INSTITUTE ELECTIVES

ELECTRONICS AND COMMUNICATION ENGINEERING

2023 SCHEME

(AUTONOMOUS)

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY
(Approved by AICTE, Autonomous Institution Affiliated to APJ Abdul Kalam Technological University)
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INSTITUTE ELECTIVE-I										
Slot	**Category**	**Course Code**	**Courses**	**Credit Structure**				**SS**	**Hours**	**Credit**
				L	**T**	**P**	**J**			
E	IEC	23IEL31I	Optimization Techniques	2	1	0	0	3.5	3	3
		23IEL31J	Biosensors and Transducers	2	1	0	0	3.5	3	3
		23IEL31K	Essentials of Entrepreneurship	2	1	0	0	3.5	3	3
		23IEL31L	Internet of Things	2	1	0	0	3.5	3	3

INSTITUTE ELECTIVE-II										
Slot	**Category**	**Course Code**	**Courses**	**Credit Structure**				**SS**	**Hours**	**Credit**
				L	**T**	**P**	**J**			
D	PEC	23IEL42I	Operations Research	2	1	0	0	3.5	3	3
		23IEL42J	Space Technology	3	0	0	0	4.5	3	3
		23IEL42K	Assistive Technology	3	0	0	0	4.5	3	3
		23IEL42L	Intellectual Property Rights	2	1	0	0	3.5	3	3

INSTITUTE ELECTIVE -I

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23IEL31I	OPTIMIZATION TECHNIQUES	IEC	2	1	0	0	3	2023

i. PREREQUISITE : Nil

ii. COURSE OVERVIEW

This course aims to provide a broad picture of various applications of optimization methods used in engineering.

iii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Formulate and classify different optimization problems.	Apply
CO 2	Apply classical and numerical methods solving linear and non-linear optimization problems.	Apply
CO 3	Apply modern methods of optimisation for solving optimisation problems.	Apply

iv. SYLLABUS

Introduction to classical method: Engineering applications of optimization, Formulation of design problems as mathematical programming problems. Classification of optimization problems/techniques.

Mathematical formulation of LP Problems- Slack, surplus and artificial variables, Reduction of a LPP to the standard form, feasible solutions.

Linear programming problems: Lagrangian method, KKT conditions

Nonlinear unconstrained optimization: Single variable optimization methods- Fibonacci search method, Newton Raphson method, multi-variable methods- Hook-Jeeves pattern search method.

Introduction to optimization tools.

Modern methods of optimization: Introduction to Genetic algorithm, Basic GA framework GA operators: Encoding, Crossover, Selection, Mutation.

Multiobjective Optimization- Concept of Dominance and Pareto optimality.

v (a) TEXT BOOKS

1.	S.S.Rao, Engineering Optimization.; Theory and Practice; Revised 4th Edition, New Age International Publishers, New Delhi, 2004
2.	H.A. Taha, “Operations Research”, 5/e, Macmillan Publishing Company, 1992.
3.	Kanti Swarup, P.K.Gupta and Man Mohan, Operations Research, Sultan Chand and Sons, 2017

4.	Kalynamoy Deb, 'Multi-objective Optimization using Evolutionary Algorithms', Wiley,2014

(b) REFERENCES

1.	A. Ravindran, D. T. Phillips, J. J. Solberg, Operations Research – Principles and Practice, John Wiley and Sons, 2007
2.	Ashok D Belegundu, Tirupathi R Chandrupatla, "Optimization concepts and Application in Engineering", Pearson Education, 2011
3.	4. Hadley, G. "Linear programming", Narosa Publishing House, New Delhi,1972
4.	J. S. Arora, Introduction to Optimum Design, McGraw-Hill Book Company, 2011

vi. COURSE PLAN

Module	Contents	Hours
I	Engineering applications of optimization, Formulation of design problems as mathematical programming problems, objective function, constraints, Classification of optimization problems/techniques. Linear, convex, and non-convex. Unconstrained optimization: Unconstrained one-dimensional optimization, necessary and sufficient conditions for optimality; Algorithms for one-dimensional unconstrained optimization problem –Fibonnacci, golden section.	9
II	Constrained optimization: Lagrangian method - First order Necessary KKT Conditions, Second order sufficient conditions, Duality (Concept) Linear programming problems: Mathematical formulation of LP Problems- Slack, surplus and artificial variables, Reduction of a LPP to the standard form, feasible solutions.	9
III	Nonlinear unconstrained optimization Newton Raphson method, multi-variable methods- Hook-Jeeves pattern search method. Familiarization of optimization tools	*9*
IV	Modern methods of optimization: Introduction to Genetic algorithm, Basic GA framework GA operators: Encoding, Crossover, Selection, Mutation. Ant Colony Optimization and Particle Swarm Optimization	9
V	Multiobjective Optimization- Principles of MOOP, Linear and Non linear MOOP. Dominance and Pareto Optimality-Concept of Domination, Multiobjective GA, Non Dominated Sorting GA	9
	Total Hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23IEL31J	Biosensors and Transducers	IEC	2	1	0	0	3	2023

