid and moment of inertia of lamina.
CO4: Apply the concepts of dry friction and compute the frictional forces for bodies in contact
CO5: Apply the fundamental principles of kinematics and kinetics of particles

CO1 Apply laws of mechanics to analyze the system of forces acting on particles and rigid bodies. **12**

Particles: Forces on a particle, Laws of Mechanics - transmissibility, resultant of two forces and several concurrent forces - resolution of a force, equilibrium of a particle, free body diagram, force in space - equilibrium of a particle in space; Rigid Bodies: Moment of a force – Varignon's theorem – Force Couple System –Reduction of system of forces into one force and couple – Equilibrium of rigid bodies in 2D.
Experimentation – Solving of forces in equilibrium of particles using pulley-hanging mass setup

CO2 Evaluate the reactions in supports and perform force analysis on structures. **12**

Types of supports, Types of Loading and determination of reactions. Structures: Simple trusses: Assumptions and Analysis of Plane Truss - Method of joints, method of sections, joints underspecial loading conditions, Failure of Joints, Analysis of frames.
Demonstration – Estimation of support reactions using a simply supported beam setup

CO3 Compute the centroid and moment of inertia of lamina. **12**

Centroids of areas, composite areas, Pappus and Guldinus theorems - determination ofmoment of inertia of plane figures, Parallel and perpendicular axis theorem - radius of gyration - polar moment of inertia
Demonstration – Centre of gravity of composite lamina, Significance of area moment of inertia in deflection of simply supported beams

CO4 Apply the concepts of dry friction and compute the frictional forces for bodies in contact **12**

Role of frictional force – Types of friction – Limiting friction – coefficientof static and kinetic friction - angle of friction – Coulomb's law of friction – Angle of Repose – Cone of friction –Problems in ladder friction, belt friction and wedge friction.

Experimentation – Estimate the coefficient of static and kinetic friction for various surfaces

CO5 Apply the fundamental principles of kinematics and kinetics of particles **12**

Kinematics: Rectilinear Motion – Uniform and Variable acceleration – Motion of particle under gravity – Relative motion. Curvilinearmotion; Kinetics: Newton's Second Law of motion – D'Alembertz Principle, Work energy principle. Impulse-Momentum principle – Motion of singular body and connected bodies.

Demonstration – Kinetics of connected bodies using pulley-mass system

TEXT BOOKS

1. Hibbeler R C, "Engineering Mechanics: Statics & Dynamics", Pearson India Education Services Private Limited, 14th Edition, 2018.
2. Irving H Shames and G.Krishna Mohana Rao, "Engineering Mechanics-Statics and Dynamics", Pearson Education, 4th Edition, 2016.
3. Timoshenko, DH Young, J V Rao, S Pati, "Engineering Mechanics", Mcgraw Hill Education Pvt. Ltd., 5th Edition, 2013.

REFERENCES

1. Beer FP, Mazurek DF, Sanghi S, Eisenberg ER, Johnston ER and Cornwell PJ, "Vector Mechanics for Engineers: Statics and Dynamics", Tata McGraw Hill Education Private Limited, 12th Edition, 2019.
2. Meriam J.L and Kraig L.G, "Engineering Mechanics-Statics and Dynamics", John Wiley & sons, New York, 9th Edition, 2021.
3. N.H.Dubey, "Engineering Mechanics – Statics and Dynamics", Tata McGraw-Hill Publishing Company, New Delhi, 2017.
4. Rajasekaran S and Sankarasubramanian G, "Fundamentals of Engineering Mechanics", Vikas Publishing House Private Limited, 3rdEdition, 2017.
5. Bansal RK, "A Textbook of Engineering Mechanics", Laxmi Publications (P) Ltd., 8th Edition New Delhi, 2017.
6. Nelson A, "Engineering Mechanics-Statics and Dynamics", Tata McGraw-Hill Publishing Company, New Delhi, 1st Edition 2019.

L:45; T:15; TOTAL:60 PERIODS

Course Code	PROFESSIONAL ENGLISH	L	T	P	E	C
23SH22C	(Common to all B.E. / B.Tech. Degree Programmes)	**2**	**0**	**2**	**0**	**2**

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Component

CO1: extend the primary language skills to develop critical thinking

CO2: build the secondary language skillsfor professional competence

Practical Component

CO3: apply the vital sub-functions of listening in particular context

CO4: take part in propagating ideas through effective oral communication

CO5: inferring information using various reading techniques

CO6: construct professional content via distinct methods of writing

Soft skill Component

CO7: develop interpersonal, communicational and behavioral attributes

CO1:extend the primary language skills to develop critical thinking

CO3: apply the vital sub-functions of listening in particular context L:6,P:16

CO4: take part in propagating ideas through effective oral communication

If Conditionals – Standard Abbreviations –Types of Listening (Comprehensive, Informational, Critical Listening) –One Word Substitution, Components of Speaking

Listening for Specific Information –Listening to Speech (Oxford Union Society) – Listening to Science Talks or Theories

Product Description – Chart Description – Process Description – Group Discussion (Uses – Structure – Strategies – Team Work – Positive & Negative Body Languages – Samples – Demo)

CO2:build the secondary language skills for professional competence L:5,P:18

CO5: inferring information using various reading techniques

CO6: construct professional content via distinct methods of writing

Synonyms – Intensive and Extensive Reading –Error Spotting (Based on Concord, Pronoun, Articles & Adverb Placement)– Writing Style (Persuasive, Expository & Descriptive)

Newspaper Reading – Reading Comprehension (Fiction & NonFiction)

Business Letters for Quotations and Clarification, Placing Orders and Making Complaints – Proposal Writing – Job Application Letter & Resume Preparation – Paragraph Writing – Content Writing

TEXT BOOKS

1. Lucantoni, Peter& Lydia Kellas. “English as a Second Language Workbook”, 6th Edition, Cambridge University Press, 2022.
2. Twain, Mark. “The Adventures of Tom Sawyer”, 1st Edition, Pegasus, 2012.
3. Clear, James. “Atomic Habits”, 1st Edition, Dreamliners, 2022.
4. Garcia, Hector & Francesc Miralles. Ikigai: The Japanese Secret to a long and Happy Life. 1st Edition, Tuttle Publishing, 2021.
5. Elbow, Peter, “Writing with Power”, 2nd Edition, Oxford University Press, 1998.

REFERENCES

1. Butterfield, Jeff. “Soft Skills for Everyone”, 2nd Edition, Cengage, 2020
2. Raman, Meenashi & Sangeetha Sharma. Professional English, 1st Edition, Oxford University Press, 2018

L: 11; P: 34; TOTAL: 45 PERIODS

Course Code	PROBLEM SOLVING TECHNIQUES	L	T	P	E	C
23CS11C	(Common to all B.E. / B.Tech. Degree Programmes)	3	0	2	0	4

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theroy Component

CO1: apply fundamentals of problem solving techniques to develop simple algorithms for arithmetic and logical problems

CO2: apply fundamental, sequential, conditional logic statements and arrays for solving basic problems

CO3: implement modular programming concept using user defined functions

CO4: inscribe programs using pointers and to allocate memory for user defined data types using dynamic memory management functions

CO5: develop file processing application programs

Practical Component

CO6: develop programs for simple algorithms using sequential and Control structures

CO7: inscribe programs using arrays, functions and pointers to work with multiple data items.

CO8: develop application programs using structures and files concept.

CO1: apply fundamentals of problem solving techniques to develop simple algorithms for arithmetic and logical problems **L:6**

Overview of programming: Problem Solving in Everyday Life, Types of Problem, Computer-based problem solving, Algorithms - Building blocks of algorithms (statements, control flow, functions) - Notation (pseudo code, flow chart) – Problem solving aspect – Top down design – Implementation of algorithms – Program Verification – Efficiency of algorithms – Analysis of algorithm.

CO2: apply fundamental, sequential, conditional logic statements and arrays for solving basic problems **L:12, P:10**

Data Types - Constants – Variables - Keywords – Operators– Problem Solving using fundamental algorithms. Control Statements: Branching and Looping - Algorithms Using Selection and Repetition - Summation of a set of numbers, Reversing Digits of an Integer - Implementation of fundamental algorithms and factoring methods - Array Techniques - Array order reversal, Array Counting, Finding maximum and the minimum value in a set

CO6: develop programs for simple algorithms using sequential and Control structures

Solve problems using control statements (Decision making and Looping)

CO7: inscribe programs using arrays, functions and pointers to work with multiple data items.

Problem solving based on Array Handling (1D and 2D, Multi-dimensional arrays, traversal, rotation) - Solve problems to handle strings

CO3: implement modular programming concept using user defined functions **L:10, P:8**

Modular Programming approach: Modularization and recursion - Bubble Sort,

Selection Sort, Linear Search, Binary Search, Implementation of sorting and searching

CO7: inscribe programs using arrays, functions and pointers to work with multiple data items.

Solve problems by using modular approach (Functions and Recursion)

CO4: inscribe programs using pointers and to allocate memory for user defined data types using dynamic memory management functions **L:12, P:10**

Pointer Concept – add numbers using call by reference – finding maximum number from list of numbers - permutations of a given string using pointers – Implementation of function returns a pointer;

Structures & Union - finding the largest element of an array using Dynamic Memory Allocation – Implementation of Student database in structure using Dynamic Memory Allocation;

CO7: inscribe programs using arrays, functions and pointers to work with multiple data items.

Build efficient solutions to manage memory efficiently through Pointers.

CO8: develop application programs using structures and files concept.

Develop applications using Structures

CO5: Develop file processing application programs **L:5, P:2**

File Handling: Files - Introduction, Types of file processing: Sequential access, Random access – Implementation of word count, copy file, Voter's age validation, Marks range validation

CO8: Develop application programs using structures and files concept.

Develop applications using Files

TEXT BOOKS:

1. Maureen Sprankle and Jim Hubbard, Problem Solving and Programming Concepts, Prentice Hall, 9th Edition, 2012.
2. R.G Dromey, How to solve it by Compute, Pearson education, Delhi, 2nd Edition, 2021.

REFERENCES:

1. Behrouz A. Forouzan, Richard F.Gilberg, P.Golda Jeyasheeli, G.Priyanka, S.T.Veena , Problem solving Using C A Structured Programming Approach, Volume I & II, 1st Edition, Cengage Publication, 2022
2. Karl Beecher, Computational Thinking: A Beginner's Guide to Problem Solving and Programming, BCS Learning & Development Limited, 1st Edition, 2017.
3. Byron S. Gottfried, Jitendar Kumar Chhabra, Programming with C, Tata McGraw Hill Publishing Company, New Delhi, 4th Edition, 2018.
4. Kernighan B.W., Ritchie D.M., C Programming Language (ANSI C), Prentice Hall of India Private Limited, New Delhi, 2nd Edition, 2010.
5. PradipDey and Manas Ghosh, Programming in C, Oxford University Press, New Delhi, 2018.
6. Yashavant P. Kanetkar, Let Us C, BPB Publications,16th Edition, 2020

7. H. M.Deitel, P. J. Deitel, C How to Program, Pearson Education., New Delhi, 7th Edition, 2016.

L: 45; P: 30; TOTAL: 75 PERIODS

Course Code	FUNDAMENTALS OF ELECTRICAL AND	L	T	P	E	C
23EE13C	ELECTRONICS ENGINEERING	3	0	2	0	4

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Component

CO1: Demonstrate the characteristic parameters of DC and AC circuits.

CO2: Explain the working of AC and DC machines.

CO3: Describe the analog and digital instruments for monitoring and control.

CO4: Demonstrate the operation of electronic and digital devices for applications.

CO5: Infer the purpose of wiring and safety.

Practical Component

CO6: Analyze basic electric circuits and characteristics of electrical machines.

CO7: Demonstrate the functionality of instruments and characteristics of electronics devices.

CO8: Perform residential wiring and measure earth resistance.

CO1: Demonstrate the characteristic parameters of DC and AC circuits. **L:9, P:6**

Sources - Passive Elements – Electrical Quantities: Voltage, Current, Power and Energy – DC circuits: Ohms Law – Kirchhoff's Laws – Mesh analysis - AC Circuits: Waveforms, RMS, Peak, real power, reactive power and apparent power, power factor.

CO6: Analyze basic electric circuits and characteristics of electrical machines

1. Verification of Ohms Law and Kirchhoff law.
2. Measurement of AC signal parameter (Peak-Peak, RMS, Period and Frequency)

CO2: Explain the working of AC and DC machines. **L:9, P:8**

Construction, Types of DC motors – Working Principles – Need for Starters - AC Motors: Construction and Working of Single Phase and Three Phase Induction Motor– Servomotor -Stepper motor.

CO6: Analyze basic electric circuits and characteristics of electrical machines.

1. Analyse the characteristics of DC Shunt Motor and DC series motor
2. Load test on single phase and three phase induction motor

CO3: Describe the analog and digital instruments for monitoring and control. **L:9, P:2**

Analog instruments: Functional Elements, Principles: PMMC, MI, And Electrodynamometer wattmeter – Digital voltmeter – energy meter - multimeter – DSO – Multifunction meter.

CO7: Demonstrate the functionality of instruments and characteristics of electronics devices.

1. Calibration of single phase energy meter using wattmeter

CO4: Demonstrate the operation of electronic and digital devices for applications. **L:9, P:6**

Characteristics and applications: Diode – Rectifiers, Zener Diode – Regulators, BJT - LEDs – Photo Diodes, Opto-Isolators- Binary Number System – Logic Gates: Basic gates, Universal gates – Boolean Algebra –ADC and DAC.

CO7: Demonstrate the functionality of instruments and characteristics of electronics devices.

1. Experimental Verification of PN Junction diode as rectifiers.
2. Experimental Verification of Zener Diode as Voltage Regulators.
3. Verify the truth table of logic gates.

CO5: Infer the purpose of wiring and safety. **L:9, P:8**

Diagrams & Symbols used in basic Electrical wiring -Electric shock -Protection: PPE, Switches, Plug and Socket, Fuse, MCB, ELCB, MCCB and Earthing- Wiring & installations- Inverters – UPS- Energy Consumptions –Electrical safety and standards– Schematic Electrical Layout for building.

CO8: Perform residential wiring and measure earth resistance.

1. Measurement of Earth Resistance using Electrical Equipment.
2. Residential house wiring, Staircase wiring and selection of fuse.

TEXT BOOKS:

1. D.P. Kothari and I J Nagrath, "Basic Electrical and Electronics Engineering", Tata McGraw Hill, 4th Edition, 2019.
2. R.K.Rajput, "Basic Electrical and Electronics Engineering", University Science Press, 2017.

REFERENCES:

1. Lionel Warnes, "Electrical and electronics engineering: Principles and practice, Palgrave Macmillan publication, 3rdEdition, 2003.
2. D.C. Kulshreshtha, "Basic Electrical Engineering", Tata McGraw Hill, Revision 1stEdition, 2011.
3. David Bell, "Electronic Devices and Circuits", Oxford university press, 5th Edition, 2008.
4. Mohamed A. El-Sharkawi, "Electric Safety Practice and Standards", Taylor & Francis, 2013.

