SCHEME & SYLLABUS OF UNDERGRADUATE DEGREE COURSE

University Electives (VII Semester)

Effective for the students admitted in the year 2021-22 and onwards.

Office: Bikaner Technical University, Bikaner Karni Industrial Area, Pugal Road, Bikaner-334004
Website:https://btu.ac.in

S.No.		Subject Code	Subject Name	Pg. No.
1	Civil Engineering	7CE6-60.1	Disaster management	
2	Civil Engineering	7CE6-60.2	Waste management	
3	Civil Engineering	7CE6-60.3	Sustainable transportation systems	
4	CSE	7CS6-60.1	Computer Networks	
5	CSE	7CS6-60.2	Database Management Systems	
6	CSE	7CS6-60.3	Operating Systems	
7	CSE	7CS6-60.4	Introduction to Python Programming	
8	CSE	7CS6-60.5	Linux and Shell Programming	
9	Electrical Engineering	7EE6-60.1	Generation of Electrical Power	
10	Aeronautical Engineering	7AE6-60.1	Basics of Aeronautical Engineering	
11	Aeronautical Engineering	7AE6-60.2	Aircraft Maintenance Management	
12	Aeronautical Engineering	7AE6-60.3	Simulation Modelling and Analysis	
13	Mechanical Engineering	7ME6-60.1	Finite Element Method	
14	Mechanical Engineering	7ME6-60.2	Fundamentals of Automotive Systems	
15	Mechanical Engineering	7ME6-60.3	Numerical Methods for Engineers	
16	Mechatronics	7MX6-60.1	Digital System Design	
17	Mechatronics	7MX6-60.2	Electronics Devices and Applications	
18	Mechatronics	7MX6-60.3	Basics of Sensors technology	
19	Mining Engineering	7MI6–60.1	Tunnel Engineering	
20	Mining Engineering	7MI6–60.2	Rock Engineering	
21	Mining Engineering	7MI6–60.3	Remote Sensing and GIS	
22	Mining Engineering	7MI6–60.4	Maintenance Management	
23	Mining Engineering	7MI6–60.5	Quality and Reliability Engineering	
24	Smart AgriTech	7SA6-60.1	Waste to Energy	
25	Ceramic Engineering	7CR6-60.1	Introduction to Metallurgical Processes	

26	Ceramic Engineering	7CR6-60.2	Refractory for Steel Making	
27	Ceramic Engineering	7CR6-60.3	Plant, Equipment and Furnace Design	

NOTE: It's notifying to all the B. Tech. Students and concerned, that the paper(s) enlisted below has studied already in any semester cannot be opted as University Electives in VII and VIII semesters. So, condition must be checked and followed by all Engineering Graduates and also Verified by college Faculty/Head/Administration before choosing the paper as University Electives.

7CE6-60.1: Disaster management

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To provide basic introduction about environmental hazards and disasters.
2. To give a basic understanding about different hazards and disasters due to mankind.
3. To aware about various emerging approaches in disaster management.
4. To aware about the reduction and management methods of diverse kind of disasters.
5. To update about polices related to disaster management as well as role of different government agencies in remediation of disasters.

Course Outcomes: Upon completion of this course the students will be able to:

1. To get the fundamentals of disasters.
2. To understand about different factors responsible for natural and manmade disasters.
3. To understand and capable to develop different management strategies to handle the disastrous effect of disasters.
4. To learn about the reduction and management methods of various kinds of disasters.
5. To understand about polices related to disaster management.

S. No	Contents	Hours
1	Natural Hazards and Disasters: Concept of Environmental Hazards, Environmental stress & Environmental Disasters. Types of Environmental hazards & Disasters: Natural hazards and Disasters, Volcanic Hazards/ Disasters, - Causes and distribution of Volcanoes, - Hazardous effects of volcanic eruptions, -Environmental impacts of volcanic eruptions, Earthquake Hazards/ disasters, - Causes of Earthquakes, -Distribution of earthquakes, - Hazardous effects of earthquakes, Earthquake Hazards in India, Human adjustment, perception & mitigation of earthquake, Cumulative atmospheric hazards/ disasters- Lightning, Hailstorms, Cyclones: - Tropical cyclones & Local storms, - Destruction by tropical cyclones & local storms (causes , distribution human adjustment, perception & mitigation), Cold waves, Heat waves, Floods, Causes of floods, Flood hazards in India, - Flood control measures (Human adjustment, perception & mitigation), Droughts: - Impacts of droughts, - Drought hazards in India, - Drought control measures	9
2	Man induced hazards & Disasters: Mechanics & forms of Soil Erosion, - Factors & causes of Soil Erosion, Conservation measures of Soil Erosion, Chemical hazards/	8

	disasters— Release of toxic chemicals. nuclear explosion, Sedimentation processes, - Global Sedimentation problems, Regional Sedimentation problems, Sedimentation & Environmental problems, Corrective measures of 23 Erosion & Sedimentation, Biological hazards/ disasters, Population Explosion	
3	Emerging approaches in Disaster Management- Three Satges: I. Predisaster stage (preparedness)-(a) Preparing hazard zonation maps, Predictability/ forcasting & warning, b) Preparing disaster preparedness plan, c) Land use zoning, d) Preparedness through (IEC) Information, education & Communication Pre-disaster stage (mitigation) Disaster resistant house construction, Population reduction in vulnerable areas, Awareness 2. Emergency Stage:- a) Rescue training for search & operation at national & regional level, b) Immediate relief;c) Assessment surveys 3. Post Disaster stage-Rehabilitation- a) Political Administrative Aspect, b) Social Aspect, c) Economic Aspect d) Environmental Aspect	9
4	Natural Disaster Reduction & Management: a) Provision of Immediate relief measures to disaster affected people, b) Prediction of Hazards & Disasters, c) Measures of adjustment to natural hazards Mitigationdiscuss the work of following Institution-(a) Meteorological observatory, (b). Seismological observatory, (c). Volcanology institution, (d). Hydrology Laboratory, (e.) Industrial Safety inspectorate,(f). Institution of urban & regional planners, (g). Chambers of Architects, (h). Engineering Council, (i) National Standards Committee, Integrated Planning- Contingency management Preparedness :-a) Education on disasters, b) Community involvement, c) The adjustment of Human Population to Natural hazards & disasters, Role of Media. Application of Geographical Information System(GIS) in Disaster risk management	8
5	A regional survey of Land Subsidence, Coastal Disaster, Cyclonic Disaster & Disaster in Hills with particular reference to India, Ecological planning for sustainability & sustainable development in India-Sustainable rural development: A Remedy to Disasters, Role of Panchayats in Disaster mitigations. Environmental policies & programmes in India- Institutions & National, Centres for Natural Disaster reduction	8
	Total	42

REFERENCE BOOKS

1. Savinder Singh Environmental Geography, Prayag Pustak Bhawan, 1997.

2. Kates,B.I & White, G.F The Environment as Hazards, oxford, New York, 197
3. R.B. Singh (Ed) Disaster management, Rawat-Piiblicatiion, New Delhi, 2000.
4. R.B. Singh, Space Technology for Disaster Mitigation in India (INCED), University of Tokyo, 1994
5. A.S. Arya Action Plan For Earthquake,Disaster, Mitigation in V.K. Sharma (Ed)
6. Disaster Management IIPA Publication New Delhi, 1994.
7. R.K. Bhandani: An overview on Natural & Man made Disaster & their Reduction, CSIR, New Delhi
8. M.C. Gupta Manuals on Natural Disaster management in India. National Centre for Disaster Management,Il PA. New Delhi.

7CE6-60.2: Waste Management

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To provide a comprehensive overview of waste management.
2. To understand the characteristics, quantities, and management of Municipal Solid Waste.
3. To understand the plastic waste management.
4. To examine the components, quantification, processing, recycling opportunities, and regulations related to C&D waste.
5. To explore the issues, status, regulations, and management challenges of electronic waste in India and globally.

Course Outcomes: Upon completion of this course the students will be able to:

1. To understand the concept, elements, and implementation strategies of waste management
2. To gain the ability to identify and evaluate the characteristics, quantities, and current issues in Municipal Solid Waste management
3. To understand the sources, impact, and management of plastic waste
4. To quantify and characterize C&D waste, assess processing and recycling opportunities
5. To analyze the status and challenges of e-waste management.

S. No	Contents	Hours
1	Waste Management-Overview, basic elements, planning, implementation, Benefits of waste management for developing economies, Life Cycle Assessment (LCA), issues, regulations and guidelines in India and globally.	5
2	Introduction to Solid Waste Management, Municipal Solid Waste Characteristics and Quantities, MSW Rules 2016, Swachh Bharat Mission and Smart Cities Program, Collection, Transportation, Segregation, Processing and Disposal of Municipal Solid Waste, Current Issues in Solid Waste Management, Current Issues in Solid Waste Management and Review of MSW Management Status in the Country	10
3	Plastics waste management- Types, Uses and Global Statistics, Plastic Waste- Sources, Production, Global and Indian Context. Plastic Waste Management Rules 2016 (India) and Global Rules and Regulations.	10

	Impact of Plastics, Plastic Waste Management Practices, issues and challenges.	
4	Construction and Demolition (C&D) Waste Management – Overview, C&D Waste Components and Quantification, Characteristics & Quantity Estimation of C&D Waste, C&D Waste Processing and Recycling opportunities, C&D Waste – Regulations, Indian Scenario of C&D Waste Processing.	9
5	Electronic Waste (E-Waste) Management – Issues and Status in India and Globally, E-Waste Management Rules 2016 and Management Challenges	8
	Total	42

REFERENCE BOOKS

1. The Central Public Health and Environmental Engineering Organization (CPHEEO), "Manual on Solid Waste Management", India, 2016.
2. "Municipal Solid Waste Management Rules 2016", Central Pollution Control Board, Govt. of India, 2016.
3. "Electronic Waste Management Rules 2016", Central Pollution Control Board, Govt. of India, 2016.
4. "Construction and Demolition Waste Management Rules 2016", Ministry of Environment and Forest and Climate Change, Govt. of India, 2016.
5. McDougall, F. R., White, P. R., Franke, M., and Hindle, P (2001). Integrated Solid Waste Management: a Life Cycle Inventory, Blackwell Science, UK.
6. William A Worrell and P. AarneVeslind, (2012). "Solid Waste Engineering", 2nd Edition Cengage Learning, 2012 (ISBN-13: 978-1-4390-6217-3)
7. George Tchobanoglous, Hilary Theisen and Samuel A Vigil, (1993). "Integrated Solid Waste Management", Tata McGraw Hill.