i. PREREQUISITE :NIL

ii. COURSE OVERVIEW

This course aims to provide an understanding of the principles and applications of sensors and transducers, with a special focus on biosensors. It covers the fundamental concepts of various sensors and introduces the working principles and classifications of biosensors.

iii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the principles, classification, parameters, and characteristics (both static and dynamic) of sensors and transducers.	Understand
CO 2	Describe the working principles, functions, and applications of resistive, capacitive, thermal, optical inductive and electrochemical sensors.	Understand
CO 3	Explain the applications of physical sensors in biomedicine, including their use in blood-flow monitoring, respiratory flow measurement, imaging, and magnetic field detection.	Understand
CO 4	Describe the fundamental concepts, block diagram, characteristics, and classifications of biosensors, including enzymatic, affinity and living biosensors	Understand
CO 5	Explain the diverse applications of biosensors	Understand

iv. SYLLABUS

The principles and classification of sensors andtransducers, including their static and dynamic characteristics.

Types of sensors such as resistive potentiometers, strain gauges, capacitive sensors, electrostatic transducers, thermal sensors (thermistors, RTDs, thermocouples), and inductive sensors.

Physical sensors used in biomedicine, including skin blood-flow sensors, respiratory flow monitors, mechanical sensors, ultrasound imaging sensors, radiology detectors, and magnetic field sensors.

Fundamental concepts of biosensors, block diagrams, characteristics, and classifications. Types of biosensors covered include enzymatic, antibody-based, nanoparticle-based, and affinity biosensors.

v (a) TEXT BOOKS

1. Gaborharsany ,PhD CRC press Sensors in Biomedical Applications Fundamentals, Technology and Applications, 2000

2.	D Patranabis, Sensors andTransducers,2nd editionJanuary2003
3.	Chandra Mouli Pandey, Bansi Dhar Malhotra, Biosensors: Fundamentals and Applications, 2nd edition,· 2019

(b) REFERENCES

1.	Sensors in Biomedical applications - fundamentals, technology and applications Gabor Harsanyi, ISBN: 1-56676-885-3 CRC Press; 2000
2.	Biosensors and Their Applications, Yang, Victor C.; Ngo, That T. (Eds.) ISBN: 978-0-306-46087-6 Hardcover, 368 pages 2000
3.	Amartya Mukherjee, Ayan Kumar Panja, and NilanjanDey Academic Press, Biomedical sensors and smart sensings: A beginner's Guide, 2022

vi. COURSE PLAN

Module	Contents	Hours
I	Principles of Sensors/Transducers, Classification, Parameters, Characteristics: Static and Dynamic Characteristics	8
II	Resistive Potentiometer, Strain Gauge, Capacitive Sensors, Electrostatic transducer, Thermal Sensors, Thermistor, RTD, Thermocouple, Inductive Sensors, Electrochemical sensing	9
III	Physical Sensors and Their Applications in Biomedicine**:** Skin Blood-Flow Sensor, Respiratory Flow Monitoring by Hot-Film Anemometry, Mechanical Sensors in Biomedicine, Sensors in Ultrasound Imaging, Detectors in Radiology, Biomedical Applications of Magnetic Field Sensors	10
IV	Fundamentals of Biosensors. General block diagram of Biosensors, Characteristics of biosensors, Classification of biosensors Enzymatic Biosensor: Transducer types, Glucose Sensor Affinity Biosensors: Immuno Sensors, DNA sensors Living BioSensors: MicrobialBiosensor Case Study	10
V	Applications: wireless sensing, cardiac sensing, neuro sensing, biomarker sensing, In Vitro Detectors (IVD), microscopic/optical imagin based sensors	8
	Total Hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23IEL31K	Essentials of Entrepreneurship	IEC	2	1	0	0	3	2023

i. PREREQUISITE :NIL

ii. COURSE OVERVIEW

This course aims to introduce students to the fundamental concepts of entrepreneurship, fostering an entrepreneurial mindset and equipping them with the necessary skills to explore business opportunities. Students will learn how to identify problems, validate opportunities, create business models, and develop financial and market strategies to establish a viable venture. Through an integrated hands-on approach, learners will build a Minimum Viable Product (MVP) and pitch their business ideas to stakeholders.