L: 45; P: 30; TOTAL: 75 PERIODS

Course Code	**INNOVATION THROUGH DESIGN THINKING**	**L**	**T**	**P**	**E**	**C**
23GN02C	(Common to all B.E. / B.Tech. Degree Programmes)	**0**	**0**	**0**	**4**	**2**

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Experiential Component

CO1: Analyse the impact of design thinking process.

CO2: Practice design thinking process through real world problems.

Soft skill Component

CO3: Present survey conclusions on selected real-world problems.

CO1: Analyse the impact of design thinking process **30**

Design thinking process: history and phases -Ideation tools: brainstorming, mind mapping, scrambler method, six thinking hats - case studies.

CO2: Practice design thinking process through real world problems **30**

Real world problem selection-Practicing the preliminary stages of design thinking process - work presentation.

TEXT BOOKS

1. Falk Uebernickel, Li Jiang, Walter Brenner, Britta Pukall, Therese Naef, "Design Thinking: The Handbook", WS Professional, 2020
2. PavanSoni, "Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem solving", Penguin Random House, 2020

REFERENCES

1. Michael Lewrick, "The Design Thinking Playbook", Wiley, 2019
2. Kathryn Christopher, "Design Thinking in Engineering", Kendall Hunt Publishing Company,2019
3. Robert Curedale, "Design Thinking Process & Methods", Design Community College Inc, 5th Edition, 2019
4. David Lee, "Design Thinking in the Classroom", Ulysses Press, 2018
5. Jimmy Jain, "Design Thinking for Startups", Notion Press, 2018
6. Monika Hestad Silvia Rigoni Anders Grnli, "The Little Booklet on Design Thinking: An Introduction", Zaccheus Entertainment, 2nd Edition, 2017
7. Scott Swan, Michael G.Luchs and Abbie Griffin, "Design Thinking: New Product Development Essentials", Wiley-Blackwell, 2016
8. D.M. Arvind Mallik, "Design Thinking for Educators", Notion Press, 2019

E:60; TOTAL:60 PERIODS

Course Code		L	T	P	E	C
23GN04C	**APTITUDE EXCELLENCE**	**0**	**0**	**2**	**0**	**1**

COURSE OUTCOMES

Upon the completion of the course the students will be able to

CO1: Infer appropriate methods to simplify computation

CO2: Develop problem solving skills on Time and Work and enhance arithmetic ability

CO3: Interpret fundamentals in quantitative techniques and solve problems quickly

CO4: Improve quantitative skills and solve problems on permutation and Combination

CO5: Acquire the knowledge of Cognitive ability and solve puzzles effectively

CO1: Infer appropriate methods to simplify computation

Simplification: Nested Series simplification(fraction) -BODMAS rule – Viraculum (or Bar) rule – Modulus of a real number –Multiplication shortcuts -Comparing Fractions-Data Sufficiency **P:6**

CO2: Develop problem solving skills on Time and Work and enhance arithmetic ability

Time and Work: Work Done - Days from Work:- Ratio – Efficiency –Work and wages - Data Sufficiency **P:6**

CO3: Interpret fundamentals in quantitative techniques and solve problems quickly

Time Speed Distance: Body moving in the same direction- Body moving in the opposite direction-Average speed- Meeting point - Data Sufficiency **P:6**

CO4: Improve quantitative skills and solve problems on permutation and Combination

Probability Permutation Combination: Fundamental Counting Principle – Computing Permutation – Circular Permutation – Computing Combinations - Data Sufficiency **P:6**

CO5: Acquire the knowledge of Cognitive ability and solve puzzles effectively

Abstract reasoning: Mirror and water image – Figure Matrix –Pattern Completion – Logical puzzles – Dot situation - Ranking ordering. **Cognitive ability:** Blood Relation - Direction Sense Test-Data Sufficiency **P:6**

REFERENCE BOOKS

1. R.V.Praveen, "Quantitative Aptitude and Reasoning", 3rd Edition , Eastern Economy Edition, PHI Learning 2016
2. Arun Sharma," Quantitative Aptitude for CAT", McGraw Hill Edge, 10th Edition 2022
3. Dr.R.Aggarwal, " Quantitative Aptitude", S Chand Publishing, Revised Edition 2017

P:30; TOTAL: 30 PERIODS

Course code	**ENGINEERING THERMODYNAMICS**	**L**	**T**	**P**	**E**	**C**
23ME31C		**3**	**1**	**0**	**0**	**4**

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

CO1: Apply concepts of energy conservation to analyze open and closed systems.
CO2: Arrive benchmark performances of heat engines and refrigerator / heat pump and compute entropy changes.
CO3: Apply exergy balance to evaluate the second law efficiency of closed systems and control volumes at steady state.
CO4: Estimate properties of ideal gases, real gases and pure substances
CO5: Derive various thermodynamic relation for different systems

CO1 Apply concepts of energy conservation to analyze open and closed systems. 12

Introduction - system and their behavior - Properties of the system - Thermodynamic Equilibrium - Zeroth law of thermodynamics - temperature scale - mechanical concept of

energy - Heat and Work - Quasi static process - First law of Thermodynamics - Mass and Energy Analysis: Closed system and open system - Transient systems - Applications.

CO2 Arrive benchmark performances of heat engine, refrigerator and heat pump and compute entropy changes. **12**

Introduction- Heat engine, heat pump and Refrigerator - Second Law of Thermodynamics - Carnot Cycle - Carnot theorem and its corollaries - Absolute Temperature scale - Irreversible and Reversible Processes - Clausius Inequality.

Entropy: Principle of increase of entropy - Tds relations - Entropy balance for closed systems - Entropy rate balance for control volumes at steady state.

CO3 Apply exergy balance to evaluate the second law efficiency of closed systems and control volumes at steady state **12**

Exergy of a system - Closed system exergy balance - Exergy rate balance for control volumes at steady state - First and second law efficiency - Case studies.

CO4 Estimate properties of ideal gases, real gases and pure substances **12**

Ideal gas equation of state – Compressibility factor – Vander Waals equation of state for real gases –Ideal Gas Mixtures–Properties of Ideal Gas mixture.

Pure Substances– phases of pure substances – property diagrams – Property tables – evaluation of properties of pure substance for different applications- Simple applications.

CO5 Derive various thermodynamic relation for different systems **12**

Thermodynamics Relations - Gibbs and Helmholtz Functions, Maxwell Relations, specific heat ratio, Joule Kelvin effect, ClausiusClapeyron equation - Multi component system.

TEXT BOOKS

1. YunusA.Cengel, "Thermodynamics - An Engineering Approach", McGraw Hill publications, 9th Edition, 2019.
2. Mahesh M Rathore, "Thermal Engineering", McGraw Hill publications, 2010.

REFERENCES

1. Claus Borgnakke, Richard E. Sonntag, "Fundamentals of Thermodynamics", John Wiley & Sons, 10th Edition, 2020
2. Kalliat T.Valsaraj, "Principles of Environmental Thermodynamics and Kinetics", CRC press, 4th Edition, 2020.
3. P.K.Nag, "Engineering Thermodynamics", Mc Graw-Hill publications, 6th Edition, 2017
4. R.K. Rajput, "Thermal Engineering", Laxmi Publications, 10th Edition, 2017
5. De Didier Fontaine, "Principles of classical Thermodynamics: Applied to Material Science", World Scientific Publications, 2022
6. Moran, Shapiro, Boettner, Bailey, "Principles of Engineering Thermodynamics", Wiley publications, 8th Edition, 2015.

L:45; T:15; TOTAL:60 PERIODS

COURSE CODE	ENVIRONMENTAL SCIENCE AND ENGINEERING	L	T	P	C
23MC02C		2	0	0	--

COURSE OUTCOMES:

Upon the successful completion of the course, the student will be able to

CO1: explain the structure and functions of an ecosystem and the importance of biodiversity.

CO2: interpret the causes, effects of air and water pollution.

CO3: comprehend the causes, impacts and management of e-waste and municipal waste.

CO4: apply the knowledge of sustainability practices in the environment.

CO1: explain the structure and functions of an ecosystem and the importance of biodiversity. **L-6**

Introduction to Environment**,** scope and importance of environment – need for public awareness. Eco-system: structure and function. Biodiversity: Introduction - types – values of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India. Conservation of biodiversity: In-situ and ex-situ - Biodiversity index calculation (Simpson and Shannon diversity Index, Sorenson coefficient)

CO2: interpret the causes, effects of air and water pollution. **L-6**

Air pollution - Classification of air pollutants – sources – Effects - Measurements: dust monitor – gas analyzer, particle size analyzer. Water pollution – Classification – health hazards – sampling and analysis of water. Waste water treatment – different industrial effluents and their treatment – Measurement: BOD and COD – atomic absorption spectrometer. Case study (Okhla sewage water treatment plant)

CO3: comprehend the causes, impacts and management of e-waste and municipal waste. **L-12**

Integrated Waste Management: Introduction – Generation and types of solid waste – Swachh Bharat Mission – Solid waste management: collection, transportation, segregation and processing – Disposal: landfill – biochemical processes and energy recovery - Municipal solid waste management rules 2016.

e-Waste Management: Introduction – Composition - Types – Generation – Environmental and health hazards of e-waste – Recycling - Recovery of metals: pyrometallurgical, hydrometallurgical, and biometallurgical process – e-waste management and handling rules 2016 – e-waste management companies in India.

CO4: apply the knowledge of sustainability practices in the environment. **L-6**

Sustainability and Management**:** Introduction - concept, needs and challenges – economic and social aspects of sustainability – unsustainability to sustainability – millennium development goals and protocols – Sustainable Development Goals-targets, indicators and intervention areas – Climate change – Global, Regional and local environmental issues and possible solutions – case studies. Concept of Carbon Credit – Carbon Footprint – Environmental management in industry – A case study – Zero waste and R concept – Circular economy – ISO 14000 Series – Material Life cycle assessment.

TEXT BOOKS:

1. Miller. G.T and Spoolman.S, ‘Environmental Science’, 16th Edition, Brooks / Cole Publishing Co., 2018.

2. Peavy. H.S, Rowe. D.R and Tchobanoglous. G, 'Environmental Engineering', 2nd Edition, McGraw Hill Education, 2020.
3. Benny Joseph, 'Environmental Engineering', Tata-Mc-Graw Hill, New Delhi, 2016.
4. Gilbert M.Masters, 'Introduction to Environmental Science and Engineering', 2nd Edition, Pearson Education, 2016.

REFERENCE BOOKS:

1. Kaushik. A and Kaushik. C.P, 'Environmental Science and Engineering', 6th Edition, New Age International Publishers, 2018.
2. Weller. K, 'Environmental Science and Biological Engineering', 1st Edition, WIT Press, 2015.

L:30; TOTAL : 30 PERIODS

Course Code	STATISTICS AND NUMERICAL METHODS	L	T	P	E	C
23ME32C		3	1	0	0	4

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Component

CO1: calculate the various measures of dispersion.
CO2: apply the principles of hypothesis testing in small and large samples.
CO3: analyze the variances in design of experiments.
CO4:apply numerical techniques to solve algebraic equation and calculate derivatives andintegrals.
CO5: compute numerical solution of differential equations.

CO1 : calculate the various measures of dispersion

Central tendencies - Mean, median, mode - Measures of Dispersion: Mean deviation, and Quartile Deviation - Carry out performance study on measures of central tendencies: Case Study through software– Moments–Skewness–Kurtosis-Correlation and Regression. **L:9, T:3**

CO2 : apply the principles of hypothesis testing in small and large samples

Sampling distributions - Estimation of parameters - Statistical hypothesis – Central limit theorem - Large sample tests based on Normal distribution for single mean and difference of means - Confidence interval for mean - Chi-square distribution-Contingency table for independent of attributes – Goodness of fit. **L:9,T:3**

CO3 : analyze the variances in design of experiments

Tests based on t and F distributions for mean, variance and proportion - ANOVA - One way and two way classifications - Completely randomized design – Randomizedblock design – Latin square design – 2^2 factorial design. **L:9,T:3**

CO4: apply numerical techniques to solve algebraic equation and calculate derivatives and integrals **L:9,T:3**

Solution of Algebraic and transcendental linear equations - Newton - Raphson Method-

Solution of simultaneous equations – Gauss Elimination method – Gauss Jacobi's method- Gauss Seidel method – Interpolation – Lagrange's Method - Numerical Differentiation – Newton's forward difference and backward difference formula – Numerical integration - Single integration using Trapezoidal and Simpson's 1/3 rd and 3/8 th rules.

CO5 : compute numerical solution of differential equations

Taylor's Series Method – Euler's Method – RungeKutta fourth order Method – Predictor - corrector Methods – Milne's Method - Solution of one dimensional heat equation by explicit and implicit methods - Two dimensional Laplace and Poisson equations – Liebman's iteration Process.- Determine numerical solution of ordinary differential equations and partial differential equations: Activity through software. **L:9,T:3**

TEXT BOOKS:

1. Richard A. Johnson, Irwin Miller, John Freund, Miller & Freund's, Probability and Statistics for Engineers, 9th Edition, Pearson Education Limited, Global Edition, 2017.
2. Grewal, B.S., Numerical Methods in Engineering & Science: With Programs in C, C++ & MATLAB, 10th Edition, Khanna Publishers, New Delhi, 2014.
3. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley India, 2017.

REFERENCES:

1. R.E. Walpole, R.H. Myers, S.L. Myers, and K Ye, Probability and Statistics for Engineers and Scientists, Pearson Education, Asia, 9th Edition, 2016.
2. M.R.Spiegel, J.Schiller and R.A. Srinivasan, Schaum Outlines, Probability and Statistics, Tata McGraw Hill Edition, 2017.
3. Chapra, S.C and Canale, R.P. Numerical Methods for Engineers, 7th Edition, Tata Mc Graw Hill, New Delhi, 2016.

L: 45; T:15; TOTAL: 60 PERIODS

Course Code	BASIC MANUFACTURING PROCESSES	L	T	P	E	C
23ME33C		3	0	2	0	4

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Component

CO1: Select appropriate casting method for an industrial component and design the Gating and riser systems.

CO2: Identify the suitable metal joining process for an application.

CO3: Recognize suitable metal forming process for making an industrial component and evaluate the load Requirement in forming processes.

CO4: Analyze various polymer processing methods and identify suitable fabrication method for polymer product

CO5: Describe the need and process of additive manufacturing.

Practical Component

CO6: Demonstrate the green sand and stir casting process and prepare green sand mould for an industrial component.

CO7: Practice arc welding for making simple weld joints.