7CE6-60.3: Sustainable Transportation Systems

Credit: 3Max **Marks: 100 (IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To provide a thorough understanding of the evolution of transportation systems
2. To introduce the environmental impacts of transportation systems
3. To equip the ability to analyze and evaluate policy initiatives and programs for sustainable transport
4. To develop the skills necessary for effective urban and regional transport planning, focusing on the impacts of transport on the environment
5. To cultivate an understanding of transport economics, externalities, and pricing

Course Outcomes: Upon completion of this course the students will be able to:

1. To understand the comprehensive knowledge of Transportation Systems
2. To get proficiency in Environmental Impact Assessments
3. To critically evaluate and apply global and national policies, initiatives, and programs
4. To gain expertise in urban and regional transport planning
5. To understand the implications of externalities, analyzing transport economics, and developing and implementing strategies and regulations for sustainable transport

S. No	Contents	Hours
1	Concept of sustainable transport and sustainable development Transportation systems, transportation system components, multimodal transport, Policy initiatives and programs on sustainable transport - global perspectives (SUMP, KYOTO Protocol), national policies (NUTP, CMP and NAPCC) and local initiatives Current Scenario of Transportation in India- problems and strategies	8
2	Strategies and regulations for sustainable transport: Integrated land use and transport planning and neighbourhood designs, Planning and designing for pedestrians and bicycles, Planning and design of a public transport systems, Integrated multi-modal transport networks, Regulations and Enforcements (Parking policy, Congestion pricing)	8

3	Transport system effectiveness and efficiency – service level benchmarks. Land-use plans, land use strategics for sustainable transport systems, zoning schemes and provisions, Transit Oriented Development (TOD), TOD Implementation	9
4	Sustainable transport and Climate Change: Indicators and Impacts, Impacts on Transportation Systems, Global Best Practices in Urban and regional transport planning, Environment Impact Assessment (EIA)- methods and practise	8
5	Basics of Transport economics Externalities of transport, quantification and value association Demand – supply elasticity, externalities and pricing, factors that influence decisions, Transport pricing and user costs - internalizing externalities.	9
	Total	42

REFERENCE BOOKS

1. Hensher, David A, Kenneth Button, Handbook of Transport Modelling, Pergamon Press, 2000.
2. Button, K., 2010. Transport economics. Edward Elgar Publishing. (chapter 5, 6, 7 and 11)
3. Ortuzar, J.D. and Willhumsen, L.G. Modelling Transport, 4th edition John Wiley, 2011.
4. TERI (2013); Pro-poor mobility - Policy guidelines and case studies Available at: http://www.teriin.org/div/pro-poormobility_policy-guidelines-case-studies.pdf
5. Fundamentals of Transportation System Analysis, Volume -1: Basic Concepts by Manheim Marvin
6. National Urban Transport Policy (2012)
7. Refer research articles and reports

7CS6-60.1: Computer Networks

Credit: 3	**Max. Marks: 100 (IA:30, ETE:70)**
3L+0T+ 0P	**End Term Exams: 3 Hours**

Course Objectives:

As a result of successfully completing this course, students will:

- Become familiar with layered communication architectures (OSI and TCP/IP models).
- Understand different services offered by various OSI and TCP/IP model layers.
- Understand the client/server model and key application layer protocols.
- Understand the concept of unreliable data transfer and its role in communication.
- Understand the concepts of reliable data transfer and how TCP implements these concepts.
- Know the principles of congestion control and trade-offs in fairness and efficiency.
- Understand the role and concept of routing in communication.
- Understand the basics of error detection, including parity, checksums, and CRC.
- Familiarize the student with current topics such as security, network management, sensor networks, and/or other topics.

Course Outcomes:

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

CO-1: Understand basic computer network technology.

CO-2: Understand OSI and TCP/IP reference model and working of each layer of these reference models.

CO-3: Obtain the skills of subnetting and routing mechanisms.

CO-4: Address design and implementation aspects of various essential network protocols and its integration into network-based applications.

S. No.	Contents	Hours
1	**Introduction:** history and development of computer networks, networks topologies. Layering and protocols. OSI and TCP/IP Protocol Stacks, Basics of packet, circuit and virtual circuit switching. **Physical Layer:** Guided Transmission media: twisted pairs, coaxial cable, fiber optics, Wireless transmission.	**6**
2	**Data link layer:** Design issues, framing, Error detection and correction. Elementary data link protocols: simplex protocol, A simplex stop and wait protocol for an error-free channel, A simplex stop and wait protocol for noisy channel. Sliding Window protocols: A one-bit sliding window protocol, A protocol using Go-Back-N, A protocol using Selective Repeat, Example data link protocols. Medium Access sub layer: The channel allocation problem, Multiple access protocols: ALOHA, Carrier sense multiple access protocols, collision free protocols. Wireless LANs, Data link layer switching, Ethernet bridging.	**8**

3	**Network Layer:** Design issues, Routing algorithms, shortest path routing, Flooding, Hierarchical routing, Broadcast, Multicast, distance vector routing, link state routing, Congestion Control Algorithms, Quality of Service, Internetworking, Fragmentation, The Network layer in the internet, IP addressing, IPv4, IPv6. CIDR, NAT, Basics of IP support protocols (ARP, DHCP, ICMP)	**8**
4	**Transport Layer:** Transport Services, Elements of Transport protocols, Connection management, Error and Flow Control, Congestion Control, TCP and UDP protocols, Sockets.	**7**
5	**Application Layer**: Domain name system, Electronic Mail; the World Wide Web, HTTP, FTP, Streaming audio and video.	**7**
6.	**Current Topics Related to Computer Network**: Basic overview of the role and working of topic such as Software-defined Networks, Wireless Sensor Networks and Internet of Things, Cyber-physical systems	**6**
Total		**42**

Suggested Books:

1. Computer Networks, Andrew S. Tanenbaum and David J Wetherall, 5th Edition. Pearson publication.
2. Computer Networking: A Top-Down Approach Featuring the Internet, James F Kurose and Keith W Ross. Pearson publication.
3. Computer Networking: A Top-Down Approach, Behrouz A. Forouzan, Firouz Mosharraf, TMH.
4. Data Communications and Networking – Behrouz A. Forouzan. 4th Edition TMH.
5. Computer Networks: A Systems Approach, 5th Ed., LL Peterson, BS Davie, Morgan-Kauffman, 2011.
6. Cryptography and Network Security, Principles and Practice, 5th Ed., W Stallings, Prentice-Hall, 2010
7. Internet of Things: A Hands-on Approach , by Arshdeep Bagha and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547
8. Fundamentals of Cyber-Physical Systems - https://eprints.whiterose.ac.uk/173235/1/Chapter%201 .%20 Fundamentals%20of%20 Cyber-Physical %20Systems.pdf
9. Cyber-Physical Systems and Internet of Things - https://nvlpubs.nist.gov/nistpubs/SpecialPublications /NIST.SP.1900-202.pdf

7CS6-60.2: Database Management Systems

Credit: 3	Max. Marks: 100 (IA:30, ETE:70)
3L+0T+ 0P	End Term Exams: 3 Hours

Course Objectives:

1. To understand purpose of database management systems.
2. Apply concepts of database design and database languages (SQL based) in managing data.
3. Understand concepts and importance of relational algebra and relational calculus.
4. Importance and application of normalization in DBMS.
5. Knowledge of transaction, concurrency control, recovery strategies.

Course Outcomes:

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

CO-1: Describe DBMS architecture, physical and logical database designs, database models, entity-relationship model.

CO-2: Understand relational algebra, relational calculus importance and query writing

CO-3: Apply Structured query language (SQL) for database definition, database manipulation, data control.

CO-4: Understanding of normalization theory and apply it to normalize databases.

CO-5: Understand various transaction processing, concurrency control mechanisms and database protection mechanisms.

S. No.	Contents	Hours
1	**Introduction to database systems:** Overview and History of DBMS. File System v/s DBMS. Advantage of DBMS Describing and Storing Data in a DBMS. Queries in DBMS. Structure of a DBMS. **Entity Relationship model:** Overview of Data Design Entities, Attributes and Entity Sets, Relationship and Relationship Sets. Features of the ER Model- Key Constraints, Participation Constraints, Weak Entities, Class Hierarchies, Aggregation, Conceptual Data Base, and Design with ER Model- Entity v/s Attribute, Entity vs Relationship Binary vs Ternary Relationship and Aggregation v/s ternary Relationship Conceptual Design for a Large Enterprise.	**8**
2	**Relationship Algebra and Calculus:** Relationship Algebra Selection and Projection, Set Operations, Renaming, Joints, Division, Relation Calculus, Expressive Power of Algebra and Calculus. SQL queries programming and Triggers: The Forms of a Basic SQL Query, Union, and Intersection and Except, Nested Queries, Correlated Nested Queries, Set-Comparison Operations, Aggregate Operators, Null Values and Embedded SQL, Dynamic SQL, ODBC and JDBC, Triggers and Active Databases.	**8**

3	**Schema refinement and Normal forms:** Introductions to Schema Refinement, Functional Dependencies, Boyce-Codd Normal Forms, Third Normal Form, Normalization-Decomposition into BCNF Decomposition into 3-NF.	**8**
4	**Transaction Processing:** Introduction-Transaction State, Transaction properties, Concurrent Executions. Need of Serializability, Conflict vs. View Serializability, Testing for Serializability, Recoverable Schedules, Cascadeless Schedules.	**8**
5	**Concurrency Control:** Implementation of Concurrency: Lock-based protocols, Timestamp-based protocols, Validation-based protocols, Deadlock handling, **Database Failure and Recovery:** Database Failures, Recovery Schemes: Shadow Paging and Log-based Recovery, Recovery with Concurrent transactions.	**8**
Total		**40**

Suggested Books:

- H. F. Korth and Silberschatz: Database Systems Concepts, McGraw Hill
- Almasri and S. B. Navathe: Fundamentals of DataBase Systems
- Ramakrishnan: Database Management Systems
- C. J. Date: Data Base Design, Addison Wesley
- Hansen and Henson: DBM and Design, PHI

7CS6-60.3: Operating Systems

Credit: 3	**Max. Marks: 100 (IA:30, ETE:70)**
3L+0T+ 0P	**End Term Exams: 3 Hours**

Course Objectives: As a result of successfully completing this course, students will:

- Learn about how Operating System is Important for Computer System.
- Learn about different types of Operating Systems and their services.
- Learn different process scheduling algorithms and synchronization techniques to achieve better performance of a computer system.
- Learn about device and device management.
- Learn about the concept of memory management and virtual memory.
- Learn about the concept of file system.

Course Outcomes: Upon successful completion of the course the students will be able to

CO-1: Analyze basic concepts of operating systems and their structures.

CO-2: Analyze various issues related to inter-process communication like process synchronization and critical section.

CO-3: Synthesize the concepts of I/O management, file system implementation, scheduling, resource management and deadlocks.

CO-4: Interpret the issues and challenges of memory management.