iii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the concept of entrepreneurship, its role in economic development	Understand
CO 2	Apply design thinking to identify opportunities, assess market potential, and develop a compelling problem-opportunity statement.	Apply
CO 3	Create a Value Proposition Canvas that provides problem-solution fit and differentiate product features.	Create
CO 4	Analyse and refine business models to ensure sustainability and profitability	Analyse
CO 5	Create an investible pitch deck of their practice venture to attract stakeholders	Create

iv. SYLLABUS

Entrepreneurship Fundamentals & Macro Industry Perspective

Meaning and concept of entrepreneurship, Role in economic development, Emerging trends, Characteristics of an entrepreneur, Entrepreneur vs. Intrapreneur.

Problem-Opportunity Identification and Customer Discovery

Understanding problems and opportunities, Design thinking for validation, Market opportunity recognition, Customer segmentation, Creating customer personas.

Crafting a Compelling Value Proposition

Importance of value proposition, Identifying customer jobs, pains, and gains, Problem-solution fit, Competitive positioning, Unique selling points.

Business Model and Building Your MVP

Introduction to business models, Lean Canvas framework, Prototyping and MVP development, Hypothesis testing, Build-Measure-Learn approach.

Finance and Business Plan

Business plan components, Financial feasibility and unit economics, Go-To-Market strategies, Branding and customer acquisition, Funding sources and investor pitch.

v (a) TEXT BOOKS

1.	Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha (2020). Entrepreneurship ,McGrawHill, 11th Edition.
2.	Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business.
3.	Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons.
4.	Blank, S. G., & Dorf, B. (2012). The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company. K&S Ranch.

(b) REFERENCES

1.	Learning resource- Ignite program, Wadhwani platform https://web.nen.wfglobal.org/
2.	Roy, R. (2017). Indian Entrepreneurship: Theory and Practice. New Delhi: Oxford University Press.
3.	Paul Graham's Essays – A valuable collection of insights on startups, innovation, and personal growth. https://www.paulgraham.com/

vi. COURSE PLAN

Module	Contents	Hours
I	**Entrepreneurship Fundamentals & Macro Industry Perspective** Meaning and concept of entrepreneurship, Entrepreneurship in Indian Scenario & Its role in economic development, Emerging Trends in Entrepreneurship, types of Entrepreneurship, characteristics of Entrepreneur, Myths about Entrepreneurship, Entrepreneur vs Intrapreneur, Role of Entrepreneurial Teams.	9
II	**Problem-Opportunity Identification and Customers Discovery** Understanding the Problem and opportunity, define problem using Design thinking principles and validate problem, recognizing the market opportunity, environment scanning. Exploring market types and estimating the market size, knowing your customer and consumer, Customer segmentation, identifying niche markets and creating customer personas.	9
III	**Solution-Crafting a compelling Value proposition** Importance of Value Proposition, Knowing Customer Job, Pains, and Gains using Value Proposition Canvas, Developing Problem-	*9*

	solution fit, Differentiating features and benefits of the product/service. Competition analysis, Competitive positioning and understanding unique selling points.	
IV	**Business model and Build your MVP** Introduction to Business model and types, Lean approach, 9 block lean canvas model, riskiest assumptions to Business models. Prototyping, Building a Minimum viable product, Hypothesis testing and MVP Validation, MVP Iteration-Importance of Build - Measure – Lean approach	9
V	**Finance and Business Plan** Components of a business plan: preparing a business plan and assessing financial feasibility, understanding financial planning, cost structures, and unit economics, Introduction to Go-To-Market (GTM) strategies, startup branding and selecting the right marketing channels, creating a customer acquisition strategy, choosing a suitable business organization structure, identifying funding sources: Debt & Equity, mapping startup lifecycle to funding options, building an investor-ready pitch deck.	9
	Total Hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment : End Semester Assessment – 60 : 40

Continuous Assessment		
Attendance	:	5 marks
Assessment through Milestone submission	:	55 marks
Total Continuous Assessment	:	**60 marks**
End Semester Examination	:	**40 marks**
TOTAL	:	**100 marks**

End Semester Assessment: Business Plan Group Presentation

Total Marks: 40
Team Size: 5 members per group

Individual Assessment (20 Marks)

1. **Idea Understanding & Role Clarity (10 marks)**
   – Assesses the individual's understanding of the business idea and how clearly they define their specific contribution to the team.
2. **Communication & Delivery (10 marks)**
   – Evaluates clarity, confidence, articulation, and effectiveness in presenting the assigned content.