CO8: Prepare simple components using forging techniques and sheet metal Process.
CO9:Generate prototype for the real time component using 3D printing

CO1	**Select appropriate casting method for an industrial component and design the Gating and riser systems.**	**9**
CO6	**Demonstrate the green sand casting and stir casting process and prepare green sand mould for an industrial component.**	**8**

Sand casting- Moulding sand: types, properties and testing methods- Patterns: materials and allowances – Core making process - Solidification in casting-Riser and gating design– Fettling and Finishing Process - *Preparation of green sand mould using solid and split pattern in Laboratory.*
Working principle of special casting processes – *Demonstration of the stir casting process in Laboratory* -Recent developments in casting– Casting defects.

CO2	**Identify the suitable metal joining process for an application.**	**9**
CO7	**Practice arc welding for making simple weld joints.**	**8**

Fusion and solid-state welding processes–*Practicing with TIG and Electric arc welding for making simple weld joints in laboratory* –Brazing, soldering and adhesive bonding processes–Recent developments in welding-*Demonstration of the Automatic Welding in Laboratory - Construction and working principle*–Weld defects.

CO3	**Recognizesuitable metal forming process for making an industrial component and evaluate the load Requirement in forming processes.**	**9**
CO8	**Prepare simple components using forging techniques and sheet metal Process.**	**8**

Hot working and cold working of metals – forging, rolling, drawing and extrusion processes-principles and applications- Sheet metal forming processes- principles and applications-Load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes - *Preparation of simple objects through hot forging and simple sheet metal parts in laboratory*-Recent developments in forming.

CO4	**Analyze various polymer processing methods and identify suitable fabrication method for polymer product**	**9**

Types of plastics- plastic processing techniques: Blow moulding, Injection moulding (screw and plunger type machines), Rotational moulding, Transfer moulding and compression moulding- Recycling and Eco-friendly Processing-Recent developments and Industrial applications.

CO5	**Describe the need and process of additive manufacturing**	**9**
CO9	**Generate prototype for the real time component using 3D printing**	**6**

Need and Development of additive manufacturing systems- Classification of additive manufacturing processes - Benefits – Applications - Generation of prototype for the given real time product using 3D printing in laboratory.

TEXT BOOKS

1. Hajra Choudhury, "Elements of Workshop Technology, Vol.I Manufacturing Processes", Media Promotors Private Limited, Mumbai, 15th Reprint, 2016.
2. S.Gowri, P.Hariharan and A.SureshBabu, "Manufacturing Technology I", Pearson Education, 2017.

REFERENCES

1. Mikell P Groover, "Fundamentals of Modern Manufacturing", John Wiley & Sons, 7th Edition, 2019.
2. Rajput R.K, "A text book of Manufacturing Technology", Lakshmi Publications, 2016.
3. P.N.Rao, "Manufacturing Technology", 2nd Edition, Tata McGraw-Hill Publishing Limited, 2015.
4. P.C.Sharma, "A Text book of Production Technology", 11th Edition, S.Chand and Company, 2013.
5. Begman, "Manufacturing Process", 8th Edition, John Wiley & Sons, 2018.
6. Larry Jeffus, "Welding and Metal Fabrication", Cengage Learning, 2012.
7. Serope Kalpajian, Steven R.Schmid, "Manufacturing Engineering and Technology", Pearson Education, Inc., 2nd Indian Reprint, 2018.

L:45; P:30; TOTAL:75 PERIODS

Course Code	FLUID MECHANICS AND HYDRAULIC MACHINES	L	T	P	E	C
23ME34C		2	1	2	0	4

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Component

CO1: Explain the fundamental properties of fluids and applications of Bernoulli's Equation.

CO2: Apply dimensional analysis techniques and dimensionless parameters in fluid Mechanics.

CO3: Determine flow rates and head losses in laminar and turbulent flows.

CO4: Apply principles of fluid mechanics to design and select hydraulics turbines.

CO5: Apply principles of fluid mechanics to design and select pumps.

Practical Component

CO6: Apply Bernoulli's equations to determine the coefficient of discharge in flow measuring devices.

CO7: Determine frictional and minor head losses in flow through pipes.

CO8: Evaluate the performance of different types of turbines.

CO9: Evaluate the performance of different types of pumps.

CO1 Explain the fundamental properties of fluids and applications of Bernoulli's Equation. 9

CO6 Apply Bernoulli's equations to determine the coefficient of discharge in flow measuring devices. 12

Units and dimensions- Properties of fluids- mass density, specific weight, specific volume, Specific gravity, viscosity, compressibility, vapor pressure, surface tension and capillarity. Flow characteristics – concept of control volume - application of continuity equation, energy equation and momentum equation – E*xperimental determination of Coefficient of Discharge (Cd) – Venturimeter – Orificemeter – Rotameter*

CO2 Apply dimensional analysis techniques and dimensionless parameters in fluid Mechanics. 9

Dimension and units - dimensionless parameters - Buckingham's π theorem - Models andsimilitude - Applications of dimensionless parameters, scaling factors and law.

CO3 Determine flow rates and head losses in laminar and turbulent flows. 9

CO7 Determine frictional and minor head losses in flow through pipes. 6

Boundary layer concepts – Flow over Cylinders- Laminar flow though circular conduits and circular annuli -Darcy-Weisbach's equation - Flow through pipes in series and in parallel, friction factor –Moody diagram- Losses in pipes.

Experimental Evaluation of Friction Coefficient – Frictional Loss – Coefficients of pipe fittings – Minor Losses – Bend – Elbow – Sudden expansion - Sudden Contraction

CO4 Apply principles of fluid mechanics to design and select hydraulics turbines. 9

CO8 Evaluate the performance of different types of turbines. 6

Hydro turbines: definition and classifications - working principles - velocity triangles – workdone - specific speed - efficiencies - performance curves*with experimental verification.*

CO5 Apply principles of fluid mechanics to design and select pumps. 9

CO9 Evaluate the performance of different types of pumps. 6

Pump: Classification and working principles - Centrifugal pump velocity triangles, specific speed, efficiency and performance curves*with experimental verification* - Reciprocating pump: slip, discharge, work done - cavitation.

TEXT BOOKS

1. YunusA. Cengel and John M. Cimbala, "Fluid Mechanics: Fundamentals and Applications", McGraw-Hill Ltd, New Delhi, 4th Edition, 2017.
2. Bansal RK, "Fluid Mechanics and Hydraulics Machines", Laxmi publications (P) Ltd, New Delhi, 10th Edition, 2019.

REFERENCES:

1. Munson, Young and Okiishi, "Fundamentals of Fluid Mechanics", John Wiley & Sons, 10th Edition, 2021.
2. White FM, "Fluid Mechanics", Tata McGraw-Hill, New Delhi, 8thEdition, 2017.
3. Streeter VL and Wylie EB, "Fluid Mechanics", McGraw-Hill Ltd, Asia,8thEdition, 2017
4. Modi PN and Seth SM, "Hydraulics and Fluid Mechanics Including Hydraulics Machines", Standard Book House, 22nd Edition, 2019
5. Kumar KL, "Engineering Fluid Mechanics", Eurasia Publishing HousePrivate Limited, 15thEdition, New Delhi, 2016.
6. Shiv Kumar, "Fluid Mechanics & Fluid Machines: Basic Concepts & Principles",Ane Books Pvt. Ltd., New Delhi, 3rdEdition, 2018
7. https://nptel.ac.in/courses/112105171

L:45; P:30; TOTAL:75 PERIODS

Course Code	MATERIALS ENGINEERING	L	T	P	E	C
23ME35C		2	0	2	0	3

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Component

CO1: Describe the structure and properties of materials referring suitable phase diagrams.

CO2: Choose appropriate heat-treatment techniques to impart desired properties in materials / alloys.

CO3: Identify the suitable ferrous and non-ferrous alloys for engineering applications.

CO4: Select suitable polymers, ceramics and composites for specific engineering applications.

CO5: Explain different damage mechanisms and testing of metals.

Practical Component

CO6: Prepare the specimens and characterize the microstructures of different ferrous and non-ferrous metals.

CO7: Evaluate the effect of heat treatment on properties of steel.

CO8: Measure the hardness of ferrous and non-ferrous materials

CO1 Describe the structure and properties of materials referring suitable phase diagrams. 6

Constitution of alloys–Solid solutions, substitutional and interstitial–phase diagrams, Isomorphous, eutectic, eutectoid, peritectic, and peritectoid reactions, Iron–Iron carbide phase diagram. Classification of Steel and cast Iron - microstructure, properties and application. Study of metallurgical microscope and sample preparation.

CO2 Choose appropriate heat treatment techniques to impart desired properties in materials / alloys. 6

CO6 Prepare the specimens and characterize the microstructures of different ferrous and non-ferrous metals. 12

CO7 Evaluate the effect of heat treatment on properties of steel. 8

Definition– Introduction to furnace, Full annealing, stress relief, recrystallisation and spheroidising–normalising, hardening and Tempering of steel. Isothermal transformation diagrams–cooling curves superimposed on I.T. Diagram -Continuous Cooling Transformation (CCT) diagram- Austempering, Martempering –hardening methods-case hardening, carburizing, Nitriding, cyaniding, carbonitriding–Flame and Induction hardening–Vacuum and Plasma hardening - Thermo-mechanical treatments-elementary ideas on sintering.

Preparation and study of the microstructure of low carbon steel, mild steel, high speed steel and stainless steel. Evaluate the effect of heat treatment on properties of steel. Measurement of hardness of various heat treated and untreated plain carbon steels.

CO3 Identify the suitable ferrous and non-ferrous alloys for engineering applications 6

Effect of alloying additions on steel (Mn, Si, Cr, Mo, V, Ti& W) -α and β stabilizers –stainless and tool steels–HSLA, Maraging steels–Cast Iron-Grey, white, malleable, spheroidal–alloy cast irons, Copper and copper alloys–Brass, Bronze and Cupronickel–Aluminum and its alloys - Al-Cu–

precipitation strengthening treatment– Titanium alloys, Mg-alloys, Ni-based super alloys – Properties and Applications.

CO4 Select suitable polymers, ceramics and composites for specific engineering applications. 6

Polymers–types of polymer, commodity and engineering polymers–Properties and applications of various thermosetting and thermoplastic polymers (PP, PS, PVC, PMMA, PET,PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE, PETG, Polymers–Urea and Phenol formaldehydes)-Engineering Ceramics–Properties and applications of Al2O3, SiC, Si3N4, PSZ and SIALON–Composites-Classifications-Metal Matrix and FRP-Applications of Composites.

CO5 Explain different damage mechanisms and testing of metals 6

CO8 Measure the hardness of ferrous and non-ferrous materials 10

Mechanisms of plastic deformation, slip and twinning–Types of fracture–Testing of materials under tension, compression and shear loads–Hardness tests (Brinell, Vickers and Rockwell), hardness tests, Micro and Nano-hardness tests, Impact test Izod and Charpy, fatigue and creep failure mechanisms.

Perform Brinnell hardness test on metals, Perform Rockwell hardness test on metals.

TEXT BOOKS

1. Avner, S.H., "Introduction to Physical Metallurgy", McGraw Hill Education; 2nd Edition, 2017.
2. Williams D Callister, "Material Science and Engineering" Wiley India Private Limited, 10th Edition, 2020.

REFERENCES

1. Raghavan.V, "Materials Science and Engineering", Prentice Hall of India Pvt. Ltd., 6th Edition, 2015.
2. Kenneth G.Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 9th Indian Reprint, 2016.
3. Upadhyay.G.S. and Anish Upadhyay, "Materials Science and Engineering", Viva Books Pvt. Ltd., New Delhi, 2015.
4. U.C.Jindal: Material Science and Metallurgy, "Engineering Materials and Metallurgy", 1st Edition, Dorling Kindersley, 2012.

L:30; P:30; TOTAL:60 PERIODS

Course Code	KINEMATICS OF MACHINERY	L	T	P	E	C
23ME36C		3	0	0	2	4

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Theory Component

CO1: Discuss the fundamental concepts of the simple mechanisms.
CO2: Determine velocity and acceleration of any point on a link in simple mechanisms.
CO3: Draw the cam profile for different types of follower and motion requirements.

CO4: Apply gear and gear train fundamentals to select suitable components for specific applications.
CO5: Apply friction concepts to design clutches and brakes.

Experiential Component

CO6: Design a mechanism for a specific engineering application.
CO7: Analyse and Validate the mechanisms through kinematic principles.
CO8: Implement theoretical designs into tangible prototypes.
CO9: Collaborate and communicate effectively as a member of a team for proficient problem-solving.

CO1 Discuss the fundamental concepts of the simple mechanisms 9

Definitions – Link, Kinematic pair, Kinematic chain, Mechanism and Machine – Degrees of Freedom – Mobility – Kutzbach criterion (Gruebler‘s equation) – Grashoff‘s law- Kinematic inversions of four-bar chain and single slider crank chain.
Description of common mechanisms – Quick return mechanisms, Double slider mechanism, pantograph, straight line generators (Peaucellier and Watt mechanisms).

CO6 Design a mechanism for a specific engineering application. 10

Identification of an application, selection and design of suitable mechanism for the application.

CO2 Determine velocity and acceleration of any point on a link in simple mechanisms 9

Analysis of velocity and acceleration in simple mechanisms – Graphical Methods for relative velocity and acceleration polygons – Coriolis acceleration.

CO3 Draw the cam profile for different types of follower and motion requirements 9

Introduction – Terminology, Classifications, Types of follower motion – Uniform velocity Motion, Simple Harmonic Motion, Uniform Acceleration and Retardation Motion and Cycloidal Motion. Graphical layouts of cam profile – Knife edge follower, Roller and flat faced follower.

CO4 Apply gear and gear train fundamentals to select suitable components for specific applications. 9

Types of Gears – Spur gear terminology and definitions – Law of toothed gearing – Involute and cycloidal gear profiles- Contact ratio – Interference and undercutting. Gear trains – Simple, compound and Epicyclic gear trains–speed calculation.

CO5 Apply friction concepts to design clutches and brakes. 9

Dry friction, Friction clutch – single and multi-plateclutch. Brakes – Single and Double Block brakes. Conditions for self-locking and self energizing.

CO7 Analyse and Validate the mechanisms through kinematic principles. 10

Performing kinematic analysis of Mechanism.

CO8 Implement theoretical designs into tangible prototypes. 10

Developing a prototype, and testing.

TEXT BOOKS

1. Rattan SS, “Theory of Machines”, Tata McGraw Hill Publishers, New Delhi, 2017.
2. Robert L Norton, “Design of Machinery”, McGraw Hill Higher Education, 5th Edition, 2013.

REFERENCES

1. Uicker J J, Pennock G R and Shigley J E, "Theory of Machines and Mechanisms",Oxford University Press, 5th Edition, 2017.
2. Ambekar A G, "Mechanism and Machine Theory", Prentice Hall of India, New Delhi, 1st Edition, 2011.

L:45; P:30; TOTAL:75 PERIODS

23GN03C	INTELLECTUAL PROPERTY RIGHTS STUDY	L	T	P	E	C
	(Common to all B.E. / B.Tech. Degree Programmes)	0	0	0	4	2

COURSE OUTCOMES

Upon the successful completion of the course, the student will be able to

Experiential Component

CO1: Survey and practice the basic elements of existing patents.