CO-5: Understand protection and security issues related to the operating system.

S. No.	Contents	Hours
1	**Introduction to OS and Process Management:** Introduction to operating systems, operating system structure, system calls, Process concept, Operations on processes, cooperating processes, inter process communication, mutual exclusion, critical section problem, Synchronization hardware, wait and signal procedures, Semaphores, Classic problems of synchronization, critical regions, Monitors, process scheduling and algorithms, threads, multithreading. **CPU Scheduling**: Scheduling criteria, Scheduling algorithms, Multiple processor scheduling, Real time scheduling	**9**
2	**Memory Management:** Background, Swapping, Contiguous memory allocation, Paging, Segmentation, Segmentation with paging. Virtual Memory, Demand paging, Page replacement policies, Allocation of frames, Thrashing, case study.	**8**
3	**Deadlock and Device Management:** ***Deadlock:*** System model, Deadlock characterization, Methods for handling deadlocks,	**9**

	Deadlock prevention, Deadlock avoidance, Deadlock detection, Recovery from deadlock. ***Device management***: devices and their characteristics, device drivers, device handling, disk scheduling algorithms, Swap space management.	
4	**File Systems and Its Implementation**: File System Interface, File concepts, Access methods, Directory structure, File system mounting, Directory implementation, Allocation methods, Free space management – efficiency and performance, recovery, log structured file systems	**7**
5	**Protection and Case Studies:** ***Protection***: Goals of protection, Principles of protection, Domain of protection, Access matrix, Implementation of access matrix, Access control, Revocation of access rights, file security, user authentication ***Case Study***: Linux Operating System Linux history; Design principles; Kernel modules; Process management; Scheduling; Memory management; File systems, Input and output; Inter-process communication, Case studies of Real Time and Mobile OS.	**7**
Total		**40**

Suggested Books:

1. Silberschatz, Galvin, and Gagne, "Operating System Concepts", Wiley India Pvt Ltd.
2. Modern Operating Systems, Andrew S. Tanenbaum, Herbert Bos, Pearson Education India; Fourth edition 2016. ISBN-13:978- 9332575776
3. Operating Systems: Internals and Design Principles William Stallings, Pearson Education India; 7 edition (2013). ISBN-13: 978-9332518803
4. Gary Nutt, "Operating Systems", Third Edition, Pearson Education
5. Operating Systems: A Design-Oriented Approach, Charles Crowley, International edition, McGraw-Hill Education (ISE Editions). ISBN-13 978 0071144629

7CS6-60.4: Introduction to Python Programming

Credit: 3	**Max. Marks: 100 (IA:30, ETE:70)**
3L + 0T + 0P	**End Term Exams: 3 Hours**

Course Objectives:

1. Develop understanding of the fundamental concepts essential for programming.
2. To enable students to design algorithms, apply code and data visualized the data.
3. To enable students to apply python programming in problem solving.

Course Outcomes:

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

CO-1: Know the Essential concepts of Python Programming and its real time use.

CO-2: Design algorithms and source code.

CO-3: Use of suitable data structure and logic for problem solving.

S. No.	Contents	Hours
1	**Introduction to Python:** Why Python? - Essential Python libraries - Python Introduction- Features, Data types, variables, expressions, operators, Identifiers, Reserved words, Indentation, Comments.	**8**
2	**Decision Making**: Selective statements – if, if-else, nested if, if –elif ladder statements. Iterative statements - while, for, Nested loops, else in loops, break, continue and pass statements. **Looping**: Loop Control statement- Math and Random number functions. User-defined functions - function arguments & its types. **Strings**: Formatting, Comparison, Slicing, Splitting, Stripping, Negative indices, String functions. **Regular expression**: Matching the patterns, Search and replace.	**8**
3	**List**: Create, Access, Slicing, Negative Indices, List Methods, and comprehensions. **Tuples**: Create, Indexing and Slicing, Operations on tuples. **Dictionary**: Create, add, and replace values, operations on dictionaries. **Sets**: Create and operations on set.	**8**
4	**Functions**: Types, parameters, arguments: positional arguments, keyword arguments, parameters with default values, functions with arbitrary arguments, Scope of variables: Local and global scope, Recursion and Lambda functions. **Files**: Open, Read, Write, Append and Close. Tell and seek methods	**8**
5	**NumPy Basics**: Arrays and Vectorized Computation- The NumPy ND array- Creating ND arrays- Data Types for ND arrays- Arithmetic with NumPy Arrays- Basic Indexing and Slicing- Boolean Indexing-Transposing Arrays and Swapping Axes. Universal Functions: Fast Element-Wise Array Functions- Mathematical and Statistical Methods-Sorting Unique and Other Set Logic. , Data Visualization	**8**
Total		**40**

Suggested Books:

- Programming Python by Mark Lutz, O'Reilly.
- Learning Python, 3rd Edition by Mark Lutz, O'Reilly
- Python in a Nutshell by Alex Martelli, O'Reilly.
- Wesley J. Chun, "Core Python Programming", Prentice Hall,2006.
- Mark Lutz, "Learning Python", O'Reilly, 4th Edition, 2009.
- Introduction to Programming using Python by Y. Daniel Liang , Pearson,2012.

7CS6-60.5: Linux and Shell Programming

Credit:3	**Max. Marks: 100 (IA:30, ETE:70)**
3L+0T+ 0P	**End Term Exams: 3 Hours**

Course Objectives:

1. Understand the Linux architecture, features and Commands.
2. Understand Linux file systems, shell basics, and shell environments
3. Understand Shell Programming and to write shell scripts.
4. Understand Linux utilities, software installation and source code management.

Course Outcomes:

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

CO-1: Explain multi user Linux OS and its features

CO-2: Interpret Linux Commands, Shell basics, and shell environments

CO-3: Design and develop shell programs, communication, System calls.

CO-4: Handling installation of software for Linux based OS with source code management

S. No.	Contents	Hours
1	**INTRODUCTION TO LINUX AND LINUX UTILITIES:** history, architecture, and features of LINUX, Linux commands- sudo, man, echo, printf, script, passwd, uname, who, date, stty, pwd, cd, mkdir, rmdir, ls, cp, mv, rm, cat, more, wc, lp, od, tar, gzip, networking commands -unlink, du, df, mount, umount, find, unmask, ulimit, ps, w, finger, arp, ftp, telnet, rlogin. Text Processing commands - tail, head , sort, nl, uniq, grep, egrep, fgrep, cut, paste, join, tee, pg, comm, cmp, diff, tr, cpio	**8**
2	**LINUX FILE STRUCTURE:** Introduction to LINUX file system and Structures, inode (Index Node), file descriptors, system calls and device drivers. System Calls for File Management – create, open, close, read, write, lseek, link, symlink, unlink, stat, fstat, lstat, chmod, chown, Directory API – opendir, readdir, closedir, mkdir, rmdir, umask. File links – hard and soft links. Environment and path setting. The /etc/passwd and /etc/shadow files. Add, modify and delete users.	**8**
3	**SHELL BASICS:** Meaning and purpose of shell, Introduction to types of shell The command line, standard input and standard output, redirection, pipes, filters special characters for searching files and pathnames., command separation & grouping, redirection, directory stack manipulation, processes	**8**

4	**SHELL PROGRAMMING:** shell script-writing and executing, parameters & variables, keyword variables, Command line arguments, exit and exit status of a command. Logical operators for conditional execution. if, while, for and case control statements. The set and shift command. Expanding NULL or USET variables, functions, aliases	**8**
5	**UTILITIES:** Compiling & linking C, C++ programs, make utility, debugging C programs using gdb. Installing, updating and deleting software packages: apt-get, rpm, dpkg, etc. Source code management - RCS and CVS. awk utility	**8**
Total		**40**

Suggested Books:

- Sumitabha Das., Unix Concepts and Applications., 4th Edition., Tata McGraw Hill
- UNIX SHELL PROGRAMMING, Book by Yashavant Kanetkar, Bpb Publication
- Behrouz A. Forouzan, Richard F. Gilberg : UNIX and Shell Programming- Cengage Learning – India Edition. 2009.
- M.G. Venkatesh Murthy: UNIX & Shell Programming, Pearson Education.
- Richard Blum , Christine Bresnahan : Linux Command Line and Shell Scripting Bible, 2ndEdition , Wiley,2014.
- A Practical Guide to Linux Commands, Editors, and Shell Programming, Sobell, Pearson.
- Harley Hahn: Guide to Unix & Linux, TMH
- Blum, Bresnahan, Linux Command and Shell Scripting Bible, Wiley India

7EE6-60.1**: Generation of Electrical Power**	
Credit:3	**Max Marks:100(IA: 30, ETE: 70)**
3L+0T+ 0P	**End Term Exams:3 hrs.**

Course Outcomes:

Upon successful completion of the course, the students will be able to:

CO-1: Know the basic operation of conventional power plants, especially, Thermal, Hydro, Gasand Nuclear Power Plants.

CO-2: Understand the working of wind, tidal and solar PV systems.

CO-3: Learn about the various factors associated with the power plants & loads and tariffs.

CO-4: Understand the economics of power plants and power factor improvement.

S. No.	Contents	Hours
1.	**Introduction:** Objective, scope and outcome of the course.	**1**
2.	**Conventional Power Plants-I:** Power Plants: Scheme and operating principles.Power Plants: Classification of hydroelectric plants, Basic schemes of hydroelectric and pumped storage plants. Selection and location of power plants.	**7**
3.	**Conventional Power Plants-II:** Nuclear fission and nuclear fusion. Fissile and fertile materials. Basic plant schemes with boiling water reactor, heavy water reactor and fast breeder reactor. Impact of thermal, gas, hydro and nuclear powerstations on environment. Concept of co-generation.	**8**
4.	**Non-conventional Energy Sources:** Green House Effect, Global warming, Renewable energy scenario in India and world, Introduction to electric energy generation by wind, solar and tidal. Conservation of natural resources and sustainable energy systems, Introduction to Micro-grid.	**8**
5.	**Loads and Their Characteristics:** Various types of loads, chronological load curve, load duration curve, energy load curve and mass curve. Maximum demand, demand factor, load factor, diversity factor, capacity factor and utilization. **Tariff:** Objectives of tariffs. General tariff form. Flat demand rate, straight meter rate, block meter rate. Two-part tariff, power factor dependent tariffs, three-part tariff. Spot pricing.	**8**

6.	**Economics of Power Plants:** Capital cost of plants, annual fixed and operating costs of plants, generation cost and depreciation. Effect of load factor on unit energy cost. Role of load diversity in power system economics. Calculation of most economic power factor when (i) kW demand is constant and (ii) kVA demand is constant. Energy cost reduction: off peak energy utilization, energy conservation. **Power Factor Improvement:** Causes and effects of low power factor andadvantages of power factor improvement. Power factor improvement using	**8**
	shunt capacitors and synchronous condensers.	
	Total	**40**

Suggested Books:

1. Generation of Electrical Energy, Gupta B. R., S. Chand and Company Ltd.
2. Principles of Power system, V. K. Mehta, S. Chand Publication.
3. Generation, Distribution and Utilization of Electrical Energy, Wadhwa C. L., Wiley Eastern Ltd.
4. Elements of Electrical Power station Design, M. V. Deshpande, PHI India
5. Nagrath & Kothari, Power System Engineering, PHI India
6. Generation of Electrical Power, Soni, Gupta and Bhatnagar, Dhanpat Rai and Sons.