Group Assessment (20 Marks)

3. **Business Plan Structure & Content (10 marks)**
   – Reviews the overall organization, completeness, and clarity of the business plan including key components like problem, solution, market, and financials.
4. **Team Coordination & Cohesion (10 marks)**
   – Measures how well the team collaborates, transitions between sections, and maintains balance in contributions during the presentation.

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23IEL31L	INTERNET OF THINGS	IEC	2	1	0	0	3	2023

i. PREREQUISITE :NIL

ii. COURSE OVERVIEW

This course provides a comprehensive understanding of the Internet of Things (IoT), covering its architecture, data acquisition, communication protocols, cloud connectivity, security challenges, and real-world applications.

iii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the IoT conceptual framework, architecture, and functional components.	Understand
CO 2	Compare different IoT communication protocols and network technologies.	Understand
CO 3	Apply data acquisition techniques using sensors and microcontrollers to collect, process, and display real-time sensor data in IoT-based applications.	Apply
CO 4	Use cloud platforms to ingest, process, visualize data, and enable remote monitoring	Apply
CO 5	Explain IoT security threats, authentication and encryption techniques, and security solutions.	Understand

iv. SYLLABUS

IoT Conceptual Framework, IoT Architecture, Functional Blocks, Major Components, APIs, Device Interfacing, Platforms & Integration Tools, IoT/M2M System Layers, OSI Model for IoT, ITU-T Reference Model

IoT vs. M2M Communication, Wireless Sensor Networks (LoRa, Sigfox, NB-IoT), Communication Protocols (MQTT, CoAP, HTTP, AMQP), Network Layer Protocols (6LoWPAN, RPL, IPv6), Network Management (SDN, NFV, QoS)

Data Acquisition & Storage, Sensor Technology, Participatory Sensing, Industrial & Automotive IoT, Actuators, Sensor Communication Technologies, Wireless Sensor Networks

IoT Cloud Platforms (AWS, Google, Azure), Cloud Data Storage & Processing, Remote Monitoring, Edge-Fog Computing, Cloud-based Services, Prototyping IoT Devices (Raspberry Pi, ESP32, Arduino), Data Logging

IoT Security Challenges, Authentication, Access Control, Encryption, IoT Security Frameworks, Threat Modeling, Case Studies in Smart Homes, Smart Cities, Healthcare etc

v (a) TEXT BOOKS

1.	Raj Kamal, “Internet of Things: Architecture and Design Principles”, McGraw Hill (India) Private Limited, 2016
2.	Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on- Approach)”, 1st Edition, VPT, 2014 .
3.	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017.
4.	Charles Bell, “MicroPython for the Internet of Things: A Beginner’s Guide to Programming with Python on Microcontrollers”, Apress, 2017
5	Raspberry Pi Cookbook, Software and Hardware Problems and solutions, Simon Monk, O'Reilly (SPD), 2016, ISBN.

(b) REFERENCES

1.	Olivier Hersent, David Boswarthick, Omar Elloumi, “The Internet of Things –Key applications and Protocols”, Wiley, 2012
2.	Al-Fuqaha et al. Internet of things: A survey on enabling technologies, protocols, and applications. IEEE Communications Surveys & Tutorials (2015), pp. 2347-2376.
3.	The Internet of Things (The MIT Press Essential Knowledge series) Paperback – March 20, 2015 by Samuel Greengard
4	The Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Ovidu Vermesan and Peter Friess, River Publishers.
5.	Internet of Things - From Research and Innovation to Market Deployment-RIVER PUBLISHERS, PETER FRIESS, OVIDIU VERMESAN (Editors)
6.	Internet of Things Security and Data Protection, Sébastien Ziegler, Springer International Publishing 2019

vi. COURSE PLAN

Module	Contents	Hours
I	An Overview of Internet of Things: IoT conceptual framework, IoT Architectural View and Functional Blocks, Technology behind IoT - Server-end Technology, Major Components of IoT System, APIs and Device Interfacing Component, Platforms and Integration Tools. Design Principles for Connected Devices: IoT/M2M system layers and design standardisation - Modified OSI Model for the IoT/M2M Systems, ITU-T Reference Model	9
II	IoT Communication Protocols: IoT vs. M2M Communication, Wireless Sensor Networks and LPWAN Technologies: LoRa, Sigfox, NB-IoT, Communication Protocols: MQTT, CoAP, HTTP, AMQP, Network Layer Protocols: 6LoWPAN, RPL, IPv6, Network Management: SDN, NFV, and QoS in IoT Networks.	9
III	**Data Acquisition and organising** : Data acquiring and storage, Organising the data, Sensor Technology, Participatory sensing, Industrial IoT and Automotive IoT, Actuators, Sensor data communication technologies, Wireless sensor networks	9