CO2: Investigate and present the state of art technologies through effectual IP search.

Soft Skill Component

CO3: Present patent survey conclusions

CO1 Survey and practice basic elements of existing patents 30

Basic elements of IPR – claims – infringements – Patent examination and Report - Case studies: patent survey.

CO2 Investigate and present the state of art technologies through effectual IP search 30

Importance of IP search-factors to be considered for effective IP search-Hands-on Practice

REFERENCES

1. D.P. Mittal, "Indian Patents Law and Procedure", Taxman Publication, 2002
2. B.L. Wadera, "Patents, trademarks, copyright, Designs and Geographical Judications", 2010
3. P. Narayanan, "Intellectual Property Law", Eastern Law House, 2022
4. N.S.Gopalakrishnan & T.G.Agitha, "Principles of Intellectual Property", Eastern Book Company, Lucknow, 2009.

E:60 TOTAL:60 PERIODS

23GN06C	**PROJECT MANAGEMENT AND FINANCE** (Common to all B.E. / B.Tech. Degree Programmes)	**L T P E C** **2 0 0 0 2**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Select and formulate projects
CO2: Estimate the project cost and make an investment decision
CO3: Apply the scheduling and resource allocation techniques to control and monitor the project

CO1 Select and formulate projects 10

Project – Concepts –Project Life Cycle – Project constraints- Generation and Screening of Project Ideas - Project identification – Preliminary Analysis, Market, Technical, Financial, Economic and Ecological - Pre- Feasibility Report and its Clearance, Project Estimates and Techno-Economic Feasibility Report, Detailed Project Report – Different Project Clearances required.

CO2 Estimate the project cost and make an investment decision 10

Project Evaluation under certainty –Capital budgeting techniques; Methodology for project evaluation – Social Cost Benefit Analysis, Commercial or National Profitability, social or national profitability.

CO3 Apply the scheduling and resource allocation techniques to control and monitor the project 10

Developing a Project Plan - Developing the Project Network – Constructing a Project Network (Problems) – PERT – CPM – Crashing of Project Network (Problems - Case Study) – Resource Leveling and Resource Allocation – Steps in Project Appraisal Process – Project Control Process – Control Issues – Project Audits – the Project Audit Process – project closure – team, team member and project manager evaluations.

L:30; T:0; TOTAL:30 PERIODS

TEXT BOOKS

1. Clifford Gray, Erik Larson and Gautam Desai, “Project Management: The Managerial Process”, Tata McGraw Hill, 8th Edition, 2021
2. Prasanna Chandra, “Projects, Planning, Analysis, Selection, Financing, Implementation and Review”, Tata Mc-Graw Hill, 2023

REFERENCES

1. M Y Khan, P K Jain , “Management Accounting”, McGraw Hill, 8th Edition, 2021
2. KantiSwarup, P.K.Gupta and Man Mohan, “Operations Research”, S. Chand & Sons, 2019
3. Sudhakar, G P, “Project management: the managerial aspects”, New Century Pub, 5th Edition, 2020.
4. Gopalakrishnan P and Ramamoorthy V.E., “Textbook of Project Management”, Trinity Press, 2022
5. Dr. K.L. Gupta, “Management Accounting”, SahityaBhawan Publications, 2022
6. Prem Kumar Gupta, Dr.D.S.Hira, “Problems in Operation Research (Principles & Solutions)”, Kindle Edition, 2018
7. NPTEL videos:https://nptel.ac.in/courses/110107081

23ME41C	**MACHINING PROCESSES**	**L**	**T**	**P**	**E**	**C**
		3	**0**	**2**	**0**	**4**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

Theory Component

CO1: Infer the forces and heat generated in metal cutting operation and explain their effects on tool wear and surface finish

CO2: Explain different types of lathe and drilling machines and their respective operations.

CO3: Analyze the different flat, profile, and gear machining processes and identify the suitable machining process for the product with locating principles.

CO4: Select suitable finishing process to achieve good surface finish for an industrial component.

CO5: Recognize the need for advancements in the machining process and the environmental-friendly machining process.

Practical Component

CO6: Evaluate the cutting forces, temperature and surface finish in cylindrical machining operations.

CO7: Analyze and optimize process parameters for cylindrical surface machining and hole making operations

CO8: Select and perform appropriate machining operations to produce flat, profiled and gear components

CO1 Infer the forces and heat generated in metal cutting operation and explain their effects on tool wear and surface finish **9**

CO6 Evaluate the cutting forces, temperature and surface finish in cylindrical machining operations. **10**

Metal cutting: mechanics, tools- geometry, nomenclature and signature, Mechanism of chip formation – Merchant circle diagram, Forces and temperature in metal cutting, Tool life – Machinability and surface finish, cutting tool materials and cutting fluids, Tool wear.

Cutting force and Temperature measurement in Lathe machining operations, surface finish measurement using surface roughness tester.

CO2 Explain different types of lathe and drilling machines and their respective operations. **9**

CO7 Analyze and optimize process parameters for cylindrical surface machining and pocketing operations **10**

Cylindrical Surface Machining: operations, process parameters. Machining time calculations. Drilling Machines - process parameters, Design considerations for drilling operations, Machining time calculations.

selection of optimum machining conditions for MRR and Surface finish criteria, and manufacture the product as per the drawing

CO3 Analyze the different flat, profile, and gear machining processes and identify the suitable machining process for the product with locating principles. **9**

CO8 Select and perform appropriate machining operations to produce flat, profiled and gear components **10**

Flat and Profile Machining: Milling operations – Milling machines: process parameters. Planing and shaping machines -operations. Gear machining processes-gear hobbing and gear shaping. Tooling: Jigs and fixtures, principles of location and clamping.

create simple Prismatic parts, generate gear profile

CO4 Select suitable finishing process to achieve good surface finish for an industrial component. **9**

Finishing Processes: Theory of grinding process – Fundamentals of abrasives – Grinding wheels-Grinding operations and machines. Super finishing processes, micro finishing -honing, lapping, nano-finishing

CO5 Recognize the need for and advancements in the machining process and the environmental-friendly machining process. **9**

Unconventional methods: Mechanical, electro-chemical, chemical, Thermal, Optimizing Machining Processes for Reduced Environmental Impacts, Recent trends in machining process.

TEXT BOOKS

1. P.N. Rao, "Manufacturing Technology: Metal Cutting and Machine Tools", McGraw Hill Education, 4th edition, 2018.

REFERENCES

1. S.K. Hajra Choudhury, Nirjhar Roy, "Elements of Workshop Technology:Machine Tools", Media Promoters & Publishers Pvt. Ltd, 2010.
2. Amitabha Ghosh, Asok Kumar Mallik, "Manufacturing Science", OAFF0 Publisher, 2nd Edition, 2010.
3. P.C.Sharma, "A Textbook of Production Technology (Manufacturing Processes)", S. Chand & Company Pvt. Ltd 8th Edition, 2014.
4. SeropeKalpakjian, Steven R.Schmid, "Manufacturing Engineering and Technology", Pearson Education, 7th Edition, 2018.
5. Mikell P. Groover, "Fundamentals of Modern Manufacturing-Materials, Processes, and Systems", John Wiley & Sons Inc. publisher, 7th Edition, 2019.
6. K.C. Jain, A.K. Chitale, "Textbook of Production Engineering", PHI Learning Pvt. Ltd., 2014
7. Geoffrey Boothroyd and Winston. A. Knight, "Fundamentals of Machining and Machine Tools", CRC Press, 3rd Edition, 2005
8. https://nptel.ac.in/courses/112103202
9. https://nptel.ac.in/courses/112104028

L: 45; P: 30; TOTAL: 75 PERIODS

23ME42C	THERMAL ENGINEERING	L	T	P	E	C
		3	0	2	0	4

COURSE OUTCOMES

Upon completion of this course, the students will be able to

Theory Component

CO1: apply thermodynamic concepts to different air standard cycles and calculate the efficiency of IC engines and Gas turbines.
CO2: analyze the performance of vapour power cycles.
CO3: determine the performance of steam nozzles and turbines.
CO4: calculate the performance of Refrigeration system and demonstrate different psychrometric processes
CO5: evaluate the performance parameters of an air compressor

Practical Component

CO6: investigate the performance characteristics of IC engines and draw the valve and port timing diagram

CO7: determine the performance of Refrigerator and Air-conditioning units

CO8: conduct performance study on air compressors

CO1 Apply thermodynamic concepts to different air standard cycles and calculate the efficiency of IC engines and Gas turbines. **9**

CO6 Investigate the performance characteristics of IC engines and draw the valve and port timing diagram **18**

Otto cycle, Diesel cycle, Dual cycle, Brayton (Joule) cycle- Air standard efficiency and mean effective pressure calculations.

I.C Engines –classification and working- Valve Timing and Port timing diagrams - Performance and Heat Balance of I.C. Engines.

Performance and heat balance test, Morse test, Retardation test, Viscosity measurement, Construction of Valve timing and port timing diagrams

CO2 Analyze the performance of vapour power cycles **9**

Simple Rankine cycle, Reheat Rankine cycle, Regenerative Rankine Cycle - Performance calculations. Concept of cogeneration.

Requirements of boiler; Types: Water tube, fire tube, fluidized bed boilers;Boiler performance: Direct and indirect heat balance.

CO3 Determine the performance of steam nozzles and turbines. **9**

Steam Nozzles - Effect of friction, critical pressure ratio, supersaturated flow

Steam Turbines - Impulse and Reaction Types, Components, Working principle, Velocity diagrams and Performance calculations, Compounding and Governing

CO4 Calculate the performance of Refrigeration system and demonstrate different psychrometric processes **9**

CO7 Determine the performance of Refrigerator and Air-conditioning units **6**

Vapour Compression Refrigeration cycle with superheating and sub-cooling, Performance calculations and applications. Working principle of Vapour Absorption Refrigeration System.

Psychrometric properties, Psychrometric processes- heating, cooling, humidification dehumidification, Cooling towers – concept and types

Refrigeration and Air conditioning systems, Cooling Tower - Performance Tests

CO5 Evaluate the performance parameters of an air compressor **9**

CO8 Conduct performance study on air compressor **6**

Reciprocating Compressor - working principle, Performance study - with and without clearance. Multistage air compressor with Intercooling. Rotary compressors - Working principle, Comparison of Rotary compressors with reciprocating air compressors

Rotary & Reciprocating Compressor - Performance Tests

TEXT BOOK

1. Rajput RK, “Thermal Engineering”, 10th Edition, Laxmi Publications, Ltd., 2018

REFERENCE

1. Kothandaraman.C.P.,Domkundwar. S,Domkundwar. A.V., “A course in thermal Engineering",5th Edition, ”DhanpatRai & sons , 2016
2. Yunus A Cengel and Michael a Boles, “Thermodynamics - An Engineering Approach”, 8th

Edition, Tata McGraw-Hill Education, 2015.
3. T.D.Eastop and McConkey, "Applied Thermodynamics for Engineering Technologists" 5th Edition, Pearson Education Ltd, 2009.
4. Mahesh M Rathore, "Thermal Engineering", Tata McGraw-Hill, New Delhi, 2010.
5. S.M Yahya, "Turbines, Compressors and Fans", 4th Edition, Tata McGraw-Hill Education, 2010
6. Arora C P, "Refrigeration and Air-conditioning", Tata McGraw Hill, 2017.
7. John B. Heywood, "Internal Combustion Engine Fundamentals", 2nd Edition, McGraw-Hill Education, USA, 2018.
8. https://nptel.ac.in/courses/112103316

L: 45; P:30; TOTAL:75 PERIODS

23ME43C	STRENGTH OF MATERIALS	L	T	P	E	C
		3	0	2	0	4

COURSE OUTCOMES

Upon completion of this course, the students will be able to

Theory Component

CO1:Analyze stresses, strains, and deformations of structural members subjected to axial load

CO2:Apply Mohr's circle to determine stresses on inclined planes and analyze stresses in thin cylinders

CO3: Analyze the structural members subjected to bending and shear loads.

CO4: Apply theories of failure and analyze the stability of the column

CO5: Determine the twist and shear stresses of the shaft and springs under torsional load

Practical Component

CO6:Analyze materials under tensile and shear forces to evaluate mechanical properties

CO7:Evaluate and compare the structural behavior and load-bearing capacity of steel and timber beam

CO8: Evaluate the strength and resilience of materials through impact tests to make engineering decisions

CO9:Evaluate mild steel rod behavior under torsional stress

CO10:Analyze the load-deflection relationship to determine the spring's stiffness and ascertain its physical properties

CO1 Analyze stresses, strains, and deformations of structural members subjected to axial load **9**

CO6 Analyze materials under tensile and shear forces to evaluate mechanical properties **6**

Introduction, Properties of materials, Stress, Strain and Hooke's law, Stress-strain diagram for brittle and ductile materials, True stress and strain, Factor of safety, Calculation of stresses in straight, Stepped, and tapered sections, Composite sections, Stresses due to temperature change, Shear stress and strain, Lateral strain and Poisson's ratio, Elastic constants and relations between them.

Mechanical properties of steel specimen-Tension test of mild steel specimen- Single and double Shear test of metal specimens -ASTM Standards

CO2 Apply Mohr's circle to determine stresses on inclined planes and analyze stresses in thin cylinders **9**

Stresses on inclined planes, Principal stresses and maximum shear stress, Principal angles, Shear stresses on principal planes, Maximum shear stress, Mohr circle for plane stress conditions.
Thin cylinder: Hoop's stress, maximum shear stress, circumferential and longitudinal strains

CO3 Analyze the structural members subjected to bending and shear loads. 9

CO7 Evaluate and compare the structural behavior and load-bearing capacity of steel and timber beam 6

Type of beams, Loads and reactions, Shear force and bending moments of cantilever beams, Pin support and roller supported beams subjected to concentrated loads and uniformly distributed loads. Slope and deflection of cantilever beam and simply supported beams - Mecaulay's Method
Load-bearing capacity of steel and timber beams under bending stress- Modulus of Elasticity of the materials

CO4 Apply theories of failure and analyze the stability of the column 9

CO8 Evaluate the strength and resilience of materials through impact tests to make engineering decisions 6

Theories of Failure:Maximum Principal stress theory, Maximum shear stress theory, maximum-distortion-energy theory
Buckling of columns: Buckling and stability, Critical load, Euler buckling load- the effect of end conditions on column buckling.

Energy Absorbing Characteristics of Metal Materials- Charpy and Izod impact test- failure patterns and failure surface- ASTM Standards

CO5 Determine the twist and shear stresses of the shaft and springs under torsional load 9

CO9 Evaluate mild steel rod behavior under torsional stress 6

CO10 Analyze the load-deflection relationship to determine the spring's stiffness and ascertain its physical properties 6

Torsion formulation stresses and deformation in circular and hollow shafts – Steppedshafts– Deflection in shafts fixed at both ends – Stress and defection in open and closed coilhelical springs.
Torsion test on mild steel rod-Modulus of rigidity
Helical Springs: Close coiled helical spring and Open coiled helical spring-Load Vs Deflection Relationship Analysis

TEXTBOOKS

1. Hibbeler RC, "Mechanics of Materials", 11th Edition, Prentice Hall, 2022.

REFERENCES

1. Popov EP, "Engineering Mechanics of Solids", 2nd Edition, Prentice-Hall of India, New Delhi, 2015.
2. Ferdinand Beer, E. Johnston, John DeWolf, "Mechanics of Materials", 7th Edition, McGraw-Hill Education, 2014
3. Bansal R.K, "Strength of Materials", 6th Edition, Laxmi Publications,2018
4. Timoshenko SP, "Elements of Strength of Materials", Tata McGraw-Hill, New Delhi, 2004.
5. Irving Granet, "Strength of Materials for Engineering Technology", 2nd edition, Reston Publishing Company, 1980
6. Rajput, "Strength of Materials", S. Chand Publishing, 2018
7. Rattan SS, "Strength of Materials", 3rd Edition, McGraw Hill Education, 2017
8. NPTEL Online course, Strength of Materials IITKGPBy Prof.Sriman Kumar Bhattacharyya, IIT Kharagpur

L: 45; P: 30; TOTAL:75 PERIODS

		L	T	P	E	C
23ME44C	**MACHINE DRAWING**	**1**	**0**	**2**	**0**	**2**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

Theory Component

CO1: Explain the Indian standards for the preparation of machine drawing and blueprint reading.

Practical Component

CO2: Draw the assembled view of the mechanical products from the given part drawing.

CO3: Draw the part drawing of the mechanical products from the given assembly drawing.

CO4: Prepare assembly drawing of mechanical components with codes, standards, and symbols

CO1 Explain the Indian standards for the preparation of machine drawing and blueprint reading. 15

Introduction: Bureau of Indian Standards (BIS) for drawing practice–drawing sheets, Symbols and conventional representation – Different materials, springs, gears and other machine elements, surface roughness, weld symbols and its dimensioning, thread, bolt, nuts, screws, keys.

Dimensioning and tolerancing - Fundamental deviation and Fits - Hole and Shaft basis system - Blueprint reading – Interpretation of information from the given production drawing

CO2 Draw the assembled view of the mechanical products from the given part drawing. (Manual & Using CAD Packages) 10

Assembly drawing: Preparation of assembly drawing from the given part drawings of Screw jack, Swivel bearing and Drilling Jig and Prepare report.

Preparation of assembly drawing from the given part drawings of Screw jack, Swivel bearing and Drilling Jig

CO3 Draw the part drawing of the mechanical products from the given assembly drawing. (Manual & Using CAD Packages) 10

Preparation of part drawing from the given assembly drawings of Steam Stop valve and Machine vice *Preparation of part drawing from the given assembly drawings.*

CO4 Prepare assembly drawing of mechanical components with codes, standards, and symbols (Manual &CAD Packages) 10

Preparation of detailed drawings of assembly or part drawing of IC engine piston, Die set and milling fixture.

Preparation of detailed drawings of assembly or part drawing

TEXT BOOKS

1. K.R.Gopalakrishna, "Machine Drawing", 23rdEdition, Subhas Publications, Bangalore, 2017.
2. K.L. Narayana, P.Kannaiah and K. Venkata Reddy, "Machine Drawing", 6th Edition, New Age International Publishers, New Delhi, 2019.

REFERENCES

1. ThamosP.Olivo and Dr.C.ThamosOlivo, "Basic Blueprint Reading and Sketching", 9th Edition, Industrial Press Inc, New York, 2010.
2. PS. Gill, "A Textbook of Machine Drawing", 18th Edition Reprint, S. K. Kataria & Sons. New Delhi. 2013.

3. RK. Dhawan, "A Textbook of Machine Drawing", 1st Edition, Sultan Chand and Sons, New Delhi, 2015.
4. N. D. Bhat, V M Panchal "Machine Drawing" – Charotar Publication House – 2014
5. BIS recommendation for school practices: SP46:2003
6. Sp46 codes - https://law.resource.org/pub/in/bis/S01/is.sp.46.2003.pdf

L:15; P:30; TOTAL:45 PERIODS

23ME45C	SYSTEM MODELING	L	T	P	E	C
		0	0	2	2	2

COURSE OUTCOMES

Upon completion of this course, the students will be able to

Practical component:

CO1: Understand system modeling and various mathematical modeling techniques.

CO2: Apply mathematical modeling techniques to the equations of motion.

CO3: Develop skills in simulation and analysis of mechanical systems.

Experiential component:

CO4: Formulate mathematical models for any type of motion.

CO5: Develop and simulate mathematical models involving gear terminology.

CO1 Understand system modeling and various mathematical modeling techniques. 12

Introduction to system modeling: Overview and significance - Types of systems: Linear vs. non-linear, static vs. dynamic.

Understanding different modeling methods (e.g., analytical, numerical), Representing force systems using block diagrams, Applying mathematical modeling techniques to various systems, Formulating numerical equations to determine the unknown reactions for loaded levers and beams.

CO2 Apply mathematical modeling techniques to the equations of motion. 12

Equations of motion – Framing the equations for rectilinear motion at uniform and variable acceleration.

Formulation of Simple Equations and Applying Curve Fitting,

Formulation of Equations of Motion for Rectilinear Motion under Uniform and variable Acceleration.

CO4 Formulate mathematical model for the motion of a particle. 12

Frame mathematical model to characterize particle movement

CO3 Develop skills in simulation and analysis of mechanical systems. 12

Introduction to Simulink: Overview and basics of MATLAB-based graphical programming - Modeling mechanical systems (gears) using Simulink - Solving differential equations in mechanical systems.

Developing mathematical models for calculating the torque for single and multi-plate clutches. Introduction to simple fluid flow problems: Bernoulli's equation, laminar and turbulent flow. Simple heat transfer problems.

CO5 Develop and simulate mathematical models involving gear terminology. 12

Model the equations for the law of gearing.

REFERENCES

1. Karnopp DC, Margolis DL, Rosenberg RC, "System Dynamics: Modeling, Simulation, and Control of Mechatronic Systems," 5th Edition, John Wiley & Sons, 2012.
2. Cha PD, Rosenberg JJ, Dym CL, "Fundamentals of Modeling and Analyzing Engineering Systems," Cambridge University Press, 2000.
3. Mukherjee A, Karmakar R, "Modeling and Simulation of Engineering Systems through Bondgraphs," Narosa, 2000.
4. Hibbeler RC, "Engineering Mechanics: Statics & Dynamics," Pearson India Education Services, 14th Edition, 2018.
5. Rattan SS, "Theory of Machines," Tata McGraw Hill Publishers, New Delhi, 2017.
6. NPTEL Course: https://nptel.ac.in/courses/110101142
7. NPTEL Course: https://nptel.ac.in/courses/112107214

P: 36; E:24; TOTAL:60 PERIODS

Course Code	LINEAR ALGEBRA, MATHEMATICAL LOGIC AND SET THEORY	L	T	P	E	C
23SH01E		2	1	0	0	3

COURSE OUTCOMES:

Upon successfully completing the course, the students will be able to:

CO1: analyze concepts of vector spaces. (CDL 1)

CO2: measure the similarity between different datasets using Inner product spaces. (CDL 1)

CO3: decompose the matrix for computational convenience. (CDL 1)

CO4: illustrate the validity of the arguments. (CDL 1)

CO5**:** analyze the concepts of Sets, Relations and Functions. (CDL 1)

CO1: analyze concepts of vector spaces **L:6 T:3**

Vector spaces – Subspaces – Linear combinations – linear span - Linear independence and linear dependence – Bases and dimensions.

CO2: measure the similarity between different datasets using Inner product spaces **L:6 T:3**

Linear transformation - Null spaces and ranges – Rank Nullity theorem - Matrix representation of a linear transformations - Inner product space - Norms - Orthonormal Vectors - Gram Schmidt orthogonalisation process**.**

CO3: decompose the matrix for computational convenience **L:6 T:3**

Generalized eigenvector - QR decomposition- generalized inverse - Singular value decomposition and applications – Pseudo Inverse.

CO4: illustrate the validity of the arguments. **L:6 T:3**

Propositional Logic – Equivalences and Implications – Normal forms – Predicate Calculus and Quantifiers - Rules of inference – Proof methods and Strategies - Forward Proof, Proof by Contradiction, Proof by Contraposition, Proof of Necessity and Sufficiency.

CO5: analyze the concepts of Sets, Relations and Functions **L:6 T:3**

Basic Definitions - Set operations – Laws of set theory – Relations – Properties of relations - Partial Ordering Relation - Equivalence Relation - Matrices of relations - Closure of relations – Functions – Bijective functions - Inverse and Compositions of functions.

TEXT BOOKS

1. Kenneth H.Rosen, Discrete Mathematics and its Applications (with Combinatory and Graph Theory), Special Indian Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 8th Edition, 2021.
2. Bernard Kolman and David Hill, "Elementary Linear Algebra with Application" Pearson India, 9th Edition, 2019.
3. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2017.

REFERENCE BOOKS

1. Trembly J.P and Manohar.R. Discrete Mathematical Structures with Applications to Computer Science, 1st Edition, Tata McGraw-Hill Pub. Company Limited, New Delhi,2017.
2. Friedberg, A.H., I nsel,A.J.and Spence, L., Elementary Linear Algebra, a matrix approach, 2nd Edition pearson Publication.
3. Raju.K.George and Abhijith Ajayakumar, A course in Linear Algebra, Springer, 2024.
4. Seymour Lipschutz Marc Lipson., "Linear Algebra" Schaum's Out lines series, 6th Edition, McGraw – Hill Education, 2018.

L : 30; T :15; TOTAL : 45 PERIODS

Course Code	LINEAR STRUCTURES AND	L	T	P	E	C
23SH02E	TRANSFORMATIONS	2	1	0	0	3

COURSE OUTCOMES:

Upon successfully completing the course, the students will be able to:

CO1: solve the linear system of equations. (CDL 1)

CO2: determine the dimension of vector spaces. (CDL 1)

CO3: find the orthonormal vectors using Inner product spaces. (CDL 1)

CO4: illustrate Jordan canonical form on a finite dimensional vector space. (CDL 1)

CO5:decompose the matrix using Generalized Eigen vectors for computation.(CDL 1)

CO 1: solve the linear system of equations **L:6**

General system of linear equations – Matrices– Echelon form of matrix- Solving linear systems- Consistency of a system of linear equations -LU factorization. **T:3**

CO2: determine the dimension of vector spaces

Vector spaces – Subspaces – Linear combinations – linear span - Linear independence and linear dependence – Bases and dimensions. **L:6 T:3**

CO3: find the orthonormal vectors using Inner product spaces

Linear transformation - Null spaces and ranges – Rank Nullity Theorem - Matrix representation of a lineartransformations - Inner product space - Norms - Orthonormal Vectors - Gram Schmidt orthogonalisation process. **L:6 T:3**

CO4: illustrate Jordan canonical form on a finite dimensional vector space

Generalized eigenvector- Chains- Canonical basis the minimum polynomial- - Algebraic and Geometric multiplicity of Eigen Values - Similar matrices-Modal matrix-Jordan canonical form. **L:6 T:3**

CO5: decompose the matrix using Generalized Eigen vectors for computation

Eigen-values using QR transformations – Generalized Inverse Eigen vectors – Canonical forms – Singular value decomposition and applications – Pseudo inverse **L:6 T:3**

TEXT BOOKS

1. Bernard Kolman and David Hill, “Elementary Linear Algebra with Application” Pearson India, 9th Edition 2019.
2. Seymour Lipschutz Marc Lipson., “Linear Algebra” Schaum’s Out lines series, Six edition, McGraw – Hill Education, 2018.

REFERENCE BOOKS

1. Friedberg, A.H., I nsel,A.J.and Spence, L., Elementary Linear Algebra, A Matrix Approach, 2nd Edition, Pearson 2019.
2. Jim Defranza. Daniel Gagiardi “Introduction to Linear Algebra with Applications” Waveland Pr Lnk, 2015.
3. Eggar.Goodaire “Linear Algebra Pure & Applied”, World Sceintific, New Delhi, first edition, 2015.
4. Raju.K.George and Abhijith Ajayakumar, A course in Linear Algebra, Springer, 2024.

L : 30; T :15; TOTAL : 45 PERIODS

Course Code		L	T	P	E	C
23SH03E	**NUMBER THEORY**	2	1	0	0	3

COURSE OUTCOMES:

Upon successfully completing the course, the students will be able to:

CO1: acquire the concepts of theory of numbers. (CDL 1)

CO2: apply the fundamental propositions to interpret solutions of congruence. (CDL 1)

CO3: find the primitive roots for the congruence. (CDL 1)

CO4: analyze the inter-relation between arithmetical functions. (CDL 1)

CO5: determine quadratic residues of congruence. (CDL 1)

CO1 : acquire the concepts of theory of numbers

Introduction – Divisibility- Greatest common divisor - Prime numbers - The fundamental theorem of arithmetic - The series of reciprocals of the primes - The Euclidean algorithm(without Proof) - The greatest common divisor of more than two numbers. **L:6 T:3**

CO2 : apply the fundamental propositions to interpret solutions of congruence

Congruence - Linear congruence - Euler-Fermat theorem - Polynomial congruence modulo p – Wilson's Theorem **L:6 T:3**

CO3: analyze the inter-relation between arithmetical functions.

The Mobius function μ(n) – The Euler Totient function φ(n)– A relation connecting φ and μ – A product formula for φ(n) – properties of φ(n) –Multiplicative functions– completely multiplicative function. **L:6 T:3**

CO4: determine quadratic residues of congruence

Quadratic Residues – Legendre's symbol and its properties – Evaluation of (-1|p) and (2|p) – Gauss lemma – The Quadratic Reciprocity law – Applications – The Jacobi symbol. **L:6 T:3**

CO5: implement the concepts of congruence in cryptography

Chinese remainder theorem - Applications of Chinese remainder theorem - Cryptography and its application – RSA algorithm and Rabin Cryptosystem. **L:6 T:3**

TEXT BOOKS

1. Tom M.Apostol, "Introduction to Analytic Number Theory", Springer International Edition, Narosa Publishing House, New Delhi, 2013.
2. G.A.Jones & J.M.Jones, "Elementary Number Theory", Springer publications, 2012.

REFERENCE BOOKS

1. David M.Burton, "Elementary Number Theory", McGraw Hill, 7th Edition,2023
2. Joseph H.Silverman, "A Friendly Introduction to Number Theory", Pearson Education, 4th Edition, 2019.
3. Titu Andreesu, Gabriel Dospinescu, Oleg MushKarov, Number Theory: concepts and problems, Springer Science & Business Media, 2017.
4. S B Malik , "Basic Number Theory", S Chand publications, 2nd Edition, 2018

L : 30; T :15; TOTAL : 45 PERIODS

Course Code	NUMERICAL ANALYSIS	L	T	P	E	C
23SH04E		2	1	0	0	3

COURSE OUTCOMES:

Upon successfully completing the course, the students will be able to:

CO1: solve algebraic and transcendental equations using numerical methods. (CDL 1)

CO2: interpolate and approximate the polynomial of data. (CDL 1)

CO3: perform numerical differentiation and integration. (CDL 1)

CO4: find numerical solution of ordinary differential equation. (CDL 1)

CO5: classify and find numerical solution of partial differential equations. (CDL 1)

CO 1: solve algebraic and transcendental equations using numerical methods

Solutions of Algebraic linear equations Newton - Raphson Method, Fixed Point Iteration method - Solutions of algebraic simultaneous linear equations - Gauss Elimination –Gauss Seidel Methods. **L:6 T:3**

CO 2: interpolate and approximate the polynomial of data

Curve Fitting – Method of Least Squares – Fitting a Straight Line – Fitting a Second Degree Parabola - Finite differences - Newton's Forward & Backward Difference Formulae - Central Differences - Stirling's Formula - Lagrange's Formula. **L:6 T:3**

CO 3: perform numerical differentiation and integration

Derivatives using forward and backward difference Formulae - Trapezoidal rule - Simpson's rules - Double integration using Trapezoidal and Simpson's rules. **L:6 T:3**

CO 4: find numerical solution of ordinary differential equation

Taylor's Series Method - Euler's Method – Runge Kutta fourth order Method – Predictor - corrector Methods - Milne's Method - Finite difference for solving ordinary differential equation. **L:6 T:3**

CO 5: classify and find numerical solution of partial differential equations

Classification of Partial Differential Equations of second order - Finite difference solution of one dimensional heat equation by explicit and implicit methods (Crank Nichelson and Bender Schmidth methods) - One dimensional wave equation and two dimensional Laplace and Poisson equations. **L:6 T:3**

TEXT BOOKS

1. Grewal, B.S., "Numerical Methods in Engineering & Science: With Programs in C, C++ & MATLAB", 11th Edition, Khanna Publishers, New Delhi, 2014.
2. M.K.Jain, S.R.K.Iyengar, R.K.Jain "Numerical Methods for scientific and Engineering Computation", 6th Edition, New age International Publishers, 2019.
3. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, J. Wiley and Sons, 2023.

REFERENCE BOOKS

1. Chapra, S. C and Canale, R. P. "Numerical Methods for Engineers", 8th Edition, Tata McGrawHill, New Delhi, 2021.
2. Saumyen Guha, Rajesh Srivastava "Numerical Methods: For Engineering and Science", Oxford University Press, New Delhi, 1st Edition with third impression, 2015.
3. K.Sankara Rao , "Numerical Methods For Scientists And Engineers", 5th Edition, New age International Publisher, 2018
4. Dr Chaitanya Kumar, Dr Harinderjit Kaur Chawla, Dr Indarpal Singh "A Textbook on Numerical Methods and Analysis" Sultan Chand and Sons Publisher, 2024

L : 30; T :15; TOTAL : 45 PERIODS

Course Code		L	T	P	E	C
23SH05E	**OPTIMIZATION TECHNIQUES**	**2**	**1**	**0**	**0**	**3**

COURSE OUTCOMES:

Upon successfully completing the course, the students will be able to:

CO1: find optimum solution of linear programming problem. (CDL 1)

CO2: determine the optimum schedule for assignment and transportation problems. (CDL 1)

CO3: acquire decision making in Pure and Mixed Strategies. (CDL 1)

CO4: analyze the network for optimal schedule. (CDL 1)

CO5: compute optimum solution of non-linear programming. (CDL 1)

CO1: find optimum solution of linear programming problem

Linear Programming Problem – Mathematical Formulation of Linear Programming Problems (LPP) – Graphical Solution Method - Canonical and Standard Forms of LPP - Simplex Method - Linear Programming using Artificial Variables - Two Phase Method. **L:6 T:3**

CO2:acquire decision making in Pure and Mixed Strategies

Basic Terms in Game Theory - Two-Person Zero-Sum Games - Maximin-Minimax Principal - Games without Saddle Points - Mixed Strategies-Pure and Mixed Strategies with Saddle Point- Mixed Strategy Problems by Arithmetic Method- Graphic Solution of $2 \times n$ and $m \times 2$ Games. **L:6 T:3**

CO3: analyze the network for optimal schedule

Development of Network Analysis - Network Analysis and Rules of Network Construction - Critical Path Method (CPM) - Programme Evaluation and Review Technique (PERT). **L:6 T:3**

CO4: compute optimum solution of non – linear programming

Formulating a Non-Linear Programming Problem – Constrained Optimization with equality Constraints- Graphical Solution – Kuhn- Tucker Conditions with Non negative constraints- Quadratic Programming – Wolfe's modified Simplex method. **L:6 T:3**

CO5: solve non-linear constrained optimization

Optimization using Gradient Descent – Constrained optimization - Lagrange Multipliers - Convex optimization - Non linear Constrained Optimization. **L:6 T:3**

TEXT BOOKS

1. KantiSwarup, Gupta P.K and Man Mohan, Operations Research: Introduction to management Science, Sultan Chand &Sons, 20th Revised Edition, 2022.
2. Hamdy A Taha, Operations Research - An Introduction, 10th Edition, Pearson Education, 2019.

REFERENCE BOOKS

1. Sharma JK., Operations Research, Trinity, New Delhi, 6th Edition, 2017.
2. Sundaresan.V, Ganapathy Subramanian. K.S. and Ganesan.K, Resource Management Techniques, A.R. Publications, 11th Edition, 2017.
3. Gupta P K, Mohan Man, Problems in Operations Research, Sultan Chand & Sons, 2014
4. V K Kapoor, Operations Research , Concept problems & solutions, Sultan Chand & Sons, 2017

L : 30; T :15; TOTAL : 45 PERIODS

Course Code	PRINCIPLES OF DISCRETE MATHEMATICS	L	T	P	E	C
23SH06E		2	1	0	0	3

COURSE OUTCOMES:

Upon successfully completing the course, the students will be able to:

CO1: illustrate the validity of the arguments. (CDL 1)
CO2: analyze the concepts of Sets, Relations and Functions. (CDL 1)
CO3: perform the principles of counting and solve recurrence relations. (CDL 1)
CO4: interpret the basic concepts of graphs. (CDL 1)
CO5: compute minimum Spanning Trees and shortest route for the graph. (CDL 1)

CO1: illustrate the validity of the arguments.

Propositional Logic – Equivalences and Implications – Normal forms – Rules of inference – Proof methods and Strategies - Forward Proof, Proof by Contradiction, Proof by Contraposition, Proof of Necessity and Sufficiency. **L:6 T:3**

CO2: analyze the concepts of Sets, Relations and Functions

Basic Definitions - Set operations – Laws of set theory – Relations – Properties of relations - Equivalence Relation - Matrices of relations - Closure of relations – Functions – Bijective functions - Inverse and Compositions of functions. **L:6 T:3**

CO3: perform the principles of counting and solve recurrence relations.

Mathematical induction - Strong induction and well ordering -The basics of counting – The pigeonhole principle - Recurrence relations – Solving linear recurrence relations – Generating functions - Inclusion and exclusion principle. **L:6 T:3**

CO4:interpret the basic concepts of graphs

Graphs and their properties - Special types of graphs – Matrix representation of graphs and graph isomorphism- Euler and Hamiltonian graphs. **L:6 T:3**

CO5: compute minimum Spanning Trees and shortest route for the graph

Trees – Some properties of Trees – Pendant vertices in a Tree – Distance and centers in a Tree – Rooted and Binary Trees - Spanning Trees- minimum spanning tree–Prim's algorithm. **L:6 T:3**

TEXT BOOKS

1. Kenneth H.Rosen, Discrete Mathematics and its Applications (with Combinatory and Graph Theory), Special Indian Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 8th Edition, 2021.
2. Trembly J.P and Manohar.R. Discrete Mathematical Structures with Applications to Computer Science, first Edition, Tata McGraw-Hill Pub. Company Limited, New Delhi, 2020.
3. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, 1st Edition, Dover Publications Inc., 2016.

REFERENCE BOOKS

1. Ralph .P. Grimaldi, Discrete and Combinatorial Mathematics: An Applied Introduction, 5th Edition, Pearson Education Asia, Delhi, 2019.
2. Bondy, J.A., Murty.U.S.R., Graph Theory with applications, North Holland publication, 2008.
3. K.Balakrishnan, Schaum's Outline of Graph Theory, Tata Mc Graw-Hill Pub, 2020.
4. Richard J.J, Introduction to Graph Theory, 1st Edition, Parker Pub. Company, 2017.

L : 30; T :15; TOTAL : 45 PERIODS

Course Code	**RANDOM PROCESSES AND QUEUEING THEORY**	**L**	**T**	**P**	**E**	**C**
23SH07E		**2**	**1**	**0**	**0**	**3**

COURSE OUTCOMES:

Upon successfully completing the course, the students will be able to:

CO1: interpret the basic characteristic features of Random processes. (CDL 1)

CO2: encapsulate the time averages of uncertain events. (CDL 1)

CO3: evaluate spectral densities of functions. (CDL 1)

CO4: analyze the characteristics of Markovian queues. (CDL 1)

CO5**:**apply the concepts of queuing theory in networks.(CDL 1)

CO1: interpret the basic characteristic features of Random processes **L:6 T:3**

Classification - Stationary process - Markov process - Markov chains - Transition probabilities.

CO2 : encapsulate the time averages of uncertain events **L:6 T:3**

Counting Process - Ergodic process - Poisson Process - Renewal Processes - Gaussian process.

CO3 :evaluate spectral densities of functions **L:6 T:3**

Auto correlation - Cross correlation – Power spectral density–Cross spectral density-Properties–Wiener – Khintchine theorem (without proof).

CO4 : analyze the characteristics of Markovian queues

Markovian models – Birth and Death Queuing models- Steady state results: Single and multiple server queuing models- queues with finite waiting rooms- Finite source models- Little's Formula. **L:6 T:3**

CO5: apply the concepts of queuing theory in networks **L:6 T:3**

M/G/1 queue- Pollaczek- Khintchine formula, series queues- open and closed networks.

TEXT BOOKS

1. Oliver C. Ibe, "Fundamentals of Applied Probability and Random processes", Academic Press, 2nd Edition, 2014.
2. Hwei Hsu, "Schaum's Outline of Theory and Problems of Probability, Random Variables and Random Processes, Tata McGraw-Hill Education, 3rd Edition, 2017.
3. John F Shortle, James M Thompson, Donald Gross and Carl M Harris, "Fundamentals of Queueing Theory", Wiley and Sons Publication Limited, 5th Edition, 2018.

REFERENCE BOOKS

1. Miller.S.L and Childers, S.L, Probability and Random Processes with applications to Signal Processing and Communications, Elsevier Inc., 2nd Edition, 2012.
2. Peyton. Z. Peebles Jr., Probability Random Variables and Random Signal Principles, 4th Edition, Tata McGraw-Hill Publishers, New Delhi, 2017.
3. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2017.

L : 30; T :15; TOTAL : 45 PERIODS

Course Code	STATISTICAL TECHNIQUES AND NUMERICAL	L	T	P	E	C
23SH08E	METHODS	2	1	0	0	3

COURSE OUTCOMES:

Upon successfully completing the course, the students will be able to:

CO1: calculate the various measures of dispersion. (CDL 1)
CO2: apply the principles of hypothesis testing in small and large samples. (CDL 1)
CO3: analyze the variances in design of experiments. (CDL 1)
CO4: find solution of linear equations and to perform differentiation and integration numerically. (CDL 1)
CO5: compute numerical solution of differential equations. (CDL 1)

CO1: calculate the various measures of dispersion

Central tendencies - Mean, median, mode - Measures of Dispersion –Mean deviation, and Quartile deviation–Moments– Skewness –Kurtosis - Correlation and Regression. **L:6 T:3**

CO2: apply the principles of hypothesis testing in small and large samples

Sampling distributions - Statistical hypothesis - Large sample testsbased on Normal distribution for single mean and difference of means -Tests based on t, and F distributions - Chi-square - Contingency table for independent of attributes – Goodness of fit. **L:6 T:3**

CO3: analyze the variances in design of experiments

One way and two way classifications - Completely randomized design – Randomized block design – Latin square design – 2^2 factorial design. **L:6 T:3**

CO4: find solution of linear equations and to perform differentiation and integration numerically

Solution of algebraic and transcendental linear equations - Newton - Raphson Method- Solution of simultaneous equations – Gauss Elimination method – Gauss Seidel method – Interpolation – Lagrange's Method - Numerical Differentiation – Newton's forward difference and backward difference formula – Numerical integration - Single integration using Trapezoidal and Simpson's 1/3 rd and 3/8 th rules. **L:6 T:3**

CO5: compute numerical solution of differential equations

Taylor's Series Method – Euler's Method – Runge Kutta fourth order Method – Predictor - corrector Methods – Milne's Method - Solution of one dimensional heat equation by explicit and implicit methods(Crank Nichelson and Bender Schmidth methods) - Two dimensional Laplace and Poisson equations. **L:6 T:3**

TEXT BOOKS

1. Richard A. Johnson, "Miller and Freund's Probability and Statistics for Engineers", 9th Edition, Pearson Education Private Ltd., 2018.
2. Grewal, B.S., "Numerical Methods in Engineering & Science: With Programs in C, C++ & MATLAB", 11thEdition, Khanna Publishers, New Delhi, 2014.

REFERENCE BOOKS

1. Dharmaraja Selvamuthu, Dipayan Das, Introduction to Statistical Methods, Design of Experiments and Statistical Quality Control, Springer Verleg Singapore Pvt. Ltd., 2018.
2. S.C. Gupta and V.K. Kapoor, "Fundamentals of Mathematical Statistics, 12th Edition, Sultan Chand & Sons, Delhi, 2014.
3. M.K.Jain, S.R.K.Iyengar, R.K.Jain "Numerical Methods for scientific and Engineering Computation", 6th Edition, New age International Publishers, 2019.
4. Chapra, S. C and Canale, R. P. "Numerical Methods for Engineers", 8th Edition, Tata McGraw - Hill, New Delhi, 2021.

L : 30; T :15; TOTAL : 45 PERIODS

Course Code	TRANSFORMS, MATHEMATICAL LOGIC AND SET THEORY	L	T	P	E	C
23SH09E		2	1	0	0	3

COURSE OUTCOMES:

Upon successfully completing the course, the students will be able to:

Theory Components:

CO1: apply Laplace transform to solve ordinary differential equations. (CDL 1)

CO2: compute the Fourier transforms of various functions. (CDL 1)

CO3: solve difference equations using Z-Transform. (CDL 1)

CO4: illustrate the validity of the arguments. (CDL 1)

CO5**:** analyze the concepts of Sets, Relations and Functions. (CDL 1)

) 1 : apply Laplace transform to solve ordinary differential equations

finition of Laplace transform and its inverse – Transforms of elementary functions – Properties – Transforms of periodic functions – Initial and final value theorems – Convolution theorem.- solutions of linear ordinary differential equations with constant coefficients. **L:6 T:3**

)2 : compute the Fourier transforms of various functions

urier Integral theorem (without proof)–Fourier transform pair–Fourier Sine and Cosine transforms– Properties–Transforms of simple functions–Convolution theorem –Parseval's theorem. **L:6 T:3**

)3 : solve difference equations using Z-Transform

transform –Elementary properties – Inverse Z–transform – Convolution theorem- Initial and final value theorem – Formation of difference equations –Solutions of difference equations using Z–transform. **L:6 T:3**

CO4: illustrate the validity of the arguments.

)positional Logic – Equivalences and Implications – Normal forms – Rules of inference – Proof methods and Strategies - Forward Proof, Proof by Contradiction, Proof by Contraposition, Proof of Necessity and Sufficiency. **L:6 T:3**

CO5: analyze the concepts of Sets, Relations and Functions

Basic Definitions - Set operations – Laws of set theory – Relations – Properties of relations - Equivalence Relation - Matrices of relations - Closure of relations – Functions – Bijective functions - Inverse and Compositions of functions **L:6 T:3**

TEXT BOOKS

1. Grewal.B.S. "Higher Engineering Mathematics", 44th Edition, Khanna Publications, Delhi, 2021.
2. Kenneth H.Rosen, Discrete Mathematics and its Applications, Tata McGraw-Hill Publishing Company Limited, New Delhi, 8th Edition, 2021.
3. Erwin Kreyszig, "Advanced Engineering Mathematics", 10thEdition, Wiley India, 2017.

REFERENCE BOOKS

1. Ramana B.V, "Higher Engineering Mathematics", Tata Mc-Graw Hill Education, New Delhi, 2017.
2. Trembly J.P and Manohar.R. Discrete Mathematical Structures with Applications to Computer Science, 1st Edition, Tata McGraw-Hill Pub. Company Limited, New Delhi, 2017.
3. J K Goyal, K.P.Gupta, Laplace and Fourier Transforms, Pragati Prakashan, 2016

L : 30; T :15; TOTAL : 45 PERIODS

Course Code	FUNDAMENTALS OF LASER TECHNOLOGY	L	T	P	E	C
23SH10E		3	0	0	0	3

COURSE OUTCOMES:

Upon successfully completing the course , the students will be able to:

CO1: explain the fundamentals of lasers (CDL1)

CO2: demonstrate the laser surface modification process (CDL1)

CO3: describe the laser machining processes (CDL1)

CO4: identify the laser measurement and testing process (CDL1)

CO5: organizethe advanced applications and safety measures of laser (CDL1)

CO1: explain the fundamentals of lasers

Characteristics of laser -laser principle- population inversion-line broadening mechanisms-Q switching - threshold condition for laser-three-level and four-level systems-conditions for continuous wave (CW) and pulsed laser action- pumping schemes-classification of lasers: Er:YAG - carbon dioxide lasers - argon laser - X-Ray lasers - fiber lasers - Raman lasers. **L:9**

CO2: demonstrate the laser surface modification process

Laser surface heat treatment: process parameters - advantages and disadvantages of laser surface treatment; laser surface melting - laser direct metal deposition: processing parameters - methods for applying the coating material- laser alloying and cladding - advantages and disadvantages -laser physical vapor deposition - laser shock peening: analysis - advantages and disadvantages **L:9**

CO3: describe the laser machining processes

Laser welding parameters: beam power, spot diameter and traverse speed; welding efficiency; mechanism of laser welding: conduction mode welding, keyhole welding; laser cutting – process characteristics-fusion cutting, sublimation cutting, photochemical ablation;laser drilling –single pulse drilling-percussion drilling, trepanning applications - laser marking - dot matrix marking, engraving, image micro machining -lasers for marking - application **L:9**

CO4: identify the laser measurement and testing process

Laser for measurement - distance -length-velocity-acceleration-current-voltage-atmospheric effect-laser application in spatial frequency filtering. **L:9**

Holography: basic principle - methods - Holographic interferometry and applications-holography for non – destructive testing – holographic components

CO5: organizethe advanced applications and safety measures of laser

Laser advanced application in defence-laser weapons- industry for material handling: ASRS and AGV- medicine -laser activated therapy - photodynamic therapy, laser angioplasty, lasers in surgery - photocoagulation, photodisruption and photoablation - laser scanning confocal microscopy - Laser safety - danger - safety limits for eye and skin - class four safety arrangements - electric hazards- chemical hazards - fume hazards - explosion hazards - safety guidelines **L:9**

TEXTBOOKS:

1. William M. Steen, “Laser Material Processing”, Springer Verlag, 2010
2. K.Thyagarajan, AjoyK.Ghatak, “Lasers, Theory and Applications”, Springer, 2nd Edition, 2011.
3. Chunlei Guo, Subhash Chandra SinghHandbook of Laser Technology and Applications Lasers Applications: Materials Processing and Spectroscopy, 2nd Edition, (Vol.3), 2021

REFERENCES:

1. Uday Shanker Dixit, Shrikrishna N. Joshi, J. Paulo Davim, “Application of Lasers in Manufacturing” Springer Singapore, 1st Edition, 2019

2. Stephan Wieneke and Christoph Gerhard, "Lasers in Medical Diagnosis and Therapy Basics, applications and future prospects" IOP Publishing Ltd, 2018
3. AK Katiyar, CK Pandey and Manisha Bajpai, "Fundamentals of Laser Systems and Applications", Wiley, 2017.

L : 45; TOTAL : 45 PERIODS

Course Code		L	T	P	E	C
23SH11E	**NANOMATERIALS FOR ENGINEERS**	**3**	**0**	**0**	**0**	**3**

COURSE OUTCOMES:

Upon successfully completing the course , the students will be able to:

CO1: explain the fundamentals of nanomaterials (CDL1)

CO2: interpret the different properties of nanomaterials (CDL1)

CO3: demonstrate the synthesis of nanomaterials (CDL1)

CO4: illustrate the characterization of nanomaterials (CDL1)

CO5: organize the applications of nanomaterials(CDL1)

CO1: explain the fundamentals of nanomaterials

Introduction to nanomaterials - size effect - specific surface area - surface to volume ratio - quantum confinement effects - morphology - density - melting point - wettability - classification based on the dimension - nanoparticles - nanowires - nanoclusters - nanotubes - quantum wells - metal based nanomaterials - nanocomposites - carbon nanotubes - nanosized metals - alloys - semiconductors - ceramics **L:9**

CO2: interpret the different properties of nanomaterials

Mechanical behavior- comparison of bulk and nano materials - elastic and plastic deformation - tensile strength - superplasticity -hardness - nano hardness -influence of porosity - grain size – thermodynamics of nanoparticles- heat capacity – phase transformation of nanoparticles- electrical and optical properties: electrical conductivity in nano tubes, nano rods and nanocomposites - photoconductivity of nanorods - electroluminiscesnce in nanoparticles- magnetic properties: magnetic hysteresis - superparamagnetism **L:9**

CO3: demonstrate the synthesis of nanomaterials

Bottom-up and top-down approach - inert gas condensation - plasma arc technique - ion sputtering - ball milling - molecular beam epitaxy - chemical vapour deposition - method - electrodeposition - ultrasonication - microemulsions method - solvothermal synthesis - microwave assisted synthesis. **L:9**

CO4: illustrate the characterization of nanomaterials

X-ray diffraction - energy dispersive spectrum - atomic force microscopy - high resolution transmission electron microscopy - Raman spectroscopy - x-ray photoelectron spectroscopy - electrochemcial characterization measurements - cyclic voltammetry - linear sweep voltametry - Brunauer-Emmett-Teller - surface area analysis - nanoindentation - determination of nano hardness. **L:9**

CO5: organize the applications of nanomaterials

Functional graphene - carbon nanotube - polymer composite applications in defence and aerospace - nanomaterials for solar cells - nanoscale catalysts for energy and automobile industries - rechargeable batteries based on nanomaterials - nanomaterials for electrodes and wearable electronics - nano based coating and paints - nanosensors -gas sensors - bio sensors **L:9**

- nano electro mechanical systems

TEXTBOOKS:

1. Charles P Poole, Frank J Ownes, Introduction to Nanoscience and Nanotechnology, An Indian Adaption, Wiley, 2020
2. Hornyak, G.Louis, Tibbals, H.F., Dutta, Joydeep, Fundamentals of Nanotechnology, CRC Press, 1st Edition, 2018
3. Dieter Vollath, Nanomaterials an introduction to synthesis, properties and applications, Wiley, 2nd Edition, 2013

REFERENCES:

1. Narendra Kumar, Sunita Kumbhat, Essentials in Nanoscience and Nanotechnology, Wiley, 1st Edition, 2016
2. G. Cao,Ying Wang, Nanostructures and nanomaterials: Synthesis, properties and applications, Imperial College Press, 2nd Edition, 2011
3. B.S. Murty , P. Shankar , Baldev Raj , B B Rath , James Murday, Textbook of Nanoscience and Nanotechnology, Springer, 1st Edition, 2013

L : 45; TOTAL : 45 PERIODS

Course Code		**L**	**T**	**P**	**E**	**C**
23SH12E	**PHOTONICS**	**3**	**0**	**0**	**0**	**3**

COURSE OUTCOMES:

Upon successfully completing the course , the students will be able to:
CO1: explain the basics of photonics (CDL1)
CO2: demonstrate the properties of photonic crystal (CDL1)
CO3: outline the basics of bio photonics (CDL1)
CO4: interpret the quantum confinement in photonic materials(CDL1)
CO5: organize the applications of photonic materials (CDL1)

CO1:explain the basics of photonics

Wave phenomena – interference, diffraction-photon properties - energy, flux, statistics-Interaction of photons with atoms-optical amplification-three and four level system -EDFA-semiconductor light sources-detectors-light manipulation - birefringence - Faraday's rotation - interaction of light with RF and acoustic waves - Raman-Nath diffraction experiment . **L:9**

CO2: demonstrate the properties of photonic crystal

Electromagnetic theory of light-electromagnetic properties of material- polarization of light; Reflection and refraction- Fresnel equations; absorption, dispersion, and scattering of electromagnetic waves -Bragg grating; 1D photonic crystals -photonic band structure-real and reciprocal lattices; 2D and 3D photonic crystals-emerging applications of photonic crystals - 1D Bragg grating - periodic dielectric wave guide - 2D photonic crystal slab and fibre. **L:9**

CO3:outline the basics of bio photonics

Fundamentals of light and matter-basics of light-matter interactions in molecules, cells and tissues -lasers for biophotonics -bioimaging: principles and applications-transmission microscopy, Kohler illumination-optical biosensors-light activated therapy: photo thermal and photo dynamic therapy- tissue engineering with light- optical tweezers, scissors and traps - bio nanophotonics applications - bio chip - DNA micro-arrays - gene chip - lab on chip. **L:9**

CO4:interpret the quantum confinement in photonic materials

Quantum confined materials: quantum wells, quantum wires, quantum dots, quantum rings, manifestations of quantum confinement, optical properties, quantum confined stark effect, dielectric confinement effect. **L:9**

Nanoplasmonics: optical response of metals, plasmons, optical properties of metal nanoparticles, size dependent absorption and scattering, coupled nanoparticles - metal-dielectric core-shell nanoparticles - local electromagnetic fields in metal nanoparticles.

CO5: organize the applications of photonic materials

Excitation energy transfer – device operation: nanophotonic AND gate - nanophotonic OR gate – interconnection with photonic devices - metamaterials concept; super lens, hyperbolic metamaterials and application in high-resolution imaging: hyper lens - tunable photonic metamaterials based devices - electro-optical metamaterials - phase-change metamaterials - metamaterials in solar energy harvesting - perfect absorbers and thermal emitter **L:9**

TEXTBOOKS:

1. Bahaa E. A. Saleh, Malvin Carl Teich, Fundamentals of Photonics, 3rdEdition, Wiley,2019.
2. Brian Culshaw, Introducing Photonics, Cambridge University Press, 2020.
3. Gerd Keiser, Biophotonics: Concepts to Applications, second edition, Springer Nature Singapore Pvt. Ltd 2022.

REFERENCES:

1. Joseph W. Haus, Fundamentals and Applications of Nanophotonics, Woodhead Publishing, 2016.
2. W.Cai and V. Shalaev, Optical Metamaterials: Fundamentals and Applications, 2ndEdition, Springer, 2024.
3. P PYupapin, K Srinuanjan, S Kamoldilok, Devices, Circuits and Systems: Nanophotonics, Pan Stanford Publishing, 2013.
4. Paulo Ribeiro, Maria Raposo, "Optics, Photonics and Laser Technology", Springer International publishing, 1stEdition, 2018

L : 45; TOTAL : 45 PERIODS

Course Code		L	T	P	E	C
23SH13E	**BIOLOGY FOR COMPUTING**	3	0	0	0	3

COURSE OUTCOMES:

Upon successful completion of the course the students will be able to

CO1: describe the structure, interaction and applications of biomolecules
CO2: interpret the structure and functions of the gene and protein using the bioinformatics data
CO3: simulate the behavior of simple biological models using computational softwares
CO4: identify and design molecules for new drug development by computational methods

CO1: describe the structure, interaction and applications of biomolecules **L:9**

Biomolecules-I :

Introduction – monomeric units and polymeric structures of carbohydrates, proteins, nucleic acids and lipids. Enzymes: enzymatic action via Lock and key – Enzyme therapy - immune response monitoring – molecular modification – encapsulation. Agarose gel electrophoresis: SDS, PAGE and 2D – Molecular interactions: covalent and non-covalent interactions, antigen – antibody interactions. Methods to measure the interactions: UV-visible and single

crystal X-ray diffraction.

Biomolecules -II **L:9**

Chromosome structure and function – chromosome abnormalities – chromosome dynamics – nuclear architecture. DNA transcription, replication and segregation. DNA finger printing. Pedigree analysis. Identifying human disease genes (functional cloning versus positional cloning; mutation screening). Human genome project: introduction – steps – salient features. Hap map project – salient features.

CO2: interpret the structure and functions of the gene and protein using the bioinformatics data **L:9**

Bioinformatics: introduction – biological databases – types. DNA databases – EMBL, gene bank, DDBJ. Protein databases: Swiss Prot/TrEMBL, PIR. Sequence motif databases - Pfam, PROSITE, Protein structure databases, protein data Bank – SCOP, CATH, and KEGG. Sequence analysis – methods of sequencing: sangar method, maxama - gilbert method and edman degradation method, NGS methods of sequencing.Basic local alignment search tool (BLAST) – types – determining the identity of an organism from its r DNA gene nucleotide sequence. Softwares for handling the databases – ChemDiff.

CO3: simulate the behavior of simple biological models using computational softwares **L:9**

Quantum mechanics: influence of physics on theoretical chemistry. Semi empirical methods – slater determinants – Hartree – Fock equation. Semi empirical models - Ab-initio calculations: Thermodynamic functions – koopmans's theorem – isodesmic reactions, Density functional theory for larger molecules. Introduction to Gaussian and ADF : Geometry optimization, frequency calculation, location of transition state, intrinsic reaction co-ordinates, molecular orbitals and population analysis, natural bond orbital analysis, calculation of equilibrium constants and rate constants. Introduction to GROMACS: GROMACS input files, simulations of liquid water, water methanol mixtures, S-peptide and free energy of salvation. Introduction to SCILAB- Scilab programming: Curve fitting, integral transforms and introduction to molecular dynamics. Execution of programs for liquid argon.

CO4: identify and design molecules for new drug development by computational methods **L:9**

Drug design: General approach to discovery of new drugs – lead modification – calculation of the various drug likeness rules like Lipinski's rule, MDDR - like rule, Veber rule, Ghose filter, BBB rule, CMC-50 like rule and Quantitative estimate of drug-likeness (QED) using DruLiTo and Swiss ADMEsoftware. Pharmacokinetic properties of drug using Osiris and Molinspiration software. Structure-based drug designing approaches - target identification and validation - physiochemical principles of drug action – drug stereo chemistry – drug action - 3D database – computer aided drug design. Identification of the suitable target using Pharmmapper - Molecular docking programs using Autovina softwares and visualization tools - Preparation of protein and ligand using ADT and pymol-generation of paper publication-quality images and data analysis-protein-protein docking-Protein DNA docking

TEXT BOOKS

1. Shawn T. O'Neil, A Primer for Computational Biology, Oregon State Campus, Corvallis, USA, 2019.
2. Frank Jensen, Introduction to Computational Chemistry, 3rd Edition, Wiley publishing LLC. USA, 2016
3. Philly Charles, Genes, Genomes, Genetics and Chromosomes, Nottinghamshire, England, 2020.

REFERENCE BOOKS

1. Ariel Fernández Stigliano, Biomolecular Interfaces: Interactions, Functions and Drug Design, 1st Edition, Springer International Publishing AG, London, 2016.
2. S.C. Rastogi, P.Rastogi, N.Mendiratta, Bioinformatics: Methods and Applications - Genomics,

Proteomics and Drug Discovery, 5th Edition, PHI Learning Pvt. Ltd., Delhi, 2022.

3. Robert A. Copeland, Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis, 3rd Edition, Wiley-Blackwell, New York, 2023.

L: 45; TOTAL: 45 PERIODS

Course Code	BIOLOGY FOR ENGINEERS	L	T	P	E	C
23SH14E		3	0	0	0	3

COURSE OUTCOMES:

Upon successful completion of the course the students will be able to

CO1: understanding of bio design principles to create novel devices and structures and cell biology

CO2: explain the structure and stability of biomolecules

CO3: describe the principle, components and applications of various instruments for medical diagnosis

CO4: interpret the major bio-energetic pathways

CO5: explain the properties characterization and application of various biomaterials

CO1: understand the basic principles of biology to create novel devices **L:9**

Cell - prokaryotic and eukaryotic cells - plant cell and animal cell - structural and function of Mitochondria - Chloroplast - Lysosomes - Golgi bodies - Nucleus. Cell cycle: mitosis and meiosis. Bioinspired devices: GPS, aircrafts, swim suits, bullet train, super hydrophobic and self-cleaning surfaces.

CO2: explain the structure and stability of biomolecules **L:9**

Introduction - monomeric units and polymeric structures of carbohydrates, proteins, nucleic acids and lipids. Molecular interactions: covalent and non-covalent interactions – methods of quantification and determination: UV – visible, CD, and SPR.

Enzymes - classification - specific activity - enzyme activity - chemical nature of enzymes. Protein and non-protein nature of enzymes. Metalloenzymes and metal activated enzymes. Industrial applications of enzymes: biosensors and bio bleaching.

CO3: describe the principle and applications of various instruments for medical diagnosis **L:9**

Basic concepts of instrumentation: static and dynamic characteristics, design criteria, instrumentation, amplifiers. Biopotential electrodes: fundamentals - body surface electrodes - microelectrodes - Principle, components and applications of microscope: light and electron microscope. Electrocardiograph, glucometer, CT, magnetic resonance imaging, ultrasonic imaging. Artificial Intelligence for disease diagnosis.

CO4: interpret the major bio-energetic pathways **L:9**

Thermodynamics in biological systems - exothermic and endothermic versus endergonic and exergonic reactions - concept of K_{eq} and its relation to standard free energy - spontaneity - ATP as an energy currency. Glucose synthesis from CO_2 + H_2O (photosynthesis) – decomposition of glucose (Glycolysis and Krebs cycle). Energy yielding and energy consuming reactions. Concept of energy charge. Regulation of glycogenesis - measurement of blood glucose level.

CO5: explain the properties, characterization, and applications of various biomaterials. **L:9**

Biomaterials: introduction - types: alloys, polymers. Composites - properties: biocompatibility, elasticity, immune compatibility, resorbability, cytotoxicity, hemocompatibility and biodegradability. Physicochemical characterization: XRD and SEM. Applications: tissue engineering, heart valves, dental and orthopaedic implants.

TEXT BOOKS

1. Y.Nelson, L.David, Lehninger, "Principles of Biochemistry", International Edition. New York, 7th Edition, 2017.
2. Nagata, Kazuhiro, Real-Time Analysis of Biological Interactions, Springer, Japan, 3rd Edition, 2015.
3. I. Bertini, H.B Gray, Bioinorganic Chemistry, University Science Book, California, 4thEdition, 2014.

REFERENCE BOOKS:

1. P.N.Bartlett, Bioelectrochemistry: Fundamentals, Experimental Techniques and Applications, 2nd Edition, John Wiley & Sons, New Delhi, 2014.
2. Ratner and Hoffmann, Biomaterial Science: An Introduction to Materials in Medicine, 2nd Edition, Elsevier Academic Press, London, 2015.
3. Lesile Cromwell, "Bio-medical instrumentation and measurement", Prentice Hall of India, New Delhi, 2nd Edition, Reprint, 2017.

L: 45; TOTAL: 45 PERIODS

Course Code		L	T	P	E	C
23SH15E	POLYMER SCIENCE AND TECHNOLOGY	3	0	0	0	3

COURSE OUTCOMES:

Upon completion of this course, the students will be able to

CO1: acquire knowledge on structure - property relationship of polymers

CO2: identify the suitable polymerization techniques for the large scale synthesis of polymers

CO3: explain the basic principles of various polymer processing techniques and their applications

CO4: interpret the chemical, thermal, electrical, and mechanical properties of the polymers

CO5: familiar with plastics waste disposal, value addition, associated environmental issues and legislation

CO1: acquire knowledge on structure - property relationship of polymers **L: 9**

Basic concepts of polymerization - polydispersity - conformation and configuration of macromolecules - stereo isomerism and tacticity in polymers - geometrical isomerism. Structure - property relationship -molecular force and chemical bonding in polymers - effect of polymerization on PDI. General rules for polymer solubility - crystallinity and orientation in polymers. Polymer chain flexibility: concept - factors deciding polymer flexibility - amorphous and crystalline polymers - crystallinity in polymers - factors affecting crystallinity - properties affected by crystallinity of polymers. Glass transition temperature and crystalline melting points. Factors affecting glass transition temperature.

CO2: identify the suitable polymerization techniques for the large scale synthesis of polymers **L:9**

Basic aspects of polymer synthesis - bulk, solution and suspension polymerization (styrene and MMA) - emulsion polymerization (vinyl acetate, styrene) - preparation of phenolic and epoxy resins. Modern techniques in polymerization: metathesis polymerization - controlled polymerization methods, viz., nitroxide mediated polymerization (NMD), atom transfer radical polymerization (ATRP), group transfer polymerization (GTP), and reversible addition fragmentation termination (RAFT).

CO3: explain the basic principles of various polymer processing techniques and their applications **L:9**

Plastics technology: raw materials - additives for compounding (fillers, plasticizers and softeners, lubricants, promoters, anti-aging additives, flame retarders, colorants, blowing agents, UV stabilizers,) - requirements and functions of additives. Pre-compounding operations: mixing, drum blenders, ribbon blenders, mixing rolls, internal mixers, mixing extruders, blenders for making organosol and plastisol, granulators, pelletizers.

Advanced fabrication techniques: RTM, RIM, filament winding, BMC/SMC. Post-forming and finishing, machining, welding and design of polymers products. Selections of polymers, additives, mold design. Analysis of defects in moulded products. Processing of reinforced thermoplastics and thermosets: manual processing methods and semi-automatic processing methods. Rubber processing: internal mixer and open mill.

CO4: interpret the chemical, thermal, electrical, and mechanical properties of polymers **L:9**

Physical testing: density, mechanical behaviour, MFI, and water/solvent adsorption. Chemical testing: ignition - pyrolysis - solvent extraction - elemental analysis. Thermal analysis: vicat softening point - dynamic mechanical thermal analysis. Morphological analysis: atomic force microscopy and chemical force microscopy. Spectroscopic analysis: IR peaks assigned for rubber. Study of hydrogenation, halogention, evidence for cyclization and formation of ionomers. Analysis of carbon filled rubber - Case studies.

CO5: familiar with plastics waste disposal, value addition, associated environmental issues and legislation **L-9**

Polymer waste: sources, collection, segregation, and identification by simple techniques. Life cycle assessment, risk factor analysis. Plastics waste management techniques: chemical recycling, thermal conversion technologies, microbial, microwave, and ultrasonic. Use of plastics waste for value addition. Plastics waste management rule - environmental issues.

TEXT BOOKS

1. Premamoy Ghosh, Polymer Science and Technology: Plastics, Rubber, Blends and Composites, 3rd Edition, McGraw Hill Education, 2017.
2. Richard A Petherick, Polymer Science and Technology for Engineers and Scientists, Whittles Publishing, 2010.
3. Michael L. Berins, SPI Plastics Engineering Handbook of the Society of the Plastics Industry, Inc. 1st Edition, Springer New York, 2012
4. Vishu Shah, Handbook of Plastics Testing Technology,2nd Revised edition, Wiley–Blackwell, 1998**.**

REFERENCES

1. Gowarikar V R, Polymer science, 5th Edition, New Age International Private Limited, 2023
2. Fred W. Billmeyer, Textbook of Polymer Science, 3rd Edition, John Wiley & Sons, 2007
3. Nayak S.K, Text Book on Fundamentals of Plastics Testing, Springer (I) Private Limited, 2020
4. J S Anand, Recycling & Plastics Waste Management, Central Institute of Plastics Engineering and

Technology, 1997.
5. Korschwitz J, Polymer Characterization and Analysis, John Wiley and Sons, 1990.

L: 45; TOTAL: 45 PERIODS

Course Code		L	T	P	E	C
23SH16E	**SENSORS FOR ENGINEERING APPLICATIONS**	3	0	0	0	3

COURSE OUTCOMES:

Upon completion of this course, the students will be able to

CO1: Gain knowledge on basic concepts of sensors and Transducer.

CO2: know about the thermal and motion sensors for various applications.

CO3: enumerate the principles and applications of optical and magnetic sensors and transducers used in various field.

CO4: explain the construction, working principle and applications of electrochemical and electric sensors.

CO5: Design the sensors for environmental monitoring

CO1: Gain knowledge on basic concepts of sensors and Transducer. **L: 9**

Introduction – Historical development of sensors – Human body as a sensor system – sensors and transducers. Principle and classification of sensor. Sensor characteristics – sensor properties – various transducers – piezoelectric effect – pyroelectric effect – seebeck effect and peltier effect. Advantages and limitations of Sensors.

CO2: know about the thermal and motion sensors for various applications. **L:9**

Thermal sensors: introduction – types - primary sensor: gas thermometer and He low temperature thermometer. Secondary sensor: Resistance thermometer and NQR thermometer. Temperature sensing technologies: IC sensor, resistive temperature detectors, thermocouples and thermistor.

Motion sensors: Introduction and principle. Types: Infra red and microwave. Specialized motion sensor: proximity and ranging sensor. Motion Sensors in everyday life: The role of motion sensors in home security.

CO3: enumerate the principles and applications of optical and magnetic sensors and transducers used in various field **L:9**

Magnetic sensors: Introduction – principle and applications: magnetic field sensors and magneto-resistive Sensors, hall effect sensors.

Optical sensors: light intensity – wavelength and color – light dependent resistors, photodiode, photo transistor, CCD, CMOS sensors. Pulse oximeter, portable pulse oximeter, wearable pulse oximeter; wearable capnometer for monitoring of expired.

CO4: explain the construction, working principle and applications of electrochemical and electric sensors **L-9**

Electrochemical sensors: Introduction - fundamental concepts – chemiresistors. Conductometric sensor: amperometric sensor - potentiometric sensors - impendence sensors.

Electric sensors: Introduction- conventional volt and ammeters, high current sensors, (current transformers), high voltage sensors, High power sensors. Real time applications: Glucose Monitoring

Devices, GlucoWatch G2 Biographer, GlucoTrackTM; Pulse oximeter, Portable Pulse Oximeter, wearable pulse oximeter.

CO5: Design the sensors for environmental monitoring **L-9**

Environmental Sensor: Introduction - environmental quantities**:** time, moisture acidity/alkalinity, wind-chill, radioactive count rate. Surveying and security. Sensors for environmental monitoring. Smoke and fire detector. Pressure sensor in emission testing, pollution devices, and wind management systems.

TEXT BOOKS

1. Jacob Fraden, Handbook of Modern Sensors: Physics, Design and Applications, 5th edition, Springer Nature, New Delhi, 2016
2. D. Patranabis, Sensors and Transducers, 2nd Edition, PHI Learning Private Limited, New Delhi, 2013.
3. John Veteline, Aravind Raghu, Introduction to sensors, CRC press, New Delhi,2011.
4. S Nihtianov, A. Luque Smart Sensors and MEMS, 2nd Edition, Woodhead Publishing Limited, New Delhi,2018.
5. Edward Sazonov and Michael R. Neuman, Wearable Sensors - Fundamentals, Implementation and Applications, Elsevier publishing company, Amsterdam, Netherland,2014.

REFERENCE BOOKS

1. Shantanu Bhattacharya,A K Agarwal, NripenChanda, Ashok Pandey and Ashis Kumar Sen Environmental, Chemical and Medical Sensors, Springer Verlag, Singapore,2018 .
2. Krzysztof Iniewski, Optical, Acoustic, Magnetic, and Mechanical Sensor Technologies, 1st Edition, CRC Press, New Delhi, 2017.

L: 45; TOTAL: 45 PERIODS