7AR6-60.1: Basics of Aeronautical Engineering

Credit: 3 Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

6. To provide students with a foundational understanding of the history, classification, and basic components of aircraft, including helicopters and their functions.
7. To teach students the basic principles of flight, including the generation of lift and drag, and the significance of aerodynamic factors such as airspeed, Mach number, and aspect ratio.
8. To equip students with knowledge about different types of aircraft propulsion systems, their principles of operation, and performance characteristics.
9. To provide students with an understanding of the forces acting on an aircraft in flight, the concepts of static and dynamic stability, and the basics of aircraft control systems.

Course Outcomes

Student will be able to

6. Students will be able to identify and describe the major components of an aircraft, their functions, and the different structural materials and construction types used in aircraft design.
7. Students will demonstrate an understanding of the basic principles of flight, including the generation of lift and drag, and will be able to solve simple problems related to lift and drag.
8. Students will understand the different types of aircraft propulsion systems, including the principles of operation and performance characteristics of turboprop, turbojet, turbofan engines, and other propulsion methods.
9. Students will gain knowledge about the forces acting on an aircraft in flight, the concepts of static and dynamic stability, and will be able to solve simple problems related to aircraft stability and performance.
10. Students will be able to describe the various mechanical and electrical systems in an aircraft, including hydraulic, pneumatic, environmental control, fuel, oxygen, flight control, communication, and navigation systems, and their applications.

SN	Contents	Hours
1	**Introduction to Aircrafts:** History of aviation; Atmosphere and its properties; Classification of aircrafts; Basic components of an aircraft; aircraft axis system; aircraft motions; control surfaces and high lift devices; conventional design configurations; principle of operation of each major part; Helicopters, their parts and functions. **Aircraft Structures and Materials:** Introduction; structural members; general types of construction; monocoque, semi-monocoque and geodesic structures; typical wing and fuselage structure; metallic and non-metallic materials for aircraft application.	**8**
2	**Basic principles of flight:** Significance of speed of sound; airspeed and groundspeed; standard atmosphere; Bernoulli's theorem and its application for generation of lift and measurement of airspeed; forces over wing section, aerofoil nomenclature, pressure distribution over a wing section. Lift and drag components – generation of lift and drag; lift curve, drag curve, types of drag, factors affecting lift and drag; centre of pressure and its significance; aerodynamic centre, aspect ratio, Mach number and supersonic flight effects; simple problems on lift and drag.	**8**

3	**Aircraft Propulsion:** Aircraft power plants, classification based on power plant and location and principle of operation. Turboprop, turbojet and turbofan engines; ramjets and scramjets; performance characteristics. Aircraft power plants – basic principles of piston, turboprop and jet engines; Brayton cycle and its application to gas turbine engines; use of propellers and jets for production of thrust; comparative merits and limitations of different types of propulsion engines; principle of thrust augmentation.	**8**
4	**Aircraft Stability:** Forces on an aircraft in flight; static and dynamic stability; longitudinal, lateral and roll stability; necessary conditions for longitudinal stability; basics of aircraft control systems. Effect of flaps and slats on lift, control tabs, stalling, gliding, landing, turning, aircraft manoeuvres; stalling, gliding, turning. Simple problems on these. Performance of aircraft – power curves, maximum and minimum speeds for horizontal flight at a given altitude; effect of changes in engine power and altitude on performance; correct and incorrect angles of bank; aerobatics, inverted manoeuvre, manoeuvrability. Simple problems.	**8**
5	**Introduction to Aircraft Systems:** Aircraft systems (Mechanical) – hydraulic and pneumatic systems and their applications; environment control system; fuel system, oxygen system. Aircraft systems (Electrical) – flight control system, cockpit instrumentation and displays; communication systems; navigation systems; power generation systems – engine driven alternators, auxiliary power Module, ram air turbine; power conversion, distribution and management.	**8**
	Total	**40**

TEXT BOOK

1 Anderson, J.D., “Introduction to Flight”, McGraw-Hill, 1995.

2 Stephen.A. Brandt, “Introduction to Aeronautics: A design perspective" American Institute of Aeronautics & Astronautics,1997

3 Fundamentals of Flight Vol-I to Vol-IV, Lalit Gupta and O P Sharma, Himalayan Books, 2006

REFERENCE BOOKS

1 Kermode, A.C., “Mechanics of Flight”, Himalayan Book, 1997

2 Flight without formulae, A.C. Kermode, Pearson Education India, 1989

3 Flight stability and automatic control, Nelson R.C, McGraw-Hill International Editions ,1998

4 Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration Ian Moir, Allan Seabridge, John Wiley & Sons, 2011

7AR6-60.2: Aircraft Maintenance Management

Credit: 3 Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To educate students on safe working practices in aircraft and workshop environments, including precautions with electricity, gases, oils, and chemicals, and appropriate remedial actions in case of accidents.
2. To provide students with knowledge and skills related to the care, control, and use of various maintenance tools, including calibration, precision measuring, and lubrication equipment.
3. To familiarize students with the types, inspection, testing, and maintenance of various aircraft hardware components such as pipes, hoses, springs, and bearings.
4. To impart practical knowledge and skills in material bonding techniques, including sheet metal work, riveting, welding, and brazing, as well as planning and executing maintenance procedures.

Course Outcomes

Student will be able to

1. Students will demonstrate an understanding of safe working practices in aircraft and workshop settings, including the proper handling of hazardous materials and emergency procedures.
2. Students will show proficiency in the use, care, and calibration of both hand and power tools, as well as precision measuring instruments, and understand standards of workmanship and tolerances.
3. Students will be able to inspect, test, and maintain various aircraft hardware components, including pipes, hoses, springs, and bearings, and understand their lubrication requirements and defect causes.
4. Students will gain knowledge in inspecting and maintaining aircraft transmission systems, such as gears, belts, pulleys, chains, and control cables, including swaging and testing.
5. Students will acquire skills in sheet metal work, composite bonding, riveting, soldering, welding, brazing, and the inspection of these joints, understanding the tools and methods used.

SN	Contents	Hours
1	**Safety Precautions-Aircraft and Workshop:** Aspects of safe working practices including precautions to take when working with electricity, gases especially oxygen, oils and chemicals. Instruction in the remedial action to be taken in the event of a fire or another accident with one or more of these hazards including knowledge on extinguishing agents.	8
2	**Maintenance Practices Tools:** Care of tools, control of tools, use of workshop materials; Dimensions, allowances and tolerances, standards of workmanship, Calibration of tools and equipment, calibration standards. Common hand tool types; Common power tool types, Operation and use of precision measuring tools, Lubrication equipment and methods. Operation, function and use of electrical general test equipment.	8
3	**Aircraft Hardware:** **Pipes and Hoses:** Types of pipes and hoses used in aircraft, Bending and belling/flaring aircraft pipes, Inspection and testing of aircraft pipes and hoses, Installation and clamping of pipes.	8

	Springs: Inspection and testing of springs used in aircraft. **Bearings:** Testing, cleaning and inspection of bearings, Lubrication requirements of bearings, Defects in bearings and their causes.	
4	**Transmissions:** Types of gears used in the aircraft, Inspection of gears, backlash, Inspection of belts and pulleys, chains and sprockets, Inspection of screw jacks, lever devices, push-pull rod systems. **Control Cables:** Swaging of end fittings, Inspection and testing of control cables, Bowden cables, aircraft flexible control systems.	**8**
5	**Material Bonding** **Sheet Metal:** Marking out and calculation of bend allowance, Sheet metal working, including bending and forming, Inspection of sheet metal work. Composite and non-metallic: Bonding practices, **Riveting:** Riveted joints, rivet spacing and pitch, Tools used for riveting and dimpling, Inspection of riveted joints. **Welding, Brazing, Soldering and Bonding:** Soldering methods, inspection of soldered joints. Welding and brazing methods, Inspection of welded and brazed joints, Bonding methods and inspection of bonded joints. Inspection methods	**8**
6	**Maintenance Procedures:** Maintenance planning, Modification procedures, Stores procedures, Certification/release procedures, Interface with aircraft operation, Maintenance Inspection/Quality Control/Quality Assurance, Additional maintenance procedures. Control of life limited components.	**8**
	Total	**40**

TEXT BOOK

1 Kroes Watkins Delp, "Aircraft Maintenance and Repair", McGraw -Hill, New York, 1993

2 Harry A. Kinnison and Tariq Terry Siddiqui, “Aviation Maintenance Management”, 2nd Edition, McGraw -Hill, New York, 2013

REFERENCE BOOKS

1 A&P Mechanics, "Aircraft Hand Book", F A A Himalayan Book House, New Delhi, 1996

2 Michael Kroes, William Watkins, Frank Delp and Ronald Sterkenburg, “Aircraft Maintenance and Repair”, Seventh Edition, McGraw-Hill Education, 2013

7AR6-60.3: Simulation Modeling and Analysis

Credit: 3 Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To provide students with a comprehensive understanding of system modeling concepts, including continuous and discrete systems, linear and nonlinear systems, and the principles used in modeling.
2. To teach students the techniques and methods of computer simulation, including the Monte Carlo method, numerical computation techniques, and the creation of simulation models for various systems.
3. To equip students with knowledge of probability concepts and their application in simulation, including the generation and testing of random numbers and variates.
4. To impart skills in data collection, model verification, and validation, as well as output analysis, including the use of simulation software for practical applications.

Course Outcomes

Student will be able to

1. Students will be able to conceptualize and develop physical and mathematical models of systems, understanding the advantages and disadvantages of simulation.
2. Students will demonstrate proficiency in computer system simulation techniques, including the Monte Carlo method and the creation of models for waiting line systems, job shops, and flexible manufacturing systems.
3. Students will understand and apply probability concepts in simulation, including generating and testing random numbers and variates for various distributions.
4. Students will be able to perform data collection, parameter estimation, and model verification and validation, and conduct comprehensive output analysis using various simulation software packages.