	Prototyping the Embedded Devices for IoT : Sensor interfacing and data acquisition using target boards like Raspberry Pi 4B, ARM EMBED, ESP32, Arduino boards. Experiment : Data Acquisition from temperature sensor Using a microcontroller and Displaying Values on an LCD Screen	
IV	**Cloud and Remote Monitoring**: IoT Cloud Platforms- AWS IoT, Google Cloud IoT, Microsoft Azure IoT, Cloud Data Storage and Processing, Remote Monitoring Strategies and Edge-Fog Computing, Cloud based services using Xively and Nimbits. Experiment : Transmit real-time data to an IoT cloud platform using MQTT and visualize it on the cloud dashboard	9
V	**IoT Security and Case Studies**: Security Challenges in IoT, Authentication, Access Control, and Encryption Mechanisms, IoT Security Frameworks and Best Practices, Threat Modeling and Risk Assessment in IoT Systems, Case Studies: Smart Homes, Smart Cities, Healthcare,etc	9
	Total Hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

INSTITUTE ELECTIVE -II

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23IEL42I	OPERATIONS RESEARCH	IEC	2	1	0	0	3	2023

i. PREREQUISITE :NIL

ii. COURSE OVERVIEW

This course provides theoretical knowledge to solve linear programming problems, transportation and assignment problems, optimize the allocations in the best possible way, make decisions under various conditions, and solve games using gaming theory.

iii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Solve linear programming problems using appropriate techniques and optimization solvers.	Apply
CO 2	Solve transportation and assignment problems	Apply
CO 3	Optimize the allocation of resources in the best possible way using various techniques.	Apply
CO 4	Formulate decisions under various conditions.	Apply
CO 5	Model competitive real-world phenomena using concepts from game theory.	Apply

iv. SYLLABUS

Operation research models – Introduction to OR Models, Applications
Linear Programming – Problem formulation, different methods, duality concept.

Transportation problem – formulation, different methods.

Assignment problem – formulation, methods, Traveling salesman problem.
Sequencing problem– terminology and notations, assumptions, Problems with n jobs through m machines.
Network analysis – basic terms, network construction, analysis.

Queuing theory – introduction, terminologies, models
Decision theory – steps in decision theory approach, conditions, and analysis

Game theory – introduction, theorems, solutions.

Introduction to Goal Programming, Multi-Objective Programming, Parametric Linear Programming, Dynamic Programming, Non-linear Programming.

v (a) TEXT BOOKS

1. Miller, D. M. and Schmidt, J. W., Industrial Engineering and Operations Research, John Wiley & Sons, Signapore, 1990.
2. Paneerselvam, R., Operations Research, Prentice Hall of India, New Delhi, 3rd ed., 2009.
3. Srinivasan, G. “Operations Research-Principles and Applications”, Latest edition, PHI Pvt. Ltd., 2010.

4.	Pannerselvam, R., Design and Analysis of Algorithms, Prentice Hall of India, New Delhi, 2007. 4. 5. Taha, H. A., Operations Research, Pearson, 2004.

(b) REFERENCES

1.	Taha, H. A., Operations Research, Pearson, 2004.
2.	Goel, B. S. and Mittal, S. K., Operations Research, Pragati Prakashan, Meerut, 1999.
3.	Ravindran, Phillips and Solberg, Operations Research Principles and Practice, Willey & Sons, 1987.

vi. COURSE PLAN

Module	Contents	Hours
I	**Operation research models –** Introduction to OR Models, Applications **Linear Programming –** Problem formulation, Graphical Method for LPP, Convex sets, Simplex Method, Big M Method, Two-Phase, Multiple solutions of LPP, Unbounded solution of LPP, Infeasible solution of LPP, Duality in linear programming.	10
II	**Transportation problem** – formulation, balanced & unbalanced transportation problems, North-west corner rule, least cost method, Vogel's method, stepping stone method. **Assignment problem** – formulation, optimal solution, Hungarian algorithm, Variants of assignment problems, Traveling salesman problem.	9
III	**Sequencing problem–** terminology and notations, assumptions, problems with n jobs through two machines, Problems with n jobs through m machines. **Network analysis –** basic terms, network construction, time analysis – critical path method, PERT, Cost considerations in network analysis.	*9*
IV	**Queuing theory** – introduction, terminologies, classification of queuing models, single server and multi-server problems **Decision theory** – steps in decision theory approach, decision-making conditions, conditions of risk, uncertainty conditions, decision tree analysis	9
V	**Game theory** – games with saddle points, Two Person Zero-Sum Game, Theorems of Game Theory, Solution of Mixed Strategy Games, Linear Programming method for solving games. Introduction to Goal Programming, Multi-Objective Programming, Parametric Linear Programming, Dynamic Programming, Non-linear Programming.	8
	Total Hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23IEL42J	Space Technology	IEC	3	0	0	0	3	2023

i. PREREQUISITE :Nil

ii. COURSE OVERVIEW

This course offers a captivating exploration of the vast and fascinating world of space technology and introduce the fundamental principles that power our exploration of the cosmos and the related technologies.