SN	CONTENTS	Hours
1	**Physical modeling:** Concept of system and environment, continuous and discrete system, linear and nonlinear system, stochastic activities, static and dynamic models, principles used in modeling, Basic simulation modeling, Role of simulation in model evaluation and studies, Advantages and Disadvantages of simulation. Modeling of Systems, iconic analog. Mathematical Modeling	7
2	**Computer system simulation:** Technique of simulation, Monte Carlo method, experimental nature of simulation, numerical computation techniques, continuous system models, analog and hybrid simulation, feedback systems Buildings simulation models of waiting line system, Job shop, material handling and flexible manufacturing systems	8
3	**Probability concepts in simulation:** Stochastic variables, discrete and continuous probability functions mainly Normal, lognormal, Weibull, exponential, Uniform, Poisson, Binomial, Triangular **Random Numbers:** Properties, Generations methods, Tests for Random number-Frequency test, Runs test, Autocorrelation test. **Random Variate Generation:** Inverse Transform Technique- Exponential, Uniform, Weibull, Triangular distributions, Direct transformation for Normal and log normal Distributions,	9

4	**Input Modelling:** Data collection, Identification and distribution with data, parameter estimation, Goodness of fit tests, Selection of input models without data, Multivariate and time series **Verification and validation:** Design of simulation experiments, validation of experimental models, testing and analysis.	**7**
5	**Output Analysis**: Types of Simulations with Respect to Output Analysis, Stochastic Nature of output data, Measures of Performance and their estimation, Output analysis of terminating simulation, Output analysis of steady state **Selection of Simulation Software**: Simulation packages, Trend in Simulation. Do modeling using ARENA software which is freely available. Some more suggested simulation packages are Promodel, Quest, Witness, Extend, Simio etc. Students can learn	**9**
	Total	**40**

TEXT BOOK

1 Law, A. M., "Simulation Modeling and Analysis," 6th Edition, 2024, McGraw-Hill.

REFERENCE BOOKS

1 Banks, J., and Carson, J. S., "Discrete-Event System Simulation," 5th Edition, 2010, Prentice Hall.

2 Altiok, T., and Melamed, B., "Simulation Modeling and Analysis with ARENA," 1st Edition, 2007, Academic Press.

3 Kelton, W. D., Sadowski, R. P., and Zupick, N. B., "Simulation with ARENA," 6th Edition, 2015, McGraw-Hill.

4 Rossetti, M. D., and Taha, H. A., "Simulation Modeling and ARENA," 1st Edition, 2013, John Wiley & Sons.

5 Deo, N., "System Simulation with Digital Computer," 1990, PHI Publication (EEE).

7ME6-60.1: Finite Element Method

Credit: 3 Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

10. To provide knowledge of history and basics of finite element method (FEM).
11. To share knowledge of the variational methods.
12. To impart knowledge of finite element 1-D problems, finite element 2-D problems and numerical considerations

Course Outcomes

Student will be able to

11. CO-1: To understand clearly the benefits and uses of finite element methods to solve real engineering problems for distinct engineering streams.
12. CO-2: To be able to understand clearly the variational methods and its uses to solve the engineering problems for various engineering fields.
13. CO-3: To select appropriate approach with proper sequence of fem steps to solve differential equations of one-dimensional problems by using finite element method.
14. CO-4: To select appropriate approach with proper sequence of fem steps to solve differential equations of two-dimensional problems.
15. CO-5: To understand the proper selection of numerical integration method to solve integration problems corresponding to the engineering field and also awareness and uses of finite element packages.

Sr. No.	Contents	Hours
1.	Introduction: Historical background, basic concept of the finite element method, comparison among finite element method, finite difference method and classical methods.	3
2.	Variational methods: calculus of variation, the Rayleigh-Ritz and Galerkin methods.	7
3.	Finite element analysis of 1-D problems: formulation by different approaches (Direct, potential energy and Galerkin); Derivation of elemental equations and their assembly, solution and its post-processing. Applications in heat transfer, fluid mechanics and solid mechanics. Longitudinal deformation of a bar, Bending of beams, analysis of truss and frame	9
4.	Finite element analysis of 2-D problems: finite element modelling of single variable problems, triangular elements, rectangular elements, Natural coordinates and iso-parametric, sub-parametric and super-parametric elements, serendipity elements, eight noded curvilinear elements.	8
5.	Numerical considerations: one-dimensional integration formulae, two-dimensional integration formulae, error analysis, mesh refinement. Plane stress and plane strain problems; Bending of plates; Eigen value and time dependent problems; Discussion about preprocessors, postprocessors and finite element packages.	9
	Total	41

TEXT BOOK

1 J. N. Reddy, An introduction to the Finite Element Method, 3rd edition, McGraw-Hill, 2006.

2 R. D. Cook, D. S. Malkus and M. E. Plesha, Concepts and Applications of Finite Element Analysis, 4th edition, John Wiley, 2007.

REFERENCE BOOKS

1 K. J. Bathe, Finite Element Procedures in Engineering Analysis, 2nd edition (reprint), Prentice-Hall, 2009.

2 U.S. Dixit, Finite Element Methods For Engineers Paperback – 1 January 2009.

3 P. Seshu, Textbook of Finite Element Analysis Paperback – 1 January 2003.

7ME6-60.2: Fundamentals of Automotive Systems

Credit: 3 Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

5. To introduce students to the working of spark ignition and compression ignition engines and their systems.
6. To introduce students to the cooling and lubrication system of spark ignition and compression ignition engines.
7. To Gain a comprehensive understanding of various automotive systems, including clutches, brakes, gear boxes, steering systems transmission, suspension, braking, and electrical systems.
8. To Develop the ability to analyze and evaluate the design, construction, and performance of individual vehicle components, such as clutches, brakes, gear boxes, steering systems, transmissions, and chassis systems.
9. To Explore emerging trends and advanced technologies in the automotive industry, including electric and hybrid vehicles, autonomous driving, and connected systems.

Course Outcomes

Student will be able to

6. Compare the merits and demerits of different types of fuel injection systems used in IC engines
7. Determine performance and combustion characteristics of SI and CI engines
8. Get a comprehensive understanding of various automotive systems, including clutches, brakes, gear boxes, steering systems transmission, suspension, braking, and electrical systems.
9. Develop the ability to analyze and evaluate the design, construction, and performance of individual vehicle components, such as clutches, brakes, gear boxes, steering systems, transmissions, and chassis systems.
10. Understand the emerging trends and advanced technologies in the automotive industry, including electric and hybrid vehicles, autonomous driving, and connected systems.

SN	Contents	Hours
1	Classification of Internal Combustion Engines, Engine Components, Operation and Combustion in Four-stroke Engines and Two-Stroke Engines (Overview) Supercharging and Combustion in SI Engines, Knocking in SI Engines, Combustion in Compression Ignition Engines, Carburetion, Basic overview of Fuel Introduction Systems (Carburetor), Engine Emissions, Emission Control Systems	6
2	Frame & Body: Layout of chassis, types of chassis frames and bodies, Clutches: single plate, multi-plate, cone clutch, semi centrifugal, electromagnetic, vacuum and hydraulic clutches. Fluid coupling. Brakes: Classification and function; Mechanical, hydraulic, vacuum air, and self-engineering brakes; Brake shoes and lining materials.	6
3	Gear Boxes: Sliding mesh, constant mesh, synchromesh, and epicyclic gearboxes, Automatic transmission system; Hydraulic torque converter; Drives: Overdrive, Propeller shaft, Universal joints, Differential; Rear axle drives. Hotchkiss and torque tube drives; Rear axle types; Front wheel and All wheel drive.	6

4	Engine Friction & Lubrication: Determination of friction, Lubrication principles, Types of lubrication, Places of lubrication Bearings and piston rings, etc., Functions of Lubrication, Properties, Rating and Classification of lubricating oil, Additives, Lubrication systems. Engine Cooling: Requirements of cooling, Areas of heat flow, High-temperature regions of the combustion chamber, Cooling Systems, Air, Water Cooling, and Cooling system components.	5
5	Steering system: steering gearboxes, Steering linkages, Steering mechanism, Under and Oversteering. Steering Geometry, Effect of camber, caster, king pin inclination, toe in and toe out; Power steering; Integral and linkage types. Suspension system: objective and requirements, Suspension spring, front and rear suspension systems, Independent suspension system Shock absorbers.	7
6	Automotive Electrical System: Battery construction, Charging and testing, battery types, Starting and Battery Charging System: Starter motor construction, types of drive, Alternator construction, regulation, and rectification. Ignition System: Magneto and coil ignition systems, System components and requirements, Automotive lighting: Wiring systems Electrical instruments; headlamp, electric horn, fuel level indicator.	6
7	Electric Vehicles: Basic concept of EV, Types of EVs, Hybrid Architecture - Series, Parallel and Series Parallel Configuration, Electric propulsion systems. Energy Storage Technology: Battery Basics, Lead Acid Battery, Different Types of Batteries, Battery Parameters.	6
	Total	42

TEXT BOOK

1 V Ganesan, Internal Combustion Engine, 4th edition, Tata Mc-Graw Hill, 2012.
2 Singh, Kirpal "Automobile Engineering"; Standard Publishers and Distributors, New Delhi, 13th edition
3 Iqbal Husain, Electric and Hybrid Vehicles, CRC Press, ISBN13- 978-1439811757, 2nd edition.

REFERENCE BOOKS

1 John B.Heywood, Internal Combustion Engine Fundamentals, 2nd Edition, Tata McGraw Hill, 2011.
2 Giri, NK; "Automobile Mechanics"; Khanna Publishers, New Delhi; 8th Edition
3 Duffy, JE; "Modern Automotive Technology"; Goodheart-Willcox Company, Incorporated, 2017; 9th edition
4 Ed. by- Muneer T, Kohle ML, Doyle, "A Electric Vehicles: Prospects and Challenges", Elsevier, 2017.

7ME6-60.3: Numerical Methods for Engineers

Credit: 3 Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

5. To provide basics of numerical method and its analysis.
6. To share knowledge to solve linear and non-linear problems.
7. To impart knowledge of interpolation and error estimation methods in the analysis

Course Outcomes

Student will be able to

5. CO-1: To understand clearly the benefits of numerical analysis to solve real engineering problems for distinct engineering streams.
6. CO-2: To be able to select appropriate methods to solve linear and non-linear algebraic equations corresponding to the engineering problems for various engineering fields.
7. CO-3: To understand clearly different interpolation techniques to analyse the engineering problems.
8. CO-4: To understand clearly different error estimation and extrapolation techniques to analyse the engineering problems.

.

Sr. No.	Contents	Hours
1.	Introduction: Numerical analysis, Significant digits, Types of errors; Stability; Accuracy.	5
2.	Solutions of Linear Algebraic Equations: Direct elimination methods, Pitfalls of elimination methods, Norm and condition number; Iterative methods, Accuracy and convergence of iterative methods; Solution of Eigenvalue Problems;	7
3.	Solutions of Nonlinear Equations: Newton's method, System of nonlinear equations, Convergence and Error analysis;	8
4.	Interpolation: Lagrange polynomials, Divided difference polynomials, Hermite and cubic spline interpolation, Least square approximation; Numerical Differentiation – Unequally spaced data and Equally spaced data,	9
5.	Error estimation and extrapolation; Numerical quadrature – Newton-Cotes, Gauss quadrature, Multiple integrals; Initial and boundary value problems – Classification of ODEs, One step methods, Convergence and numerical stability analysis, Solution of higher order equations, Multistep methods, Convergence and stability analysis.	9
	Total	41

TEXT BOOK

1 F.B. Hildebrand, Introduction to Numerical Analysis, Second (Revised) Edition, Courier Dover Publications, 1987.

2 E. Kreyszig, Advanced Engineering Mathematics, Tenth Ed., John Wiley and Sons, 2010

REFERENCE BOOKS

1 R. L. Burden and J. D. Faires, Numerical Analysis, 9th Edition (second Indian Reprint 2012), Brooks/Cole, 2011.

2 L.N. Trefethen, David Bau III, Numerical Linear Algebra, SIAM, 1997.

3 G. M. Phillips and P. J. Taylor, Theory and Applications of Numerical Analysis, Second Edition, Academic Press, 1996.

4 J. D. Hoffman, Numerical Methods for Engineers and Scientists, Second Edition (Special Indian Edition), CRC Press, 2001.

7MX6-60.1: Digital System Design

Credit: 3 Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

13. Enable the students with various concepts of minimization of logical expressions to be familiar with logical algebra.
14. Develop the ability to understand and design combinational circuits.
15. Ability to analyze and design sequential circuits.
16. Ability to analyze and design counters.
17. Understand the applications of digital electronics.

Course Outcomes

Student will be able to

16. Students will be able to reduce digital logic function with various minimization technique like k-map, Mc-clusky methods.
17. Students will be able to analyse and design of combinational logical circuit.
18. Students will be able to design the sequential circuits using SR, JK, D, T flip-flops.
19. Students will be able to design the various counters.
20. Students will understand the applications of digital electronics.

Sr. No.	Contents	Hours
1.	Principles of combination logics: Definition of combinational logic, canonical form, Generation of switching equations from truth table, Karnaugh map for 3,4,5 variables, incompletely specified functions (don't care), Simplifying Max term equation, Quine Mc clusky minimization 3,4 variables	6
2.	Analysis and design of combinational logic: Decoders, Encoders, Digital multiplexers, Demultiplexers, Design of logic circuits by multiplexers, Parallel and serial adders, BCD adders, Binary comparators, Binary multiplier, Programmable Logic Devices, Concept of Programmable logic devices like FPGA. Logic implementation using programmable devices.	8
3.	Flip-Flops and its Applications: Basic Bistable element, Flip-flops, R-S, D, J-K, T, Master Slave flip flops. Conversions of flip-flops, Mealy and Moore machines, construction of state diagrams.	8
4.	Counters: Synchronous & Asynchronous ripple and decade counters, Modulus counter, Skipping state counter, Counter design, Ring counter, Counter applications, Registers: Buffer register, Shift register	9
5.	Applications of digital Electronics: Design of sequence detector, guidelines for construction of state graph, design of iterative circuits, design of sequential circuits using ROMs and PLA, CPLD, FPGA, serial adder with accumulator, Design of binary multiplier	9

TEXT BOOK

1 D. P. Kothari and J. S Dhillon, —Digital Circuits and Design, Pearson, 2016,

2 Morris Mano, —Digital Design, Prentice Hall of India, Third Edition.

3 K. A. Navas, —Electronics Lab Manual, Volume I, PHI, 5

REFERENCE BOOKS

1 John M Yarbrough-Digital Logic Applications and Design, Thomson Learning, 2001.

2 Donald D. Givone, —Digital Principles and Design, McGraw Hill, 2002.

3 Charles H Roth Jr., Larry L. Kinney —Fundamentals of Logic Design, Cengage Learning, 7th Edition, 2014.

7MX6-60.2: Electronic Devices and Applications

Credit: 3 Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

10. Junction behavior of Diodes, Diode as a Circuit Elements and its different applications.
11. Enable the students with various concepts of action and working principal of BJTs in different configurations.
12. Develop the ability to understand the principle of JEFTs.
13. Ability to analyze photo electronic devices.
14. Ability to analyze and design electronic device applications.

Course Outcomes

Student will be able to

11. Students will be able to analyse diode characteristics and its applications.
12. Enable the students with various concepts of action and working principal of BJTs in different configurations
13. Students will learn characteristics of JFETs.
14. Students will able to analyze photo electronic devices.
15. Students will analyze and design electronic device applications.

SN	Contents	Hours
1	PN Junction: Formation of PN junction, Depletion region, Junction capacitance, Diode equation (no derivation) Effect of temperature on reverse saturation current, V - I characteristics and simple applications of i) Junction diode, ii) Zener diode, iii) Tunnel diode and iv) Varactor diode.	8
2	Bipolar Junction Transistor (BJT) : Transistor terminals , Transistor Action, current components in BJT, BJT static characteristics (Input and Output) , Early effect , CB , CC, CE configurations of transistor and bias conditions (cut off, active, and saturation regions), CE configuration as two port network, Load line analysis (AC and DC), Transistor Biasing – Fixed and self bias.	8
3	Field Effect Transistor (FET): Construction and working of JFET, output and transfer characteristics of FET, Determination of FET parameters. Application of FET as Voltage variable resistor. Advantages of FET over BJT. MOSFET, Construction and working of enhancement and depletion modes , output and transfer characteristics Application of MOSFET as a switch.	9
4	Photo electronic Devices: Construction and Characteristics of Light Dependent; Resistor (LDR), Photo voltaic Cell, Photo diode, Photo transistor and Light Emitting Diode(LED)	9
5	Power Supplies, Breakdown Diodes, and Voltage Regulators Unregulated Power Supply, Band-gap Voltage Reference, A Constant Current Diodes, Transistor Series Regulators, Improving Regulator Performance, Current Limiting, Integrated Circuit Voltage Regulator	6
	Total	42

TEXT BOOK

1. A.S.Sedra and K.C.Smith, “Microelectronic Circuits”, 6th Edition, Oxford University Press, 2006

2. David A.Bell, " Electronics Device and Circuits ", PHI; 3rd Edition, 1999.
3. Robert Boylestad and Louis Nashelsky, " Electronic Device and Circuit Theory", PHI; 9th Edition, 2007
4. Thomas L. Floyd, "Electronic Devices", 8th Edition, Pearson Education Inc., 2007

REFERENCE BOOKS

1. Mark N. Horenstein, "Microelectronic Circuits and Devices", PHI; 2nd Edition, 1997
2. Paul Horowitz and Winfield Fill, "The Art of Electornics", Cambridge Publication; 2 Edition
3. Jacob Millman and Christos C. Halkias,and Satyabrata Jit "Millman's Electronic Device and Circuits", Tata McGraw- Hill; 2nd Edition, 2007

7MX6-60.3: Basics of Sensors Technology

Credit: 3 Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To provide an understanding of the fundamental principles and characteristics of various sensors and their classifications.
2. To explore the physical principles behind sensing technologies, including electrical, magnetic, thermal, and optical properties.
3. To introduce the design and application of interface electronic circuits for sensors, emphasizing their integration in various applications.

Course Outcomes: Students will be able to

1. Students will be able to classify and analyze sensor characteristics and their relevance to different measurement systems.
2. Students will demonstrate knowledge of the physical principles underlying sensor technologies and apply them in practical scenarios.
3. Students will design and implement interface circuits for various sensors, understanding their application in real-world systems.

Sr. No.	Contents	Hours
1.	Sensors Fundamentals and Characteristics Sensors, Signals and Systems; Sensor Classification; Units of Measurements; Sensor Characteristics	6
2.	Physical Principles of Sensing Electric Charges, Fields, and Potentials; Capacitance; Magnetism; Induction; Resistance; Piezoelectric Effect; Hall Effect; Temperature and Thermal Properties of Material; Heat Transfer; Light; Dynamic Models of Sensor Elements	8
3.	Interface Electronic Circuits Input Characteristics of Interface Circuits, Amplifiers, Excitation Circuits, Analog to Digital Converters, Direct Digitization and Processing, Bridge Circuits, Data Transmission, Batteries for Low Power Sensors	8
4.	Sensors in Different Application Area Occupancy and Motion Detectors; Position, Displacement, and Level; Velocity and Acceleration; Force, Strain, and Tactile Sensors; Pressure Sensors, Temperature Sensors	6
5.	Sensor Materials and Technologies Materials, Surface Processing, Nano-Technology	6

TEXT BOOK

1 J. Fraden, Handbook of Modern Sensors:Physical, Designs, and Applications, 5th Ed./2016 AIP Press, Springer

REFERENCE BOOKS

1 D. Patranabis, Sensors and Transducers, PHI Publication, 2nd Ed./2013, New Delhi

2 Mechatronics- Ganesh S. Hegde, Published by University Science Press (An imprint of Laxmi Publication Private Limited).

7MI6–60.1: Tunnel Engineering

Credit: 3 **Max. Marks: 100(IA: 30, ETE: 70)**
3L+0T+0P **End Term Exam: 3Hours**

Course Objectives

1. Understanding of tunnel drivage methods, ground support, transport and ventilation
2. Evaluate tunnel excavation method from technical and production aspects
3. Analyze cost and time for ordinary tunnels based on risks and construction management principles
4. Carry out a tunnel ventilation

Course Outcomes

1. Design tunnels, rock support and grouting and evaluate the most important issues in the procedure
2. Evaluate tunnel excavation method from technical and production aspects
3. Analyze cost and time for ordinary tunnels based on risks and construction management principles.

SN	Contents	Hours
1	Tunneling: Introduction about tunnels, functions, advantages and disadvantages of tunnels compared to open cuts, Criteria for selection of size and shape of tunnels, consideration in tunneling, geological investigation, tunnel alignment, tunnel shafts, pilot tunnels. Advantages of twin tunnels and pilot tunnels, portals and adits.	8
2	Conventional method of Tunneling: Drilling, Blasting, Loading and Transport of Muck, Supports, Ventilation, Drainage, and Equipments. Drivage work in varying ground conditions using conventional methods	8
3	Fast tunneling: Dill jumbos, trackless mucking and transportation units. Tunnel boring machine	8
4	Tunneling In soft ground: General characteristics of soft ground, shield methods, needle beam method and NATM method of tunneling in practice.	8
5	Tunneling (rock bolting and guniting), Safety measures, Ventilation in tunneling, Lighting, Drainage.	8
	Total	**40**

TEXTBOOKS

1. Driving Horizontal Workings and Tunnel, by Pokorovski, Mir Publishers, 1980.
2. Harbour, Dock and Tunneling Engineering by R. Srinivasan Published by R. C. Pattii, Chal'otar Book Stall, Station Road TulsiSada, Arland (W. Rly), India.