iii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Describe the key characteristics of the space environment, including vacuum, radiation, microgravity and orbital elements.	Understand
CO 2	Apply the basic principles of satellite communication systems and link budget.	Apply
CO 3	Explain the principles of remote sensing and discuss the applications of Earth observation satellites in various fields.	Understand
CO 4	Describe the functionality of satellite navigation systems like GPS, and explain the basic principles of how they determine location.	Understand
CO 5	Identify the challenges, opportunities associated with deep space exploration and key technologies used in planetary missions.	Understand

iv. SYLLABUS

The Space Environment and Space Missions -*Introduction to the universe and the solar system. Introduction to space missions and orbit fundamentals-space segment, ground segment and launch segment.*

Satellite bus vs. payload– understanding how systems support the mission. Mission types (LEO, GEO, deep space) and their implications. Orbital elements, transfer orbits (e.g., Hohmann), mission architecture basics.

Space environment: vacuum, atomic oxygen, ionizing radiation, temperature extremes, debris. Surface charging and single-event effects on electronics. Microgravity and its effects on fluid flow and biological systems.

Satellite Communication Fundamentals: *Basic principles of satellite communication systems- uplink, downlink, transponders. Applications of satellite communication. Introduction to link budgets, and the factors that affect signal strength.*

Remote Sensing and Earth Observation: *Principles of remote sensing: electromagnetic spectrum, sensors. Applications of remote sensing: weather forecasting, environmental monitoring, agriculture, disaster management.*

Satellite Navigation and Positioning: *Principles of satellite navigation systems (GPS, Galileo, GLONASS).Applications of satellite navigation: transportation, mapping, surveying.*

Space Exploration and Future Technologies: *Overview of planetary exploration missions. Challenges of deep space exploration. Emerging space technologies: space tourism, asteroid mining, space-based solar power.*

v (a) TEXT BOOKS

1. Vincent L. Pisacane, 'Fundamentals of Space Systems', second edition, OUP Higher Education Division, 2005
2. Timothy Pratt, Charles W. Bostian, Jeremy E. Allnutt,' Satellite Communications', Wiley Indian (2003)
3. Iain H. Woodhouse,' Introduction to Microwave Remote Sensing', CRC Press, 2017.

(b) REFERENCES

1. Wiley J. Larson and James R. Wertz, 'Space Mission Analysis and Design', K1uwer Academic Publishers, 2005

vi. COURSE PLAN

Module	Contents	Hours
I	**The Space Environment and Space Missions:** Introduction to the universe and the solar system.The space environment: vacuum, radiation, microgravity. Types of space missions: communication, navigation, Earth observation, exploration. Satellite bus vs. payload– understanding how systems support the mission. Mission types (LEO, GEO, deep space) and their implications. Orbital elements, transfer orbits (e.g., Hohmann), mission architecture basics. Space environment: vacuum, atomic oxygen, ionizing radiation, temperature extremes, debris. Surface charging and single-event effects on electronics. Microgravity and its effects on fluid flow and biological systems.	10
II	**Satellite Communication Fundamentals** Basic principles of satellite communication. Satellite orbits: LEO, MEO, GEO. Satellite communication systems: uplink, downlink, transponders. Applications of satellite communication: television broadcasting, internet, mobile communication.	10

	Introduction to link budgets, and the factors that affect signal strength.	
III	**Remote Sensing and Earth Observation** Principles of remote sensing: electromagnetic spectrum, sensors. Types of remote sensing satellites: optical, infrared, radar. Applications of remote sensing: weather forecasting, environmental monitoring, agriculture, disaster management.	*9*
IV	**Satellite Navigation and Positioning** Principles of satellite navigation systems (GPS, Galileo, GLONASS), How satellite navigation works: trilateration, signal timing. Applications of satellite navigation: transportation, mapping, surveying. Accuracy and limitations of satellite navigation.	8
V	**Space Exploration and Future Technologies** Overview of planetary exploration missions. Challenges of deep space exploration. Emerging space technologies: space tourism, asteroid mining, space-based solar power. The future of space exploration and its potential impact on humanity. Space debris and space law.	8
	Total Hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 Marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23IEL42K	ASSISTIVE TECHNOLOGY		3	0	0	0	3	2023

i. PREREQUISITE :NIL

ii. COURSE OVERVIEW

The objective of this course is to equip the students with a comprehensive understanding of the technologies designed to enhance accessibility and inclusivity for individuals with diverse impairments. The course will focus on key areas, including assistive technology for visual impairment, auditory impairment, cognitive impairment, physical impairment, and the principles of universal design.