REFERENCE BOOKS:

1. Rock Mechanics and Design in Mining and Tunneling, by Bieniawski, Z.T., Rotterdam A.A. Balkema, 1984.
2. Drilling and Blasting of Rocks, by Carlos L Jimeno, A.A. Balkema/Rotterdam/Brookfield 1995.
3. Hoek, E., Brown, E. Underground excavations in Rock, CRC Press, 1980.
4. Hoek, E. and Brady, J. D. Rock Slope Engineering, Taylor and Francis, 1981
5. Nick Barton,Tunnel Boring Machines, 2000

7MI6–60.2: Rock Engineering

Credit: 3Max. **Marks: 100(IA: 30,ETE: 70)**
3L+0T+0P **End Term Exam: 3Hours**

Course Outcomes

At the end of the course, the student will be able to: Study various aspects of ground control problems in underground and opencast mines with a better understanding of subsidence, slope, rock burst and caving in the mine. Also provide understanding of deformation and its measurement.

.

SN	Contents	Hours
1	Slope design: Basics mechanics of rock and spoil slope failures; Parameters for stability analysis; Design of slopes; Reinforcement of rock slopes and monitoring of slopes	8
2	Design of mine excavations like drifts, shafts and stopes; Pillar design; Theories of roof failures of small and large excavations; Cavability of ore and stratified deposit. Mining subsidence, bumps and rock burst, destressing to control rock bursts	8
3	Drillability of rocks; Mechanics of rotary and percussive drilling; Design of drills; Drill bits for optimum penetration; Parameters affecting rate of penetration; Effect of flushing medium on drill performance.	8
4	Rock reinforcement; Estimation of support requirements of underground excavation	8
5	Mechanics of rock breakage in blasting; Influence of rock properties; environmental impacts due to blasting-Vibration fly rocks, Air over pressure, dust; Controlled blasting.	8
	Total	**40**

TEXT BOOKS

1. Dr.Sushil Bhandari, Engineering Rock Blasting Operations. Pub: A.A.Balkema Publisher Old post Road, Brook field, VTO5036, USA.

2. Obert & Duall, Rock Mechanics and design of structures in rock. Pub: John Willey & Sons.

3. Railey & Dalley, Experimental stress analysis. Pub: McGraw Hill Book Company

7MI6–60.3: Remote Sensing and GIS

Credit: 3 **Max. Marks: 100(IA: 30, ETE: 70)**
3L+0T+0P **End Term Exam: 3Hours**

Course Objectives

1. How to manage and use GIS and Remote Sensing to work in real time
2. Understand the basic concept of Remote Sensing and know about different types of satellite and sensors.
3. Understand different components of GIS and Learning about map projection and coordinate system.
4. Develop knowledge on conversion of data from analogue to digital and working with GIS software.

Course Outcomes

1. Understand the principles of aerial and satellite remote sensing, Understand the basic concept of GIS and its applications, know different types of data representation in GIS
2. Understand and Develop models for GIS spatial Analysis.
3. Apply knowledge of GIS software and able to work with GIS software in various application fields
4. Apply knowledge of GIS and understand the integration of Remote Sensing and GIS

SN	Contents	Hours
1	Remote Sensing: Introduction to Remote Sensing, Terminology in Remote Sensing, Types of Remote sensing, advantage and disadvantage of remote sensing data, Electromagnetic radiation atmospheric. Windows remote sensing platforms and sensors systems, path-row referencing system, remote sensing data product, procedure for obtaining satellite data. Hardware and software related to remote sensing.	6
2	Different types of platforms, sensors and their characteristics, Orbital parameters of a satellite, Multi concept in remote sensing. Image Interpretation and analysis:Elements of visual image interpretation, Digital image pre-processing, radiometric correction, geometric correction, resolution of remote sensing data, image enhancement, contract enhancement, spatial filtering band rationing image classification supervised and unsupervised classification, remote sensing applications in forestry, geology, hydrogeology, Land use and land cover mapping.	6
3	Principles of interpretation of aerial and satellite images, equipments and aids required for interpretation, ground truth – collection and verification, advantage of multidate and multiband images. Digital image Processing concept.	6
4	Geographic Information System (GIS): Fundamental of GIS: Basis concept including definition and history of GIS, Essential Elements of GIS, Uses and users of GIS, General GIS Applications, Geodesy, Grids, Datum's and projection systems, GIS Data structure, Data Formats, GIS layers and Digitization overview of GPS and its application, Hardware and software related to GIS.	8
5	Raster and vector Based GIS: Raster based GIS, Definition of Raster Based GIS, Spatial Referencing Definition and Representation of Raster Data. Vector based GIS, Definition and concept of vector based GIS, Data structure, Data Capture and Basic operations of spatial analysis, advantages and disadvantage in raster and vector based GIS, Introduction to network in GIS, GIS Project Planning Management and Implementation.	8

6	Application of GIS in Map revision, Land use, Agriculture, Forestry, Archaeology, Municipal, Geology, water resources, soil Erosion, Land suitability analysis, change detection, Use of GIS in Mining.	**6**
	Total	**40**

TEXT & REFERENCE BOOKS

1. Remote Sensing and GIS: B.Bhatta
2. Remote Sensing and Image Interpretation : T.M. Lillensand and R.W. Keifer
3. Principles of Remote Sensing : P.J. Curren
4. Principles of Geographical Information systems for land Resources Assessment : P.A. Baurrough
5. Manual of Remote Sensing, Vol.2 : American Society of Photogrammetry and Remote Sensing
6. Geographical Information systems Management Perspective : Stan Aromof

7MI6–60.4: Maintenance Management

Credit: 3Max.
3L+0T+0P

Marks: 100(IA: 30, ETE: 70)
End Term Exam: 3Hours

Course Outcome:
At the end of the course, the student will be able to: Acquire the proper knowledge for maintenance of various mining machinery by through failure analysis, classification of maintenance systems, cost management of maintenance and decision models for maintenance planning.

SN	Contents	Hours
1	*Introduction:* General objectives, Functions; Organization and administration of maintenance systems; Requirements, Concepts and structure of suitable organizations for maintenance systems. *Failure Analysis:* Analysis for source identification, classification land selectivity of failure; Statistical and reliability concepts and models for failure analysis.	9
2	Classification of maintenance systems; Basis and models for various maintenance systems. Cost management for maintenance: cost estimates- recording, summarizing and distributing cost data, maintenance budget.	9
3	Decision models for maintenance planning; Operation and control, optimum level of maintenance; replacement aspects of breakdown and preventive types, group and individual types, obsolete facility, deteriorating and completely failing facilities, replacement vs. reconditioning, economics of overhaul, addition replacement model- additive damage case, zero memory case, partially observed situation, planning horizon procedure. Spare planning and control: static spares, insurance spares with and without salvage value, low moving spares; manpower planning-crew size, allocation etc. stand by machines; economical and operational aspects; scheduling planning of activities, monitoring and updating, resource allocation, Assigning priorities.	12
4	*Other relevant topics:* work measurement for maintenance, maintenance control indices, maintenance service contract, preventive maintenance management-guidelines, procedure, general management of lubrication system, organizing preventive maintenance program using vibration signature analysis-some basic ideas, management of records for maintenance, computerization of maintenance activities, major plant shut-down procedures.	10
	Total	**40**

Text Books/References

1. L.T. Higging, L.C. Morrow. Maintenance Engineering Handbook, McGraw Hill (1977).
2. B.T. Newbrought. Effective maintenance management, McGraw Hill (1967).

7MI6–60.5: QUALITY AND RELIABILITY ENGINEERING

Credit: 3Max. **Marks: 100(IA: 30, ETE: 70)**
3L+0T+0P **End Term Exam: 3Hours**

Course Outcome:

The course aims to impart basic knowledge about various aspects of Quality and Quality Management. It also helps students to understand the design of experiments. This subject also gives knowledge about reliability and product life cycle.

SN	Contents	Hours
1	Introduction: Need for maintenance, Facts and Figures, Modern maintenance, Problem and maintenance, Strategy for the 21" century, Engineering Maintenance objectives and maintenance in equipment life cycle, terms and definitions.	6
2	Maintenance Management and control: Maintenance manual, maintenance, facility evaluation, functions of effective maintenance management, maintenance project control methods, Maintenance management control indices.	6
3	Types of Maintenance: Preventive maintenance, elements of preventive, maintenance program, establishing, preventive maintenance program PM Program, evaluation and improvement, PM measures, PM models, corrective maintenance, corrective maintenance types, corrective maintenance steps and downtime components, corrective maintenance measures, corrective maintenance models.	7
4	Basic concepts of Reliability: Introduction, reliability and quality, failure and failure modes, causes of failure and reliability, maintainability and availability, history of reliability, reliability literature. Reliability mathematics: Introduction, random experiment, probability, random variables, distribution functions, discrete distribution, continuous distribution, numerical characteristics of random variables. laplace transform.	7
5	Component reliability & Hazard models: Introduction, component reliability from test data, mean time to failure, time dependent hazard models. stress dependent hazard models, derivation of reliability, function using markov, treatment of field data. System reliability models: Introduction, system with component within series - System with parallel component - K - out - of - M systems - Non series parallel systems - system with - mixed - mode failure - fault - tree technique.	8
6	Reliability management: Reliability programming-management policies and decisions - reliability management by objectives - reliability group-reliability data, acquisition analysis - management people for reliability.	6
	Total	**40**

TEXTBOOKS:

Reliability, maintenance and safety engineering by Dr.A.K.Gupta / Laxmi publications

Industrial safety management by L.M.Deshmukh / TMH Reliability engineering - Balaguruswamy / TMH **REFERENCES:**

1. Maintenance engineering and management by RC.Mishra / PHI

2. Reliability engineering. by Elsayed / Pearson

3. Engineering maintenance a modern approach, B.S Dhallon,2002, C.RR Publishers

7SA6-60.1 WASTE TO ENERGY

Credit: 3	**Max Marks: 100 (IA: 30, ETE: 70)**
3L+0T+0P	**End Term Exam: 3 Hours**

COURSE OBJECTIVES:

To provide a comprehensive understanding of waste to energy

COURSE OUTCOMES:

Upon successful completion of the course, the students will be able to:
CO-1: Students will be able to understand the different types of waste.

CO-2: Students will be able to understand the waste to energy conversion technologies.

S.No	Contents	Hours
1.	**Introduction of Bio-Waste:** Introduction to bio-resources and agricultural waste, Classification and characterization of agricultural waste including animal wastes, Principles of agricultural waste management: RRR approach, Potential of recyclable crop residues and its management, In-situ management of agricultural waste, Role of soil and plants in waste management, Impact of waste on soil and plant quality, Impact on the environment	**9**
2.	**Pre-treatment of Bio-waste:** Need of bio waste pre-treatment, Pre-treatment methods: physical, chemical and biological treatment, Biological processes of waste management, Composting and vermicomposting for bio conservation of biodegradable waste, Manure management during pre-spreading &spreading phase, Methods of preparation of different organic liquid manures from bio-resources	**8**
3.	**Bio-conversion technology**: organic manure, composting, vermicomposting, biogas generation, pyrolysis, operation and management of biogas plants, utilization of biogas and spent slurry, briquetting of biomass as fuel, landfill.	**8**
4.	**Thermo-conversion technology**: combustion, incineration, Bio-charcoal production, gasification, Production of natural source of dietary fiber; antioxidants; pectin; enzymes; organic acids such as acetic acid, ferulic acid, lactic acid and citric acid, Environmental benefit of waste management, Standards to bio- wastes and manures.	**8**
5.	**Smart Technologies of waste to energy:** Role of IoT and AI in waste-to-energy processes, Real-time monitoring of waste conversion systems and Predictive maintenance for waste-to-energy systems	**7**
	Total	**40**

TEXT / REFERENCE BOOKS

1. Rogoff Marc J. Waste to Energy. William Andrew Publishing

2. Waste to Energy, Shalini Yadav
3. Biomass, Bio fuel, Biochemicals waste biorefinery by Thallada Bhaskar, Sunita Varjani and Ashok pandey, Elsevier
4. Rai GD (2013). Non-Conventional Energy Sources, Khanna Publishers, Delhi.
5. Kothari DP, Singal KC and Ranjan R (2008) Renewable Energy Sources and Emerging Technologies, PHI Learning Pvt. Ltd., New Delhi.
6. Solanki CS (2008). Renewal Energy Technologies:A Practical Guide for Beginners" PHI Learning.
7. Seveda MS, Narale P and Kharpude SN. Bioenergy Engineering, CRC Press, Taylor & Francis

7CR6–60.1: Introduction to Metallurgical Processes

Credit: 3 **Max.Marks:100(IA:30, ETE: 70)**
3L+0T+0P **EndTermExam:3 Hours**

Course Objectives

1. To have a basic knowledge about the basics of metallurgy, the various operations in the metallurgical

Course Outcomes

1. To know about the basics about metals, ores and its extraction.
2. To know about the various metallurgical processes that take place during the high temperature operation.
3. To know about to measure and estimate the physical properties of metals.
4. Immense knowledge about the Iron and Iron-Carbon (Fe-Fe3C) Phase Diagrams
5. To know about the basic knowledge about powder metallurgy

SN	Contents	Hours
1	Introduction – classification – metals, metallic ores, sampling, identification, extraction – copper, aluminum, lead, iron & steel – iron carbon diagram – heat treatment process – annealing,normalizing, hardening, tempering, surface hardening process – carburizing, nitriding, cyaniding, carbonitriding,flamehardening,metallography–sampling,grinding,polishing,microscope–metallurgical, electron,testing–hardness,impact,creep,nondestructivetesting.	8
2	**Iron and Iron-Carbon (Fe-Fe3C) Phase Diagrams:** Iron-Carbon phase diagram, eutectoid/hypoeutectoid/hypereutectoid transformations in carbon-steels, nucleation & growth of pearlite, understanding ferrite, cementite, austenite formation in carbon-steel, TTT diagram, determination of TTT diagram fr eutectoid steel, transformation of austenite to pearlite or bainite or martensite, role of solute, effect of cooling rate, diffusionless transformation, factors affecting TTT diagrams,end-quenchmethod,ominytest,theeffectofcoolingrate,criticalcoolingrate(CCR), factorsaffectingCCR.	9
3	**Heat Treatment of Steel:** Theory and purpose of heat treatment, stages of heat treatment, Annealing, full annealing, process annealing, causes of residual stress, stress relief, partial annealing, spheroidization annealing, advantages, recovery, re-crystallization, grain growth, re-crystallization annealing, differencebetweenannealingandnormalizing, objectivesofhardening,Jominyend-quench test, tempering, martempering and austempering, quenching, surface hardening, case hardening, nitriding.	8
4	**Powder Metallurgy**: Introduction – production process of powders – mechanical routes, atomization routes, physicalroutes, chemicalroutes, plasmaformingprocess-powderconsolidation,compaction andsintering–advantages–disadvantages–limitations-applications.	8
5	**Physical Properties:** Single crystals, polycrystalline materials and factors affecting their mechanical properties. Yieldstrength, tensilestrengthandrupturestrength. Ductilityandmalleability,toughness andhardnessof materials.	7
	Total	40

Text and Reference Books:

1. Principles of Extractive Metallurgy: J. Newton1959(J. Wiley)
2. SeshadriSeetharaman, FundamentalsofMetallurgy,1stEdn, WoodheadPublishingLimited, 2005.
3. MaterialsScienceandEngineering: V. Raghavan2008(PHI)
4. ElementsofMaterialsScience: VanVlack1998(Addison Wesley)
5. EngineeringMaterialsScience: Richards1961(WadsworthPub.Co.)
6. StructureandPropertiesofMaterials: WulffSeries1966(JohnWiley(NewYork))
7. MaterialScience: Callister2008(JohnWiley)
8. PrinciplesofMaterialScienceandEngineering: Smith1990(McGrawHill)

7CR6–60.2: Refractory for Steel Making

Credit: 3 **Max.Marks:100(IA:30, ETE: 70)**
3L+0T+0P **EndTermExam:3 Hours**

Course Objectives

1. To have information on different steel making route and different unit associated for making steel
2. To know the importance of refractories for making clean steel and its specific consumption and cost
3. Toknowthescopeofdifferentrefractoriesfordifferentunitsofsteelplantandits failure

Course Outcomes

1. Differentiatedifferentsteelmakingrouteanddifferentunitassociatedformakingsteel.
2. Identifytheimportanceofrefractoriesformakingcleansteelanditsspecificconsumptionandcost
3. Findoutthesuitabilityofrefractoriesforbasicironandsteelmakingpractice.
4. Select suitable refractory for coke oven, sinter plant, blast furnace, Corex process and ladle used in iron making processes and Identify refractories suitable for BOF/LD, EAF etc. and mill zone CO
5. Select the refractories use dincontinuous casting process

SN	Contents	Hours
1	**Introduction:** Overview of different routes of steel making in integrated and special steel plants, Importance of refractory materials in iron & steel making process from the point of view of clean steel making, Undesirable and impact of refractory inclusions in finished steel product	5
2	**Refractory in Iron making -I** **Coke Oven**: Role of coke in iron making process, Importance of silica, fireclay refractory in wall and doorsofcokeovenbattery,Desirablepropertiesofcokeovenrefractoryforhighcampaignlife,concept of average battery life in Indian and global scenario. **Sinter Plant**: Role of sinter in iron making process, Application of refractory in ignition hood of sinter plant.	10
3	**Refractory in Ironmaking-II** **Calcination Plant**:Role of calcined limestone and dolomite in steelmaking process, Types of refractory in lime and dolomite 15 kilns. **Blast Furnace**: Application of refractory in different zones of blast furnace stove and cast house area. Role of carbon block in the hearth of blast furnace, Concept of grouting for periodic repair of tap hole. **Torpedo Ladle/Transfer Ladle**: Usage of torpedo ladle in steel plant, lining pattern of torpedo ladle, Concept of average life of torpedo ladle in Indian and global scenario.	12
4	**Refractory in steelmaking-II** **Basic Oxygen Furnace/LD Converter:** BOF steel making process and slag formation. Necessity of using basic refractory in converter; Concept of requirement of different types of refractory in impact zone, metal zone, slag zone and taphole area; Concept of heat size; Role of gunning in increasing the service life of converter. Slag coating/ slag splashing practice to improve converter life. **ElectricArcFurnace:**Lining pattern and type of refractory used in EAF steel making.	8
5	**Refractory in steelmaking-II** **Steel Ladle:** Lining pattern of steel ladle refractory, Concept of Ladle Metallurgy, Role of operational parameters in service life, Purging refractory and slide gate mechanism, Role of gunning and patching mass for hot repair. **Argon Rinsing Station and RH Degasser:** Types of refractory used in these processes. **Continuous Casting:** Importance of tundish refractory (spray mass, back up castable, impact pad, turbo stop, cover flux , insulating materials, dams and weirs) in continuous casting, Concept of open and closed casting, Concept of sequence casting, Analysis of black refractory (ladle shroud, mono block stopper, sub entry nozzle, sub immersion ladle) in billet, slab and bloom caster; An overview of manufacturing process of blackrefractory.BurnerCover:Applicationofceramicfibreblanketsandmodulesintheburnercover Of ladle pre-heater and tundish pre-heater.	5
	Total	40

7CR6–60.3 : Plant, Equipment and Furnace Design

Credit: 3 **Max.Marks:100(IA:30, ETE: 70)**
3L+0T+0P **EndTermExam:3 Hours**

Course Objectives

1. To have a sound knowledge on designing the layout of the plant and designing of the furnaces

Course Outcomes

1. To know the factors for selection of a plant layout.
2. To studied the ways of assembling the various sections in the plant for proper functioning.
3. Tostudiedandunderstandtheprinciplesofdesigningequipmentsandtheprincipleanddesigningoffurnaces.
4. To studied and know the construction of furnaces

SN	Contents	Hours
1	**Plant Design:** Plant location, plant layout, assembling of economic and engineering data, calculations pertaining to the processes, process vessels, etc. Piping and instrument flow diagrams, process flow diagrams, design of a ceramic plant, feasibility report and cost estimation of the plant. Economics of the plant, commercial aspects etc.	**8**
2	**Equipment Design:** Principles of design of the following process equipments: Crushers, materials handling systems, filter press, sieves and pug-mills, mouldin equipments. Principles of design of glass moulds such as blank mould, blow mould and neckring moulds. Drying and different types of driers used in Ceramic industries.	**7**
3	Principles of design of simple supports, i.e. footings and foundations for process equipments such as overhead tanks, motors, compressors and crushers. Different types of size-radiation equipment used in ceramic industry i.e. crushers and grinders including their design calculations	**8**
4	Chimney foundations. Essential operations of a furnace i.e. firing, charing, melting, reversal. Preheating of air, gas and fuel oil, flame systems, temperature and its control. Thermal current in a glass melting furnace. Furnace atmosphere	**8**
5	Furnacelifeandselectionofrefractories.Heatingupandcoolingdownofafurnace, furnaceconstruction,furnacecapacity,fuelefficiencyandfiringefficiency,design, Construction and thermal calculation pertaining to glass melting furnaces.	**9**
	Total	**40**