iii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the need for inclusion, and classify the sensory aids used to address specific challenges faced by individuals with visual impairment	Understand
CO 2	Describe the technologies and systems designed to support individuals with impairments in hearing, speech, cognitive functions, and communication.	Understand
CO 3	Summarize the assistive technologies designed to facilitate mobility and transportation	Understand
CO 4	Identify best practice strategies in Universal Design and the challenges involved in the idea-to-market transition in assistive technology	Understand
CO 5	Design and prototype an assistive device to address a specific functional need in individuals with disabilities.	Apply

iv. SYLLABUS

Assistive Technology (AT) definitions, Indian laws, Inclusive Education and early intervention. AT classification. Sensory aids for persons with visual impairment. Overview of hearing, hearing aids, Assistive listening devices, Alerting devices. Cochlear implants. Congenital disorders, Acquired disorders. Assistive Technologies that address Cognitive needs. Disabilities affecting speech, language, and communication, Augmentative and Alternative Communication (AAC) systems – types, options for making selections in an AAC device. Case study. Wheelchair classification, Major characteristics of manual and power mobility systems, Smart wheelchairs, Vehicle restraint systems, Vehicle access, and modifications for driving. Need for accessibility, Principles of Universal Design. Design and Redesign Strategy for a barrier-free environment, Accessibility to the built environment, Accessibility for Mainstream Information and Communication Technologies, Idea to Market transition in Assistive Technology.

v (a) TEXT BOOKS

1.	Albert M. Cook, Janice Miller Polgar, Assistive Technologies – Principles and Practices, Elsevier, 6th edition, 2024
2.	Shirly G., Akila Surendran, et al., Perspectives: Assistive Technologies in Limited Resource settings, National Institute of Speech and Hearing, 1st edition, 2022
3.	Dr. Ramakrishna Pettala, Assistive Technology and Hearing Impairment, Discovery Publishing House, 1st edition, 2020
4.	Roberta Null, Universal Design: Principles and Models, CRC Press, 1st edition, 2013

(b) REFERENCES

1.	Diane P. Bryant and Brian R. Bryant, Assistive Technology for People with Disabilities, Pearson, 2nd edition, 2011
2.	Wolfgang Preiser, Korydon Smith, Universal Design Handbook, McGraw-Hill, 2nd edition, 2011
3.	Suzanne Robitaille, The Illustrated Guide to Assistive Technology & Devices: Tools and Gadgets for Living Independently, Demos Medical Publishing, 2010

vi. COURSE PLAN

Module	Contents	Hours
I	**Introduction to Assistive Technology (AT):** Definitions of Assistive Technology, Indian Laws, AT – needs and Challenges, Inclusion in education. Early intervention, Goals of early intervention. AT types – Low, Mid, and High - Tech Assistive Technologies. **Sensory aids for persons with visual impairments:** Types of visual impairment. Assistive Technologies for vision.	9
II	**Technologies for hearing/speech impaired:** Overview of hearing, Hearing aids – principles and technologies, benefits. Assistive listening devices. Alarm and alerting devices, Cochlear implants, and risks associated with implantation. Speech synthesis for speech and hearing impaired.	9
III	**Assistive Technologies for Cognitive Augmentation:** Congenital disorders, Acquired disorders. Assistive Technologies that address Cognitive needs – General concepts, types. **Augmentative and Alternative Communication (AAC):** Disabilities affecting speech, language, and communication. The role of technology in AAC: AAC systems, options for making selections in an AAC device. *Case study: Emerging access technology for AAC.*	*9*
IV	**Assistive Technologies for mobility:** Wheelchair classification, Major characteristics of manual and power mobility systems. Smart wheelchairs. **Technologies for transportation:** Vehicle restraint systems for children with disabilities, Vehicle access, and modifications for driving.	9

V	**Universal Design and Access**: Need for accessibility, Principles of Universal Design. Design and Redesign Strategy for a barrier-free environment, Accessibility to the built environment. Accessibility for Mainstream Information and Communication Technologies - Challenges in using Mainstream ICTs for Persons with Disabilities, Computer Access, Access to Phones and Tablets. Lab to market transition in Assistive Technology.	9
	Total Hours	**45**

Course Project: *Students have to undertake a hands-on project focused on the design and development of a low-tech assistive device to address real-world accessibility needs. Emphasis will be on affordability, user-centric design, and practical implementation.*

vi. ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments/Project	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23IEL42L	Intellectual Property Rights	IEC	2	1	0	0	3	2023

i. PREREQUISITE :NIL

ii. COURSE OVERVIEW

This course introduces Intellectual Property Rights (IPR), covering its types, legal aspects, and international treaties. It explores patents, copyrights, trademarks, trade secrets, industrial designs, and geographical indications, emphasizing their role in innovation and economic growth.

iii. COURSE OUTCOMES

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

Course Outcomes	Description	Level
CO 1	Explain the fundamentals of intellectual property, its types, and the international framework governing IPR.	Understand
CO 2	Explain the legal aspects of patents, trademarks, copyrights, and trade secrets.	Understand
CO 3	Explain the significance of geographical indications, industrial designs, and traditional knowledge in IPR.	Understand
CO 4	Explain the impact of intellectual property rights on economic and technological development.	Understand
CO 5	Explain the enforcement mechanisms for intellectual property rights and the challenges related to unfair competition.	Understand

iv. SYLLABUS

Understanding and Overview of the IPR, ***Patents****: Definition, legal requirements, filing process, management, and international patent systems,* ***Trademarks****: Types, protection, acquisition, and registration process,* ***Copyrights****, related rights, plagiarism, and legal aspects of IPR in India, Geographical Indications, Traditional Knowledge, Industrial Designs, Trade Secrets, and Enforcement of IPR.*

v (a) TEXT BOOKS

1. Kompal Bansal, Parikshit Bansal, “Fundamentals of Intellectual Property for Engineers”, Bsp Books, 2014
2. P. Narayanan, "Intellectual Property Law," Eastern Law House, 4th Edition, 2007
3. Deborah E. Bouchoux, "Intellectual Property: The Law of Trademarks,
4. V.K. Ahuja, "Law Relating to Intellectual Property Rights," LexisNexis, 3rd Edition, 2021.

(b) REFERENCES

1. Gopalakrishnan & Agitha, "Principles of Intellectual Property," Eastern Book Company, 2019.
2. W.R. Cornish, "Intellectual Property: Patents, Copyright, Trademarks, and Allied Rights," Sweet & Maxwell, 8th Edition, 2013.
3. Neeraj Pandey & Khushdeep Dharni, "Intellectual Property Rights," PHI Learning, 2nd Edition, 2014.

vi. COURSE PLAN

Module	Contents	Hours
I	Understanding and Overview of the IPR Regime : Introduction, types of intellectual property, industrial property, artistic and literary property, sui generis systems. Need for intellectual property rights, rationale for the protection of IPR, and the impact of IPR on development, agriculture, and genetic resources. IPR in India: IPR in other countries. Overview of international organizations, agencies, and treaties related to IPR.	9
II	Patents : Definition under TRIPS, inventions, types of inventions protected by patents, patentable and non-patentable inventions, process and product patents, double patenting, and patents of addition. Legal Requirements for Patents: Granting of patents, rights of a patent holder, exclusive rights, patent searching, and patent drafting. Patent Filing Process. Management of IP Assets and IP Portfolio: Commercial exploration of IP, assignment, licensing, and infringement. International Patent Systems	9
III	*Trademarks : Rights of trademarks, types of signs used as trademarks, types of trademarks, purpose and functions of a trademark. Trademark protection, trademark registration, rights, protectable matter, selecting and evaluating trademarks, acquisition of trademarks, and trademark registration processes.*	*9*
IV	Copyrights, Law of Copyrights: Fundamentals of copyright law, originality of material, rights of reproduction, rights to perform the work publicly, copyright ownership issues, obtaining copyright registration, notice of copyright, and international copyright law. Infringement of Copyright. Related Rights: Distinction between related rights and copyright, celebrity rights. Academic Integrity and Plagiarism, Role and Liabilities of IPRs in India: Cyberlaw, data privacy, health privacy, freedom of expression issues..	9
V	Geographical Indication (GI) of Goods: Types, importance, need for GI protection, and GI laws. Traditional Knowledge: Indigenous knowledge, medicinal knowledge, bioprospecting examples, need for protection, possible protection mechanisms, and challenges in implementation. Industrial Designs,. Integrated Circuits and Layout Designs, Trade Secrets: Trade secret law, determination of trade secret status, liability for misappropriation of trade secrets. Enforcement of Intellectual Property Rights (IPR): Infringement of intellectual property rights, legal remedies, and enforcement mechanisms. Unfair Competition	9
	Total Hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment : End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours