B.Tech-Minors-AR 19

Minor Courses- Syllabus

GMR Institute of Technology
Rajam 532 127, Andhra Pradesh
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MINOR COURSES

S.No.	Course Code	Course Name	Offering Dept.	Page No.s
Energy Science & Technology				
1	19CHM11	Foundation of Energy Science and Technology	**CHEM**	**1-11**
2	19CHM12	Energy Generation from Waste		
3	19CHM13	Energy Storage Systems		
4	19CHM14	Hydrogen Energy and Fuel Cells		
Nano Science & Technology				
5	19CHM21	Introduction and Characterization of Nano Materials	**CHEM**	**12-20**
6	19CHM22	Carbon Nanostructures and Applications		
7	19CHM23	Energy, Environment & Biomedical Nanotechnology		
8	19CHM24	Industrial Applications of Nano Technology		
Environment Engineering				
9	19CEM11	Watershed Management	**CIVIL**	**21-29**
10	19CEM12	Industrial Pollution Control and Engineering		
11	19CEM13	Solid and Hazardous Waste Management		
12	19CEM14	Ecology and Environmental Assessment		
Artificial Intelligence & Machine Learning				
13	19CSM11	Fundamentals of AI & Machine Learning	**CSE**	**30-36**
14	19CSM12	Feature Engineering for Machine Learning		
15	19CSM13	Exploratory Data Analytics		
16	19CSM14	Deep Learning		
Cyber Security				
17	19CSM21	Fundamentals of Security	**CSE**	**37-42**
18	19CSM22	Management of Information Security		
19	19CSM23	Cyber Security		
20	19CSM24	Cloud Security		
Data Science & Analytics				
21	19CSM31	Data Cleaning	**CSE**	**43-47**
22	19CSM32	Data Engineering		
23	19CSM33	Text Analytics		
24	19CSM34	Social Network and Semantic Analysis		
Computer Systems Programming				
25	19CSM41	Programming Fundamentals	**CSE**	**48-54**
26	19CSM42	Data Structures & Algorithms		
27	19CSM43	Fundamentals of Databases		
28	19CSM44	Fundamentals of Computer Networks & Operating Systems		
Digital IC Design				
29	19ECM11	Fundamentals of VLSI Design	**ECE**	**55-65**
30	19ECM12	Digital Design using HDL		
31	19ECM13	FPGA Technology		
32	19ECM14	Analog and Mixed Signal Design		
Industrial Automation				
33	19ECM21	Microcontrollers and Interfacing	**ECE**	**66-73**
34	19ECM22	Sensors and Data Acquisition System		
35	19ECM23	Fundamentals of Labview		
36	19ECM24	Medical Robotics		
Communications and Networking				
37	19ECM31	Principles of Communications	**ECE**	**74-83**
38	19ECM32	Coding Theory and Practice		
39	19ECM33	Ad-hoc and Wireless Sensor Networks		

40	19ECM34	Fundamentals of Multimedia Networking		
Avionics				
41	19ECM41	Principles of Aerodynamics	**ECE**	**84-92**
42	19ECM42	Aircraft Electrical Systems		
43	19ECM43	Aircraft Instrument Systems		
44	19ECM44	Aircraft Communication and Navigational Systems		
Geographic Information System				
45	19ECM51	Sensors and Sensing Technology	**ECE**	**93-101**
46	19ECM52	Geographic Information Systems		
47	19ECM53	Digital Image Processing		
48	19ECM54	Lidar Systems		
Electric Vehicles Technology				
49	19EEM11	Introduction to Electric Vehicles Technologies	**EEE**	**102-110**
50	19EEM12	Electrical Drives and Controllers for Electric Vehicles		
51	19EEM13	Charging Technology in Electric Vehicles		
52	19EEM14	Computer Vision in Electric Vehicles		
Smart City Management				
53	19EEM21	Fundamentals of Smart City	**EEE**	**111-119**
54	19EEM22	Smart City Infrastructure		
55	19EEM23	Computational Methods for Smart City Management		
56	19EEM24	Communication Technologies and Mobility for Smart City		
Industrial Applications and Control				
57	19EEM31	Modelling and Simulations of Industrial Applications	**EEE**	**120-128**
58	19EEM32	Industrial Sensors and Actuators		
59	19EEM33	Programmable Logic Controllers		
60	19EEM34	Control Design for Industrial Applications		
		Cloud Application Development		
61	19ITM11	Introduction to Cloud Computing	**IT**	**129-138**
62	19ITM12	Introduction to Web Development with HTML, CSS, JavaScript		
63	19ITM13	Developing Cloud Native Applications		
64	19ITM14	Developing Cloud Apps with Node.js and React		
Robotics and Automation				
65	19MEM11	Introduction to Robotics	**MECH**	**139-145**
66	19MEM12	Drives and Sensors		
67	19MEM13	Control Systems for Robotics		
68	19MEM14	Machine Learning for Robotics		
Industrial Systems Engineering				
69	19MEM21	Industrial Management	**MECH**	**146-155**
70	19MEM22	Fundamentals of Operations Research		
71	19MEM23	Enterprise Resource Planning		
72	19MEM24	Production Planning and Control		

DEPARTMENT OF CHEMICAL ENGINEERING

AR19 MINOR COURSES

Minors for other Departments offered by Chemical Engineering

Minor Track 1: ENERGY SCIENCE & TECHNOLOGY

Preamble

Energy transformation and energy frameworks have molded and will keep on forming the advancement of humankind. In various ways, they are totally essential for the human life. The minor program in Energy Science and Technology gives an elite instructive climate to prepare understudies accountable for creating future advances in the field of energy designing.
The Minor program "Energy Science and Technology" manages present day innovations for energy change and capacity and with the logical standards fundamental these advances.
There is an earnest need to create and market innovations for the practical change and utilization of energy. This minor gets ready understudies for professions that require preparing in energy science and innovation, proficiency, and strategy. Clean advances and green advances including energy are probably the quickest developing business sectors for new ventures. The minor obliges people of different foundations with instructive interests in regions that might incorporate designing, science, strategy, financial matters, arranging, and the board.

Prospectus

People in the future will depend on energy sources made accessible by enormous sustainable power assets. The innate idea of these assets is presenting exceptional specialized and the board difficulties to engineers. With a normal development of 150% of the energy designing position market by 2030 and solid interest for people with assorted ranges of abilities, the program handles these difficulties via preparing fantastic understudies to become top experts in this field with the target of driving industry, science, and market advancements.
This program aims to give students a scientific understanding of energy and energy conversions. Students will develop the self-confidence to use and manipulate the governing equations of energy. In this context the broader issues will be discussed. The program will give a detailed explanation of the energy conversion system, energy storage systems and energy generation from waste, their importance and future contribution to anthropogenic energy uses.

Placement Opportunities:

There are many organisations that employ energy engineers, including:

- International oil companies like Saudi Arabian Oil Company (Saudi Aramco),Exxon Mobil Corporation, Reliance Industries, Chevron Corporation, Nextera Energy
- Indian Oil Companies like HPCL, ONGC, IOCL, BPCL, MRPL GPCL
- Thermal power plants like NHPC Ltd, NTPC Ltd, GMR Energy
- EMV companies like Tesla, TATA motors, Volks Wagon, Chevrolet, BMW, Hero
- Battery and mobile manufactures
- Nuclear Power Corporation of India Ltd.
- Power Grid Corporation of India Ltd.
- Manufacturing companies
- Government departments.
- R&D in the area of alternative sources, such as wind, solar, tidal and geothermal power.

Track 1: Energy Science and Technology							
No	**Course Code**	**Course**	**POs**	**Contact Hours**			
				L	**T**	**P**	**C**
01	19CHM11	Foundation of Energy Science and Technology	1,2,3,5,7,12	4	-	-	4
02	19CHM12	Energy Generation from Waste	1,2,3,4,5	4	-	-	4
03	19CHM13	Energy Storage Systems	1,2,3,6,7	4	-	-	4
04	19CHM14	Hydrogen Energy and Fuel Cells	1,2,3,7	4	-	-	4

19CHM11 Foundation of Energy Science and Technology

4 0 0 4

Course Outcomes:

1. Develop the concepts of basic energy systems and its conversion processes
2. Acquire knowledge on different types of energy sources, its types and utilization
3. Formulate techniques for the process of production and treatment of solid, liquid and gaseous fuel.
4. Explore the various types of non-conventional energy systems and its utilization
5. Demonstrate the basic mechanism of generation, collection and storage of ono-conventional energy systems
6. Understand the environment and energy correlation and its impact on climate change

COs-POs Mapping

COs	PO_1	PO_2	PO_3	PO_5	PO_7	PO_{12}
1	2	2	2			
2	2	2	1			
3	2		3	3		2
4	2		2	2		
5	2		3	3		
6	2		1		3	2

Unit I

Basics of energy

Different forms of energy, energy conversion process, indirect and direct energy conversion; Different energy sources; Units and scales of energy use, Mechanical energy and transport, Heat energy, Electromagnetic energy: Storage, conversion, transmission and radiation

Laws of heat transfer, Entropy and temperature

15 Hours

Unit II

Conventional energy source

Solid Fuels: Biomass, Wood and Charcoal. Classification & Rank of Coal, Peat, Lignite, Sub-Bituminous coal, Bituminous coal, Anthracite coal, Cannel &Bog head coal. Physical Properties of coal, Proximate & Ultimate Analysis of Coal, Cleaning, washing & Storage of coal. Carbonization: Low Temperature carbonization (LTC), High Temperature Carbonization (HTC),

Liquid Fuels: Constitution of petroleum, theory of formation of crude petroleum oil. Characterization of crude oil & petroleum fuels. Thermal & catalytic cracking and reforming processes, coking, visbreaking, Parameters and testing logistics of petroleum products

Gaseous Fuels: Classification of gaseous fuel, Calorific Value, Wobbes index, and flame speed. Flow sheet & operation of Producer gas, Water gas, Carburetted water gas, oil gas, coke-oven gas, blast furnace gas, Natural Gas and LPG.

Liquid fuel from coal, Coal Bed Methane

15 Hours

Unit 3

Non- conventional energy source

Non-conventional (alternative energy) resources, Production &consumption pattern in India.

Solar Energy: Devices for measurement of solar flux. Different types of Solar collectors (Flat plate, parabolic, concentric & heliostat), solar Pond, Photovoltaic cells, Chemical storage, Geothermal Energy & Wind Energy: Utilization of Geo thermal Energy; Operating principles of different types of Wind Energy Mills, Nuclear energy: Sources of Nuclear fuels, Nuclear reactions and power generation by Nuclear reactors, Breeder reactor- reaction &operation.

Energy from Ocean, Exploration of geothermal energy

15 Hours

Unit-4

Systems and Synthesis

Energy and environment correlations, Environmental degradation due to energy production and utilization, global warming; Environmental Impact Assessment, Life cycle analysis (LCA) and sustainability issues, Overview of World Energy Scenario, Climate change, Concept of Green Building and Green Architecture; Energy Audit of facilities and optimization of energy consumption.

Circular economy, SWOT analysis

15 Hours

Total: 60 Hours

Text Book(s)

1. S. Sarkar, Fuels & Combustion: Universities Press; 3rd Ed., 2009
2. O.P .Gupta, Elements of Fuels. Furnace and Refractories, Khanna Publishers, 1989
3. A. E. Dessler, Introduction to Modern Climate Change, Cambridge University Press, 2019

Reference Book(s)

1. G. D. Rai, Non-Conventional Energy Sources, Khanna Publishers, 1998
2. D.S. Chauhan and S.K. Srivastava, Non-Conventional Energy Resources, New Age International Pvt. Ltd., 2012
3. D. Mukherjee and S. Chakrabarti, Fundamentals of Renewable Energy Systems, New Age International, 2004
4. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000
5. Boyle, Renewable Energy: Power for a Sustainable Future, 3rd Ed, Oxford University Press. 2012
6. Stephen Peake, Renewable Energy: Power for a Sustainable Future,, 4th Edition, Oxford University Press, 2017

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open book Examination (%)
Remember	20	20	--
Understand	30	20	--
Apply	25	30	40
Analyze	25	20	40
Evaluate	--	10	20
Create	--	--	--
Total (%)	100	100	100

Sample Question (s)
Remember

1. What are the different types of ovens available for high temperature carbonization of coal to obtain coke? Also explain with a neat flow sheet how the waste heat can be utilized which is formed during the process in the ovens.
2. What do you mean by weathering of coal? What are the various precautions to be taken during coal storage?
3. What are the important operating parameters in thermal cracking of petroleum feedstocks?
4. Mention the characteristics of a good fuel.
5. What is gross calorific value? How does it differ from net calorific value?
6. What is Wobbe's Index?

Understand

1. What are the criteria for judging the suitability of a thermochemical reaction for solar application?
2. Explain the functions of the following elements in a nuclear reactor.
   (i) Fuel (ii) Control rods (iii) Moderator (iv) Radiation Shield (v) Coolant
3. Enumerate the significance of flash point and pour point in transport and handling of petroleum products.
4. Write down the various steps required for the recovery of by-product during high temperature carbonization of coal.
5. What is the function of two glass cover in a solar flat plate collector?
6. Write down the benefits and drawbacks of geothermal energy source on the basis of:
   (i) Installation cost (ii) Direct usability (iii) Environmental considerations (iv) Job creation and economic status (v) Suitability of site

Apply

1. Enumerate with the help of a flow diagram of a crude oil refining process mentioning production in order of boiling range
2. Enumerate the process of catalytic reforming operation mentioning the reactions involved, influence of different parameters on each reaction, catalyst used, and operating conditions maintained using a neat flow diagram.

3. Find the stored energy per unit volume and mass of the pebble bed to store heat for a air tight solar heating system when the temperature is to be raised by 20°C. The bed is required to store 25KWH. The density of the pebble (ρ) =3000 kg/m^3 and the specific heat capacity (C_P) = 800 J/kg°C.
4. The coal obtained from Raniganj coal field gave the following proximate analysis:- Moisture – 1.6%; Ash - 15.7%; Volatile matter – 27.8% and Fixed Carbon – 54.9%.
   Calculate its ash on a dry basis and volatile matter on d.a.f (dry ash free) and d.m.m.f (dry and mineral matter free) bases
5. Calculate the Wobb's index of natural gas comprising of 89% CH_4, 8% C_2H_6, 2% C_3H_8 and 1% C_4H_{10} by Volume. The calorific values (K-cal/N-m^3) of the constituents are as given below: CH_4 = 9500, C_2H_6 = 16644, C_3H_8 = 23688, C_4H_{10} = 30714

Analyze

1. Differentiate between extraneous and inherent mineral matter of the coal and how they can be removed.
2. Differentiate between the proximate and ultimate analysis of a Lignite and Bituminous coal.
3. What are the different types of catalytic cracking processes? Explain Houndry's fixed bed catalytic cracking process with a neat flow sheet.

Open Book Question(s)

1. Calculate the volume of cow dung based biogas plant to meet cooking requirement of 5 persons (250 l/day) and lighting of four 100 CP mantle lamps consuming 125 l/h for 5 hrs. Also calculate the required number of cows to run the plant in case cow dung produced is 10 kg/day and collection efficiency is 80%, percentage of solid is 20% and production of gas from solid is 375 l/kg.
2. A school in a remote place has the following energy requirements.
   i. 10 lamps each of 100 cp that operate for 4 hrs daily
   ii. 6 computers, each of 250 W, that operate 6 hrs. daily by a duel fuel engine driven
   iii. 2 HP water pump driven by duel fuel engine for 2 hrs daily

   Calculate size of the biogas plant and the no. of cows required to feed the plant. Assuming standard values of data where required.
3. A propeller type aero turbine of turbine diameter of 120 m and turbine operating speed of 40 rpm at maximum efficiency is operating at 1 standard atmospheric air pressure and 15^0 C. The wind velocity is 15 m/s. Calculate
   i) The total power density in the wind stream.
   ii) The maximum obtainable power density
   iii) A reasonable obtained power density
   iv) The total power
   v) The torque and axial thrust
4. A flat plate collector is made up of a copper absorber plate, copper tubes fixed on the underside and one glass cover. The following data is given:

Length of collector	: 2.08 m
Width of collector	: 1.07 m
Length of absorber plate	: 2.00 m
Width of absorber plate	: 0.98 m
Plate to cover spacing	: 2.5 cm
Thermal conductivity of plate material	: 350 W/m-K
Plate thickness	: 0.15 mm
Plate absorptivity for solar radiation	: 0.94
Plate emissivity for re-radiation	: 0.14
Outer diameter of the tube	: 13.7 mm
Inner diameter of the tube	: 12.5 mm
Tube centre to centre distance	: 11.3 cm
Glass cover emissivity/absorptivity	: 0.88
Extinction coefficient of glass	: 19.0 m^{-1}
Thickness of glass cover	: 4 mm
Refractive index of glass relative to air	: 1.526
Location of collector	: Pune ($18^032'$ N, $73^051'$ E)
Date	: May 15
Time	: 12 noon (IST)
Collector tilt	: latitude angle
Surface azimuth angle	: 0^0
Intensity of beam radiation (I_b)	: 725 W/m^2
Intensity of diffuse radiation (I_d)	: 230 W/m^2
Adhesive resistance	: Negligible
Fluid to tube heat transfer coefficient	: 205 W/m^2-K

Water flow rate	: 70 kg/h
Water inlet temperature	: 60^0C
Ambient temperature	: 25^0C
Wind speed	: 3.1 m/s
Back insulation thickness	: 5 cm
Insulation thermal conductivity	: 0.04 W/m-K
Reflectivity of the surrounding surface	: 0.2

Assume that the side loss coefficient is 10% of the bottom loss coefficient.
Calculate,

i. The angle of incident of beam radiation on the collector
ii. The total solar flux incident on the collector
iii. $(\tau\infty)b$ and $(\tau\infty)d$
iv. The incident flux absorbed by the absorber plate
v. The collector heat removal factor and overall loss coefficient
vi. The water outlet temperature
vii. The instantaneous efficiency

19CHM12 Energy Generation from Waste

4 0 0 4

Course Outcomes

1. Understand the sources of waste and its characterization
2. Understand the basic principles of waste management
3. Understand the knowledge about the operations of Waste to Energy Plants
4. Apply the various aspects of Waste to Energy Management Systems
5. Carry out Techno-economic feasibility for Waste to Energy Plants
6. Apply the knowledge in planning and operations of Waste to Energy plants

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_4	PO_5
1	1	3	2	3	2
2	1	3	3	3	2
3	1	2	3	3	2
4	1	2	3	3	2
5	1	3	3	3	2
6	1	3	3	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Waste Sources and Characterization

The Principles of Waste Management and Waste Utilization. Waste Management Hierarchy and 3R Principle of Reduce, Reuse and Recycle. Waste as a Resource and Alternate Energy source.

Waste production in different sectors such as domestic, industrial, agriculture, postconsumer, waste etc. Classification of waste – agro based, forest residues, domestic waste, industrial waste (hazardous and non-hazardous).

Characterization of waste for energy utilization. Waste Selection criteria.

15 Hours

Unit II

Technologies for Waste to Energy

Biochemical Conversion – Energy production from organic waste through anaerobic digestion and fermentation.

Thermo-chemical Conversion – Combustion, Incineration and heat recovery, Pyrolysis, Gasification; *Plasma Arc Technology and other newer technologies*. **15 Hours**

Unit III

Waste to Energy options

Landfill gas, collection and recovery.

Refuse Derived Fuel (RDF) – fluff, briquettes, pellets.

Alternate Fuel Resource (AFR) – production and use in Cement plants, Thermal power plants and Industrial boilers.

Conversion of wastes to fuel resources for other useful energy applications. Energy from Plastic Wastes – Non-recyclable plastic wastes for energy recovery.

Energy Recovery from wastes and optimization of its use, benchmarking and standardization.

Energy Analysis **15 Hours**

Unit IV

Chromatography and Spectroscopy

Environmental standards for Waste to Energy Plant operations and gas clean-up. Savings on non-renewable fuel resources.

Carbon Credits: Carbon foot calculations and carbon credits transfer mechanisms.

15 Hours

Total: 60 Hours

Textbook (s):

1. Rogoff, M.J. and Screve, F., Waste-to-Energy: Technologies and Project Implementation,3rd Ed., Elsevier Store, 2019
2. Mondal, P. and Dalai, A.K. eds., Sustainable Utilization of Natural Resources. CRC Press, 2017
3. Report of the task Force on Waste to Energy, Niti Ayog, 2014
4. Waste-to-Energy in Austria – White Book – Figures, Data Facts, 2nd Ed., 2010

Reference (s):

1. Breeze, P., Energy from waste, 1st Ed., Elsevier, 2017.

2. Rogoff, M. J. and Screve, F., Waste-to-Energy technologies and project implementation, 3rd Ed., Elsevier, 2019.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	20	20	-
Understand	60	60	-
Apply	20	20	60
Analyze	-	-	40
Evaluate	--	-	-
Create	--	-	-
Total (%)	100	100	100

Sample Question (s)

Remember

1. What is composting? Distinguish between aerobic and anaerobic composting?
2. What is leachate?
3. List the five important components of HPLC

Understand

1. What is Incineration? With the help of a neat sketch, explain incineration process.
2. Explain the 3Ts of Incineration process.
3. Discuss the governing factors considered in design of an incinerating system.
4. Enumerate and discuss the factors affecting aerobic composting.
5. Explain the area method of landfilling technique.

Apply

1. Determine the landfill area required for a population of 50000, given the following data.
   i) Solid waste generation: 1.5 kg/person/day
   ii) Compacted density of solid waste in landfill: 500kg/m^3
   iii) Average compacted depth of solid waste:
2. Estimate the moisture content, density and energy content (on dry basis and on ash free dry basis) of the solid waste sample using the data given below. Assume ash content as 5%.

Component	% by mass	Moisture content,%	Density*, Kg/m^3	Energy**, kJ/kg
Food waste	12	70	290	4000
Paper	40	06	85	16000
Card board	08	05	50	16000
Plastics	04	02	65	32000
Grass trimmings	15	60	105	6500
Wood	05	20	240	18000
Tiin cans	16	03	90	700

Open book questions

1. You are asked to segregate the various wastes that are generated from the college canteen. Segregate the wastes from which the energy can be generated? What are the methods that can be adopted for the conversion of these wastes into bioenergy, electrical energy, etc? Also, suggest a proper flow sheet for such wastes to energy conversion.
2. A poultry farm has a capacity to produce 20000 boilers every day. However, it also has the capacity to produce 10 tons of litter every week. How to dispose of such 10 tons of litter? Further, suggest any methods can be adapted for reuse of such a huge quantity of litter generation. Also whether such litter waste can be converted into methane and bioelectricity to meet such huge generation? If yes, propose the conversion method with a neat flow sheet.

19CHM13 Energy Storage Systems

4 0 0 4

Course Outcomes:

1. Understand the need for storage of energy and various technologies available.
2. Understand the working principle of advanced batteries, supercapacitors and fuel cells.
3. Learn sizing of battery, battery management system and state-of-charge estimation.
4. Study battery testing methods and performance curves.
5. Learn safety features of storage devices and operational requirements.
6. Various codes and standards for batteries and electrification of vehicles.

COs – POs Mapping

COs	PO1	PO2	PO3	PO6	PO7
1					2
2		3	3		
3	3				
4	2				
5				3	
6				2	

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Introduction to energy storage systems (ESS)

Introduction: Alternative energy sources and sustainability-Introduction to electric based transportation-Other applications of ESS; Renewable and nonrenewable energy sources

Electric and Hybrid electric vehicles (HEV)-Electric vehicle (EV) configuration-Energy and power requirement of various systems in EVs. Introduction to different types of ESS-Advantages and disadvantages.

Extended range hybrid vehicles. Full electric vehicles.

15 Hours

Unit II

Battery testing methods and performance curves

Types of batteries and their applications: Lead Acid, Lithium ion, Nickel Metal Hydride; Fuel Cells; Supercapacitors; Solar cell; Hybridization of ESS.

Battery charger and testing procedures: Constant current and constant voltage methods; Hybrid methods; Inductive chargers; Battery power testing for various vehicles; Battery testing for fast and deep discharge applications.

Life cycle test; Failure modes; Overcharging and water loss

15 Hours

Unit III

Battery management system (BMS), sizing and design

Fundamentals of BMS and controls, Thermal Management-Active cooling-liquid and air systems; passive cooling-PCM systems. Flat plate and Tubular batteries; Design of battery power rating; Importance of battery dimensions and connector specifications; Design aspects of automotive and industrial application batteries. Charging current calculations.

Difference between automotive and industrial batteries, Deep discharge; recent advances in Battery Technology

16 Hours

Unit IV

Safety and regulatory requirements

Safety aspects of high voltage batteries, Safety handling of Fuel cells and Batteries

Code and standards; Technology and economic aspects of battery recycling;

Recycling of batteries; Role of government to control unorganized sector.

14 Hours

Total: 60 Hours

Textbook (s)

1. Amlan Chakrabarti, Energy Engineering and Management, 2nd Ed., PHI Learning Pvt. Ltd., 2018.
2. J. Jensen and B. Sorenson, Fundamentals of Energy Storage, Wiley-Inter-science, 1984.

Reference (s)

1. R. Narayan and B. Viswanathan, Chemical and Electrochemical Energy System, Universities Press, 1998.
2. C. D. Rahn and C. Wang, Battery Systems Engineering, John Wiley and Sons, 2013

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	20	20	-
Understand	60	60	-
Apply	20	20	60
Analyze	-	-	40
Evaluate	--	-	-
Create	--	-	-
Total (%)	100	100	100

Sample Question (s)

Remember

1. List any two types of energy storage devices and their applications.
2. Define self-discharge and sulphation.
3. List the role of battery in automotive application.

Understand

1. Explain the performance curve during discharge of a lead acid battery.
2. Explain with suitable diagram, the charging circuit in a hybrid electric vehicle.
3. Discuss the effects of unauthorized disposal of lead acid batteries on environment.

Apply

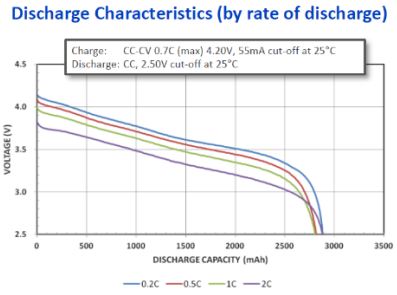
1. Justify the role of government in controlling unorganized sector for batteries in India.
2. Differentiate between the application of flat plate and tubular batteries.
3. Differentiate between constant current and constant voltage charging characteristics.

Analyze

1. Which of the following battery is more suitable for deep discharge application and why?
   (a) Flat plate (b) Tubular plate
2. Which is the most economically viable energy storage system? Give reasons.
3. How do you increase the efficiency of a Fuel Cell?

Open book Question(s)

1. Estimate the backup time provided by the UPS graphically assuming nominal battery characteristics of Voltage: 3.7 V and Capacity: 2800 mA.h. The UPS is supplying power to a unit of 12 V requiring current of 0.8 Amps. The battery discharge characteristics are given below:



19CHM14 Hydrogen Energy and Fuel Cells

4 0 0 4

Course Outcomes

1. Understand the need of hydrogen production & hydrogen energy systems
2. Design and develop suitable hydrogen storage system to be used along with fuel cell system
3. Minimize environmental hazards associated with the use of hydrogen storage and fuel cell technology
4. Summarize the different types of fuel cells, its components and characterization
5. Evaluate the performance of fuel cells under different operating conditions
6. Select and defend appropriate fuel cell technology for a given application

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_7
1	3	-	-	3
2	-	-	3	3
3	2	2	1	3
4	2	-	-	3
5	-	-	3	3
6	-	-	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Hydrogen Production & Hydrogen energy systems

Properties of hydrogen as fuel, Hydrogen pathways introduction-current uses, general introduction to infrastructure requirement for hydrogen production, hydrogen production plants.

Thermal-Steam reformation, thermo chemical water splitting, gasification-pyrolysis, nuclear thermal catalytic and partial oxidation methods. Electrochemical-Electrolysis, photo electro chemical method.

Hydrogen Economy-Hydrogen fuel for transport

15 Hours

Unit II

Hydrogen storage and safety

Physical and chemical properties, general storage methods, compressed storage-composite cylinders, metal hydride storage, carbon based materials for hydrogen storage. Hydrogen safety aspects, backfire, pre-ignition, hydrogen emission NOx control techniques and strategies, Hydrogen powered vehicles.

Hydrogen safety codes and standards

15 Hours

Unit III

Fuel Cells

History, Working principle of fuel cells, Fuel cell thermodynamics, fuel cell electrochemistry - Nernst equation, Electrochemical kinetics, Butler-Volmer equation, performance evaluation of fuel cells, Types of Fuel Cells: AFC, PAFC, SOFC, MCFC, DMFC, relative merits and demerits.

High & low temperature proton exchange membrane fuel cells

15 Hours

Unit IV

Fuel cell characterization and applications

In-situ and ex-situ characterization techniques, V-I curve, frequency response analyses; Fuel cell system integration Application of Fuel Cells Fuel Cell usage for domestic power systems, large scale power generation, Automobile, environmental analysis. Future trends in fuel cells, portable fuel cells, laptops, mobiles, submarines.

Faraday's law, Open circuit voltage, ohomic resistance, limiting current

15 Hours

Total: 60 Hours

Textbook(s)

1. Barbir, Frano. PEM fuel cells: Theory and Practice, 1st Ed., Academic press, 2012
2. O' Hayre R. P., Cha S. W., Colella W., and Prinz F. B., Fuel cell fundamentals, John Wiley, 2008
3. Larminie J., Dicks A. and McDonald M. S., Fuel cell systems explained. Vol. 2, Wiley, 2003
4. Gupta R. B, Hydrogen Fuel: Production, Transport and Storage, CRC Press, 2008

Reference (s)

1. Vielstich W., Lamm A., and Gasteiger H. A, Handbook of Fuel Cells: Fundamentals, Technology, Applications, Vol (1-4), Wiley, 2003
2. Gupta R. B, Hydrogen Fuel: Production, Transport and Storage, CRC Press, 2008
3. Bard A. J., Faulkner L. R., Leddy J., and Zoski, C. G, Electrochemical methods: fundamentals and applications (Vol. 2), Wiley, 1980

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	20	20	--
Understand	30	30	40
Apply	50	50	60
Analyze	--	--	--
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Sample Question (s)

Remember

1. List any two types of fuel cells and their uses.
2. What is open circuit voltage?
3. Define limiting current.
4. Define glass transition temperature.

Understand

1. Distinguish high temperature fuel cell and low temperature fuel cells.
2. Explain in detail hydrogen production plants.
3. Explain about fuel cell characterization.
4. Discuss about portable energy storage systems.

Apply

1. A company is developing a new car powered by a fuel cell system that runs on H_2. You have been asked to consider generating the H_2 by electrolysis with a fuel cell. The H_2 tank to be used is 10 liters in volume and a fill-up requires a pressure of 34 atm.

Open Book Question(s)

1. Consider the following specifications of the system. 60% conversion of H_2O Eo = 1.172 V The cathode pressure is maintained at 1 atm. The anode pressure is maintained at 1 atm Membrane thickness = 100 µm Membrane conductivity (σ) = 0.1 S/cm (S = 1/Ω) Electrolysis T = 373 K (assume water is in the gas phase) H2 storage tank T = 298 K
   a) Calculate the current required to operate at a voltage of 1.8V.
   b) Calculate the rate of hydrogen production per membrane area and the total membrane area required to fill the tank in 2 minutes.
   c) How the fuel cell car is viable than a diesel or petrol car. Justify?

Department of Chemical Engineering

Minor Track 2: Nano Science & Technology

Preamble

Nano science and Nanotechnology is the science of dealing with atoms with only a few nanometres in dimensions. As the size of objects is scaled down to the nanometre regime, the material properties undergo a transformation, presenting a great potential for promising applications. Nanotechnology is one of the continuously emerging scientific areas combining knowledge from the fields of Physics, Chemistry, Biology, Medicine, Informatics and Engineering. Nanostructured materials and Nano systems are fabricated and fully characterised by Nano technological tools and techniques, at sizes below 100 nm. Although there are restrictions related to Nano scale size, it is the handling and processing of matter at this scale that leads to the development of new and novel materials which may have the same bulk composition but widely varying properties. The diverse applications of nanomaterials ranging from electronic and engineering systems and devices, to optical and magnetic components, Nano devices in medicine, cosmetic merchandise, agricultural and food products are believed to pave the way and have a significant economical and societal impact.

Prospectus

Beginning of the 21st century has witnessed a tremendous upsurge of scientific activity in the field of Nano science and Nanotechnology, whose seeds were sowed in the last century. Scientists, technocrats and even governments of many countries all over the world are convinced that it is the technology of 21st century. The main applications in engineering field are catalysts, sensor, coating, adsorption, and drug delivery. Despite of many advantages, preparation and maintaining the proper size of nanomaterials are the crucial job. Engineers play a vital role in the development of such nanomaterials over catalyst synthesis, sensors and nanocoating materials. Further, as Engineers also need to trained in the field of synthesis of graphene and carbon nanotubes for its various applications like drug delivery. Moreover, chemicals engineers with specialized in Nano science and nanotechnology are responsible for develop drugs that target specific cells in the body or building materials that can grow in artificial organs. Nanotechnology can also be used to improve sustainability and access to natural resources with inventions such as molecular water filtration and self-cleaning materials. Simultaneously, the nanotech catalysts are widely used for clean-up the air pollution, specifically the greenhouse gases like carbon dioxide from the air and flue gas and then reconfigure into valuable chemicals those can be used in many industries.

Employability Opportunity

The nanotechnology professionals will have ample of career options like medical, healthcare, industry research, environment industries, pharmaceutical, agriculture, product development and advising, communication and media. Even the nanotechnology is used by the engineers to develop computer components and microscopic sensors. The demand of nanotechnology is increasing day by day because of widen applicability in the day to day life. Further, the aspirants with nanotechnology can have choice for pursuing higher studies owing to ample opportunities in research studies. Candidates with specialization with Nano science and nanotechnology can have opportunities in the following areas.

1. Electronics and semiconductor industries
2. Textiles, polymer industries
3. Environmental monitoring and control
4. Agriculture
5. Geosciences
6. Energy capture and storage
7. Auto and aerospace industries
8. Medical field and pharmaceuticals
9. Forensics
10. Military and national security
11. Biotechnology
12. Food science including quality control and packaging

Track 2: Nano Science & Technology

No	Course Code	Course	POs	Contact Hours			
				L	T*	P	C
01	19CHM21	Introduction and Characterization of Nano-Materials	1,2,3,7	4	-	-	4
02	19CHM22	Carbon Nanostructures and Applications	1,3,4,5	4	-	-	4
03	19CHM23	Energy, Environmental and Biomedical Nanotechnology	1,2,3,7	4	-	-	4
04	19CHM24	Industrial Applications of Nanotechnology	2,3,5,,7	4	-	-	4

19CHM21 Introduction and Characterization of Nano Materials

4 0 0 4

Course Outcomes

1. Apply various chemical and physical methods for the synthesis of nanomaterial's
2. Understand the properties of nano-materials and their applications in relation to bulk materials
3. Describe the synthesis of nano materials
4. Characterize nano materials by Spectroscopic and microscopy techniques.
5. Characterize nano materials by Thermal methods.
6. Characterize nano materials by Magnetic Microscopy & Mechanical Properties.

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_7
1	3	-	-	3
2	-	-	3	3
3	2	2	1	3
4	2	-	-	3
5	-	-	3	3
6	-	-	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Introduction to Material Science and Nano Science & Technology

Crystal Systems – Unit Cells – Bravias Lattices – Crystallographic Planes – Miller Indices – Space Groups – Crystalline and Amorphous Materials Bonds in the Materials: Metallic, Ionic- Covalent and Van-der-Waals Bonds – Crystal Defects – Basics of Nanoscience and Nanotechnology – Scientific Revolutions – Nanosized Effects – Surface to Volume Ratio – Energy at the Nanoscale - Quantum Confinement Effects – Classifications of Nanosystems - 1D- 2D- 3D Nanomaterials – Top-down and Bottom-up approach

Size Dependent Properties of Nanomaterials.

15 Hours

Unit II

Synthesis of Nanomaterials

Top down approach–Ball milling-Types of balls; Types of milling- parameters- Nnaolithography techniques- Bottom-up approach- physical routes- Thermal evaporation, sputtering, pulsed laser deposition Arc discharge method.; Chemical vapor deposition; liquid phase methods- Polyol route–Colloidal precipitation–Sol-Gel process– Chemical precipitation Hydrothermal–Salvothermal–Sonochemical–Microbial routes– Biosynthesis– Template route: DC and Pulsed electrodeposition and Electroless deposition

Combustion route.

15 Hours

Unit III

Characterization of Nano Materials by Spectroscopy and Microscopy

Basic principles and applications of UV-Vis-NIR, FTIR, FT-Raman, Photoluminescence- Microscopy: Scanning Electron Microscopy: SEM -Transmission Electron Microscopy (TEM) – Atomic Force Microscopy AFM-Thermal Properties: TG-DTA Analysis- X-ray diffraction- X-Ray Photoelectron Spectroscopy

Particle size- DLS and Zeta potential

15 Hours

Unit IV

Nano Materials: Characterization by Magnetic Microscopy & Mechanical Properties

Magnetic measurements using vibrating sample magnetometer (VSM)- magnetic force microscopy (MFM) - Electron Paramagnetic Resonance (EPR)-Nuclear Magnetic Resonance (NMR) spectroscopy – Mechanical properties-micro hardness - nano indentation- I-V/C-V

Hall - Quantum Hall effects - Kelvin-probe measurements

15 Hours

Total: 60 Hours

Textbook(s)

1. B. Bhushan, Handbook of Nanotechnology,1st Ed., Springer-Verlag, 2004
2. A. Roth, Vacuum Technology, ., 2nd Ed., North- Holland Pub., 1982
3. C.N.R. Rao, A. Muller, A. K. Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications, 1st Ed., Wiley-VCH Verlag,2004
4. B. S. Murthy, P. Shankar, Baldev Raj, B.B. Rath, Ames Murday, Text book of Nanoscience and Nanotechnology, Springer & Universities Press (India) Pvt. Ltd., 2013

Reference(s)

1. Encyclopaedia of Materials Characterization by C. Richard Brundle Charles A. Evans, Jr.Shaun Wilson ,Butterworth-Heinemann, 1992

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	20	20	--
Understand	30	30	40
Apply	50	50	60
Analyze	--	--	--
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Sample Question (s)

Remember

1. List any two types of fuel cells and their uses.
2. What is open circuit voltage?
3. Define limiting current.
4. Define glass transition temperature.

Understand

1. Distinguish high temperature fuel cell and low temperature fuel cells.
2. Explain in detail hydrogen production plants.
3. Explain about fuel cell characterization.
4. Discuss about portable energy storage systems.

Apply

1. A company is developing a new car powered by a fuel cell system that runs on H_2. You have been asked to consider generating the H_2 by electrolysis with a fuel cell. The H_2 tank to be used is 10 liters in volume and a fill-up requires a pressure of 34 atm.

Open Book Question(s)

1. Consider the following specifications of the system. 60% conversion of H_2O Eo = 1.172 V The cathode pressure is maintained at 1 atm. The anode pressure is maintained at 1 atm Membrane thickness = 100 μm Membrane conductivity (σ) = 0.1 S/cm (S = 1/Ω) Electrolysis T = 373 K (assume water is in the gas phase) H2 storage tank T = 298 K

   a) Calculate the current required to operate at a voltage of 1.8V.

   b) Calculate the rate of hydrogen production per membrane area and the total membrane area required to fill the tank in 2 minutes.

   c) How the fuel cell car is viable than a diesel or petrol car. Justify?

19CHM22 Carbon Nanostructures and Applications

4 0 0 4

Course Outcomes:

1. Understand the graphite derivatives, fullerenes and its type, nano-diamond, grapheme
2. Understand the various method of synthesis of the carbon nanostructures and their mechanism
3. Understand the various structures of carbon nanotubes and its growth mechanisms
4. Understand the different the physical and chemical synthesis methods of graphene
5. Precisely characterize the developed carbon nanotubes and graphene using various characterization techniques
6. Understand the application of the carbon nanotubes and graphene

COs – POs Mapping

COs	PO_1	PO_3	PO_4	PO_5
1	1	2	2	3
2		2		3
3	1		3	
4	1		3	
5	1	3		3
6			2	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I:

Allotropes of carbon and their derivatives

Allotropes of Carbon: Diamond – Graphite – Graphene – Fullerenes – Metallofullerenes – Solid C60 – Bucky onions – Carbon nanotubes (CNT): Single walled carbon nanotubes, Multi-walled carbon nanotubes – Carbon dots – Carbon nanocones – Carbon nanohorns –Nanodiamond *Stability of carbon phases at nanolevel: Phase diagram.*

15 Hours

Unit II:

Synthesis of carbon nanostructures

Synthesis of Carbon Nanostructures: Ultra high vacuum chamber: Pumps- Gauges – Arc discharge method: CNT-fullerene- Chemical vapor deposition: Graphene- CNT- various gases precursors – Pulsed laser deposition: CNT Laser pulse-target interactions – Thermal flash deposition

Mechanical-chemical- thermal exfoliation of graphene.

15 Hours

Unit III:

Structure, characterization and applications of carbon nanotubes

The Structure of Carbon Nanotubes- Nomenclature, Structure of Single-Walled Carbon Nanotubes and Structure of Multiwalled Carbon Nanotubes; Structure and Production of Further Tubular Carbon Materials- Spectroscopic Properties of Carbon Nanotubes- Raman and Infrared Spectroscopy of Carbon Nanotubes, Absorption and Emission Spectroscopy of Carbon Nanotubes, ESR-Spectroscopic Properties of Carbon Nanotubes. Mechanical, Thermal Applications

Electronic Applications and biological Applications of CNTs.

15 Hours

Unit IV:

Structure, characterization and applications of graphene

Structure of graphene; Preparation of graphene – synthesis of graphene by various physical and chemical methods and Purification; Electronic Properties Band Structure of Graphene - Mobility and Density of Carriers - Quantum Hall Effect - Spectroscopic Properties of graphene - Raman, Application of Fullerene, CNT, Graphene and other carbon nanomaterials Mechanical, Thermal Applications,

Electronic Applications and biological Applications- Graphene.

15 Hours

Total: 60 Hours

Textbook (s):

1. Morris, J.E. and Iniewski, K., Graphene, Carbon Nanotubes, and Nanostructures: Techniques and Applications, CRC Press, 2013
2. Kelker, A.D., Herr, D.J.C. and Ryan, J.G., Nanoscience and Nanoengineering: Advances and Applications, CRC Press, 2014
3. Guldi, D.M. and Martin, Carbon Nanotubes and Related Structures: Synthesis, Characterization and Applications, Wiley-VCH Verlag, 2010
4. Reich, S., Thomsen, C. and Maultzsch, J., Carbon Nanotubes: Basic Concepts and Physical Properties, Wiley-VCH Verlag, 2004

References

1. James E. Morris, Krzysztof Iniewski, Graphene, Carbon Nanotubes, and Nanostructures: Techniques and Applications, CRC Press, 2013
2. Ajit D. Kelkar, Daniel J.C. Herr, James G. Ryan,Nanoscience and Nanoengineering: Advances and Applications, CRC Press, 2014
3. Dirk M. Guldi, Nazario Martín, Carbon Nanotubes and Related Structures: Synthesis, Characterization and Applications, Wiley, 2010
4. Stephanie Reich, Christian Thomsen, Janina Maultzsch, Carbon Nanotubes: Basic Concepts and Physical Properties, Wiley, 2004
5. R Saito, G Dresselhaus, M S Dresselhaus, Physical Properties of Carbon Nanotubes, World Scientific, 1998
6. M. S. Dresselhaus, G. Dresselhaus, P. Avouris, Carbon Nanotubes: Synthesis, Structure, Properties, and Applications, Springer, 2000

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	20	20	-
Understand	60	60	-
Apply	20	20	100
Analyze	-	-	-
Evaluate	--	-	-
Create	--	-	-
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define a nanomaterial. List any four naturally occurring/synthetically prepared nanomaterils used in daily life.
2. Differentiate between nano materials & bulk materials in terms of physical properties.
3. List two methods of preparing nanomaterials in bottom up approach & top down approach.

Understand

1. Explain the sol-gel method of preparing nano materials. What kind of materials can be prepared by this method in nano form.
2. How will the electrical, magnetic & optical properties vary for nano amterials compared to bulk. Explain with an example for each.
3. What are the various carbon nano materials available? Describe one methos of producing Carbon nano tubes.

Apply

1. How is SEM used for characterization of nano materials? Describe the principle and working of instrument.
1. Based on the optical properties of Nano TiO_2 and ZnO, describe the design & construction of nano sensors.
2. Describe the functions and applications of Carbon nano tubes and gaN nano wires.

Open Book Questions

1. How is the size of nanomaterials characterized? Assess the advantage of using SEM & TEM instead of powder XRD for size of particle, grain size characterization.
2. For a semiconductor, as the materials is sized down to nano, the electronic band structure is found to vary from bulk material. Explain the changes in electronic band structure for a direct band gap material.
3. Calculate the changes in surface to volume ratio (S/V ratio) for a particle of 1 micrometer cube divided into 10 nanometer cubes by top down approaches. Comment on its impact in catalysis

19CHM23 Energy, Environmental and Biomedical Nanotechnology

4 0 0 4

Course Outcomes

1. Illustrate the basic principles of energy environmental and biomedical nano technology.
2. Classify various treatment methods for toxic metals and industrial waste water.
3. Summarize the different types of solar cells, Electro chemical energy systems.
4. Explain nano based materials and applications of biosensors.
5. Utilize the biomedical nano particles for pharmaceutical industry.
6. Explain biodegradable polymers for biomedical applications.

CO-PO Mapping

COs	PO1	PO2	PO3	PO7
1	1	2	3	1
2	2	-	3	2
3	3	3	-	2
4	-	2	3	2
5	-	-	3	1
6	-	3	2	1

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit-1

Introduction to Solar Energy-Nanotechnology in Energy Conversion and Storage

Principles of photovoltaic energy conversion (PV), Types of photovoltaic Cells-Organic photovoltaic cell cells, thin film Dye Sensitized Solar Cells, Quantum dot (QD) Sensitized Solar Cells (QD-SSC), Organic- Inorganic Hybrid Bulk Hetero Junction (BHJ-SC) Solar cells- Perovskite solar cells-Nanostructured Materials for electrochemical Energy Storage Systems, Primary and Secondary Batteries (Lithium ion Batteries), Cathode and anode materials, Capacitor Electrochemical super capacitors, electrical double layer model, Principles and materials design, Nanostructured Carbon based materials, Nano-Oxides, Novel hybrid electrode materials-Nanostructured Materials for electrochemical Energy, Conversion Systems, Fuel Cells.

Applications of solar energy-Types of fuel cells

15 Hours

Unit II

Environmental and Biomedical Nanotechnology

Nano membrane process nanosorbants – Mesoporous materials – Ground water remediation – Air purifier – Nano photo catalysis - Pt nanoparticles for sulphur removal – Ge nano particles for lead removal- Nano materials for waste water treatment- organic and pharmaceutical waste treatment- Nano sensor for environmental applications-Environmental protection – Food processing & packaging –Bioremediation- removal of bacteria and microbes for food products-Nano Biosensors for Pesticide Detection and degradation-Nano Biosensors for Plant Pathogen Detection.

Nano membranes for water purification-Types of nano biosensors

15 Hours

Unit III

Applications of Biosensors

Biosensors using CNT- FET; DNA detection – glucose detection, CNT based electrochemical biosensor – optical biosensor with metal nanoparticles. Quantum dot based sensors-Dendrimer based biosensor, regent biosensor based on nanoparticles. Gold Nanocages for Cancer Imaging and Therapy-Photo thermal therapy with Gold Nano cages invitro and invivo- Gold Nano rods.

Applications of gold nano particles for biomedical industries

15 Hours

Unit IV

Applications of Biomedical nanoparticles

Biomedical nanoparticles – Liposome's – Dentrimers – Different types of drug loading and release – Biodegradable polymers –Development of nano medicines – Nano shells – Nano pores – Tectodendrimers – Nanoparticle drug system for oral administration.

Structure of nano shells-Types of biodegradable polymers

15 Hours

Total: 60 Hours

Textbook(s)

1. Wilson, M., Nanotechnology: Basic Science and Emerging Technologies. CRC press, 2002
2. O' Hayre R. P., Cha S. W., Colella W., and Prinz F. B., Fuel cell fundamentals, John Wiley, 2008
3. David J. Lockwood, Nanostructured Materials for Electrochemical Energy Production and Storage, Springer, 2009
4. Lens, Piet, Nanotechnology for water and wastewater treatment. Iwa Publishing, 2013

Reference (s)

1. Hornyak, Gabor L., et al. Fundamentals of nanotechnology. CRC press, 2018.Gupta R. B, Hydrogen Fuel: Production, Transport and Storage, CRC Press, 2008
2. Mendelson, Mel I. Learning Bio-micro-nanotechnology. CRC Press, 2019
3. Madou, Marc J. Manufacturing techniques for microfabrication and nanotechnology. Vol. 2. CRC press, 2011

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	20	20	--
Understand	30	30	40
Apply	50	50	60
Analyze	--	--	--
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Sample Question (s)

Remember

1. List any two types of Biodegradable polymers.
2. What is Perovskite solar cell?
3. Define limiting current.
4. Define glass transition temperature.

Understand

1. Explain in detail Nano Biosensors for Plant Pathogen Detection.
2. Distinguish high temperature fuel cell and low temperature fuel cells.
3. Explain about fuel cell characterization.
4. Discuss about Electrochemical super capacitors.

Apply

1. A company is developing a new car powered by a fuel cell system that runs on H_2. You have been asked to consider generating the H_2 by electrolysis with a fuel cell. The H_2 tank to be used is 10 liters in volume and a fill-up requires a pressure of 34 atm.
   Consider the following specifications of the system. 60% conversion of H_2O Eo = 1.172 V The cathode pressure is maintained at 1 atm. The anode pressure is maintained at 1 atm Membrane thickness = 100 μm Membrane conductivity (σ) = 0.1 S/cm (S = 1/Ω) Electrolysis T = 373 K (assume water is in the gas phase) H2 storage tank T = 298 K
   a) Calculate the current required to operate at a voltage of 1.8V.
   b) Calculate the rate of hydrogen production per membrane area and the total membrane area required to fill the tank in 2 minutes.

Open Book Examination

1. In problem number 1. (Mentioned above), with the same parameter specifications how the fuel cell car is viable than a diesel or petrol car. Justify?

19CHM24 Industrial Applications of Nanotechnology

4 0 0 4

Course Outcomes:

1. Learn different aspects of application of nanotechnology in industry
2. Learn present and future scope of nanoscience in electronics industry
3. Learn preparation, characterization and application of nanomaterials in electromechanical devices
4. Study the application of nanoscience in sensor technology
5. Study the role of nanotechnology in healthcare
6. Study the safety aspects of using nanotechnology in body-implants and biosensors

COs – POs Mapping

COs	PO2	PO3	PO5	PO7
1	3	2		
2			2	
3			3	
4	3			
5		2		
6		3		2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Introduction to various applications

Optoelectronic Devices Different types of semiconductor Nanostructures Devices - Semiconductor Quantum dots (QDs) – QD LASER- Quantum cascade LASER-QD. White LEDs - LEDs based on nanorods. Silicon horizontal and vertical core shell Nanowires. Electro optical devices - Optical memory - Present and future trends - Nanomaterials as Electrolytes - Nanoscale Electronic and Ionic Transport – Energy Conversion and Storage in Electrochemistry – Industrial applications of energy devices.

White LEDs - LEDs based on nanorods

15 Hours

Unit II

Nano based electromechanical systems

Magnetic and Electro Mechanical Materials Near field optical recording- holographic data storage- AFM based recording technology. Storing and reading device – current trends of spin based electronic devices. Nano Electro Mechanical Systems: Overview- Nano-Electromechanical systems - fabrication process - choice of materials- performance of different structures - advantages and disadvantages of different approaches. Applications in sensors - Micro actuators - Extension to the nanoscale.

Applications in sensors - Micro actuators - Extension to the nanoscale

15 Hours

Unit III

Nanotechnology enabled sensors

Sensors Applications Inorganic Nanotechnology Enabled Sensors - Nanotechnology Enabled Mechanical Sensors - Thermal energy sensors - temperature sensors - Electromagnetic sensors- electrical resistance sensors- electrical current sensors- electrical voltage sensors- electrical power sensors - liquid flow sensors- position sensors - chemical sensors - radiation sensors – organic nanotechnology enabled sensors - nanosensors based on nucleotides – glucose sensors.

Nanosensors based on nucleotides- glucose sensors

15 Hours

Unit IV

Nanotechnology in biomedical applications

Biomedical and Healthcare Nanoparticles and Micro–organism- Nano-materials in bone substitutes & Dentistry- Food and Cosmetic applications- Catalysis- Drug delivery and its applications- Biochips- analytical devices- Biosensors and Biomass energy. Improved diagnostic products and techniques- in vivo imaging- plaque- genetic defects and other disease states- Nanobot medical deviceslogic and intelligence embedded medical devices- standalone sensing and computing devices. Toxicity of Nanoparticles - Future Perspectives.

Toxicity of Nanoparticles - Future Perspectives

15 Hours

Total: 60 Hours

Textbook (s):

1. Parag Diwan and Ashish Bharadwaj, Nano Electronics, Pentagen Press, 2006.
2. C. W. Turner and Van Duzer. T, Principles of Superconductive Devices and Circuits, Prentice Hall, 1999

Reference (s):

1. Yariv, Principles of Optical Electronics, John Wiley and sons, 1984.
2. M. C. Petty, M. R. Bryce, D. Bloor (eds.), Introduction to Molecular Electronics, Oxford University Press, 1995.
3. Rainer Waser, Nano Electronics and Information Technology, John Wiley and sons, 2003.
4. Kourosh Kalantar-Zadeha and Benjamin Fry, Nanotechnology Enabled Sensors, Springer, 2008.
5. David J. Lockwood, Nanostructured Materials for Electrochemical Energy Production and Storage, Springer, 2009.
6. Tuan Vo-Dinh, Nanotechnology in Biology and Medicine: Methods, Devices and Applications, CRC Press, 2007

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	20	20	-
Understand	60	60	-
Apply	20	20	60
Analyze	-	-	40
Evaluate	--	-	-
Create	--	-	-
Total (%)	100	100	100

Sample Question (s)

Remember

1. List any two applications of nanomaterials in each of pharmaceuticals and cosmetics.
2. What are nanobots?
3. Name few naturally occurring nanomaterials.

Understand

1. Explain the parameters affecting the efficiency of nanomaterials.
2. Explain the precautions to be taken during the application of nanomaterials for bio-implants.
3. Discuss the safety or environmental concerns with the present-day usage of nanomaterials.

Apply

1. Explain the process of corrosion resistant coating of ceramics using nanocrystals.
2. Justify that the ayurvedic preparations contain biologically prepared nanomaterials.
3. Explain the importance of compressive strength of nanotubes and methods to estimate the same with corresponding inferences.

Analyze

1. Explain with suitable examples why some conductors exhibit insulator properties at nanoscale?
2. Explain the statement: “There is plenty of room at the bottom”-Robert Feymann.
3. Distinguish between magnetic force microscopy and atomic force microscopy.

Open book problem example:

1. Compare various lithographic techniques. Demonstrate using limitations and specific suitability of each technique for various industrial applications

DEPARTMENT OF CIVIL ENGINEERING

AR19 MINOR COURSES

Minors for other Departments offered by Civil Engineering

Stream (Environmental Engineering)

Preamble: B.Tech. – Minors in Environmental Engineering focuses on the application of science and engineering in the area of air, water and soil. It focuses on providing wholesome water for the public, controlling air pollution and rehabilitating polluted soil. Furthermore, it focuses on providing the appropriate solution for pollution, providing solutions for improving water quality and quantity and enforces laws and regulations for controlling pollution. In recent years the world is facing many environmental-related problems and it had become a major challenge for society. It starts from local problems like groundwater depletion, water pollution and solid water management to global problems like climate change. So, it is very important that all engineering graduates need to focus on these global and local challenges. The contribution of environmental engineers is focused on sustainable development. The major scope of environmental engineering is the management of natural resources, protecting biodiversity and controlling various pollutions.

Key Features: This Minor degree covers a spectrum of courses ranging from foundations to modern techniques of watershed management, Industrial pollution control methods, solid and hazardous waste management and Environmental risk assessment

Career Prospects: The major scope of environmental engineering is the management of natural resources, protecting biodiversity and controlling various pollutions. Nowadays the major opportunity that an environmental engineer can play an important role are in industries where they need to comply with rules and regulations, consultancy, Research and Development, Academics, Green Marketing, Green Media, Green Advocacy and role in various international NGOs. In the mere future, career and opportunities in the area of environmental engineering will be very high. Students can also purse multi-disciplinary research-oriented studies at eminent institutes.

Track 1: Environment Engineering							
No	**Course Code**	**Course**	**POs**	**Contact Hours**			
				L	**T***	**P**	**C**
01	19CEM11	Watershed Management	6,7	4	-	-	4
02	19CEM12	Industrial Pollution Control and Engineering	3,6,7,12	4	-	-	4
03	19CEM13	Solid And Hazardous Waste Management	1,3,6,7	4	-	-	4
04	19CEM14	Ecology And Environmental Assessment	1,3,6,7	4	-	-	4

19CEM11 Watershed Management

4 0 0 4

Course Outcomes

1. Analyze the characteristics of watershed
2. Summarize the various types of Erosion and Sedimentation process
3. Understand the principles or measures to control Erosion
4. Analyze the various Water Harvesting methods
5. Evaluate Ecosystem Management and its practical implications
6. Assess the current status of the watershed at field, by taking up accurate investigation measures and conduct survey

COs–POs Mapping

COs	PO6	PO7
1	3	1
2	3	2
3	2	2
4	2	3
5	3	3
6	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Introduction and Characteristics of Watershed

Concept of watershed development, objectives of watershed development, need for watershed development in India, Integrated and multidisciplinary approach for watershed management. Characteristics of Watershed: size, shape, physiography, slope, climate, drainage, land use, vegetation, geology and soils, hydrology and hydrogeology, socio-economic characteristics, basic data on watersheds.

Watershed Improvements- Another Approach of Watershed Management

12 + 3 Hours

Unit II

Principles of Erosion and Measures to Control Erosion

Types of erosion, factors affecting erosion, effects of erosion on land fertility and land capability, estimation of soil loss due to erosion, Universal soil loss equation. Measures to Control Erosion: Contour techniques, ploughing, furrowing, trenching, bunding, terracing, gully control, rockfill dams, brushwood dam, Gabion.

Difficulties for Development of Watershed

11 + 4 Hours

Unit III

Water Harvesting and Land Management

Rainwater Harvesting, catchment harvesting, harvesting structures, soil moisture conservation, check dams, artificial recharge, farm ponds, percolation tanks. Land Management: Land use and Land capability classification, management of forest, agricultural, grassland and wild land. Reclamation of saline and alkaline soils.

Improvement Techniques for soil Strength- Advanced Techniques for Prevention of Soil Erosion

11 + 4 Hours

Unit IV

Ecosystem Management & Planning and Administration

Role of Ecosystem, crop husbandry, soil enrichment, inter, mixed and strip cropping, cropping pattern, sustainable agriculture, bio-mass management, dry land agriculture, Silvipasture, horticulture, social forestry and afforestation. Planning and Administration: Planning of watershed management activities, peoples participation, preparation of action plan, administrative requirements.

EcoSystem Development.

11 + 4 Hours

Total: 45+15 Hours

Text Book (s):

1. Murthy, V.V.N. and M.K. Jha Land and Water Management, Kalyani Publishers, 2015
2. Watershed Management by Madan Mohan Das and M.D. Saikia, Prentice Hall of India, 2013
3. Watershed Management Muthy, J. V. S., , New Age International Publishers, 2098

Reference Book(s):

1. Watershed Hydrology by P E Black, Prentice Hall Englewood Cliffs, 2091
2. Watershed Hydrology by R Suresh, Standard Publishers and Distributors, Delhi, 2007

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	30	30	50
Understand	70	70	50
Apply	--	--	
Analyze	--	--	--
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Sample Question (S)

Remember

1. What is the function of watershed?
2. List all the types of erosion.
3. What are the consequences of erosion?
4. Write a short note on land grading operation?
5. Small Water System Operation and Maintenance in Andhra Pradesh (OBE)

Understand

1. Explain classifications of land use and land capability.
2. Explain in detail inter, mixed and strip cropping
3. Discuss the importance of watershed management in India
4. Explain the causes of erosion
5. Explain the detailed procedure to protect the surface water sources based on the Andhra Pradesh Water, Land and Trees act. (OBE)

19CEM12 Industrial Pollution Control and Engineering

4 0 0 4

Course Outcomes

1. Outline industrial wastes and discuss about the basic theories of industrial waste water management
2. Explain characteristics, sources, sampling of wastewater
3. Explain different treatment techniques for industrial wastewater treatment
4. Identify the problems of joint treatment and industrial waste water discharges, recirculation and use of municipal waste water in industries
5. Explain about common effluent treatment plants (CETP) and effluent disposal methods.
6. Explain the manufacturing processes and design origin of liquid waste from different industries

COs-POs Mapping

COs	PO_3	PO_6	PO_7
1	2	2	3
2	2	2	3
3	3	2	3
4	2	2	3
5	2	2	3
6	2	2	3

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I

Introduction to Industrial Pollution

Industrial scenario in India– Industrial activity and Environment - Uses of Water by industry – Sources and types of industrial wastewater – Nature and Origin of Pollutants - Industrial wastewater and environmental impacts – Regulatory requirements for treatment of industrial wastewater – Industrial waste survey – Industrial wastewater monitoring and sampling -generation rates, characterization and variables

Toxicity of industrial effluents and Bioassay tests; Major issues on water quality management

11+4 Hours

Unit II

Industrial Wastewater Treatment

Equalisation - Neutralisation – Oil separation – Flotation – Precipitation – Heavy metal Removal– Aerobic and anaerobic biological treatment – Sequencing batch reactors – High Rate reactors - Chemical oxidation – Ozonation – carbon adsorption - Photocatalysis – Wet Air Oxidation – Evaporation – Ion Exchange.

Membrane Technologies – Nutrient removal.

11+4 Hours

Unit III

Wastewater Reuse and Residual Management

Individual and Common Effluent Treatment Plants – Joint treatment of industrial and domestic wastewater - Zero effluent discharge systems - Quality requirements for Wastewater reuse – Industrial reuse, Present status and issues - Disposal on water and land – Residuals of industrial wastewater treatment – Quantification and characteristics of Sludge – Thickening, digestion, conditioning and dewatering

Disposal of sludge; Management of RO reject

12+3 Hours

Unit IV

Case Studies

Industrial manufacturing process description, wastewater characteristics, source reduction options and waste treatment flow sheet for Diaries - Textiles – Tanneries – Pulp and paper – Sugar and Distilleries - metal finishing.

Oil Refining; Pharmaceuticals.

11+4 Hours

Total: 45+15 Hours

Textbook (s)

1. Eckenfelder, W.W., 'Industrial Water Pollution Control', Mc-Graw Hill, 1901.
2. Frank Woodard, 'Industrial waste treatment Handbook', Butterworth Heinemann, New Delhi, 1901.
3. Metcalf & Eddy/ AECOM, "water reuse Issues, Technologies and Applications", The Mc Graw- Hill companies, 1907.

Reference (s)

1. Nelson Leonard Nemerow, “Industrial waste treatment – contemporary practice and vision for the future”, Elsevier, Singapore, 1907
2. "Industrial wastewater management, treatment & disposal, Water Environment" Federation Alexandria Virginia, Third Edition, 1908.
3. World Bank Group, ‘Pollution Prevention and Abatement Handbook – Towards Cleaner Production’.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	30	30	--
Understand	70	70	--
Apply	--	--	100
Analyze	--	--	--
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Sample Question (s)

Remember

1. List sources of industrial wastewater.
2. List any four characteristics of industrial effluent.
3. What is the method used to remove oil and grease from wastewater?
4. What is mean by common effluent treatment plant.
5. Draw the treatment flowchart for dairy industries.

Understand

1. What are the important chemical parameters of industrial wastewater? Write the methods of estimation for any three parameters.
2. Explain in detail about basic theories of industrial waste management and explain in detail about volume reduction.
3. Explain in detail about various methods for neutralizing acid and alkaline waste.
4. Explain in detail about problems arising when industrial wastewater is mixed in ocean.
5. Explain in detail about treatment methods for the wastewater discharged from tannery industries.

19CEM13 Solid and Hazardous Waste Management

4 0 0 4

Course Outcomes

1. To understand the sources of solid and hazardous wastes
2. To understand methods of solid and hazrdous waste disposal
3. To realize the significance of solid and hazardous waste management in today life
4. To understand the processes involved in solid and hazardous waste management
5. To comprehend the techniques for various waste management
6. To appreciate the role of common/integrated waste management plants

COs – POs Mappings

COs	PO_1	PO_3	PO_6	PO_7
1	3	1	3	3
2	3	2	2	3
3	2	3	3	2
4	3	3	3	2
5	1	3	1	3
6	2	2	2	3

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I

Solid Waste Management

Introduction: Definition of solid waste – waste generation, sources and types of solid waste – sampling and characterization – Determination of composition of Municipal Solid Waste

Collection and Transport of Solid Waste:Type and methods of waste collection systems, analysis of collection system Optimization of collection routes– alternative techniques for collection system. Transfer and Transport: Need for transfer operation, transport means and methods, transfer station types and design requirements. Separation and Processing and Transformation of Solid Waste- Waste as a Resource Economics, Disposable Materials, Recycling Collection, Processing, Potential for Reuse

Onsite storage and handling of solid waste

16 Hours

Unit II

Solid Waste Handling and Processing

Processing and disposal: Unit operations used for separation and processing, Materials Recovery facilities, Source reduction and waste minimization, Metal Separation & Recovery Waste transformation through combustion and composting, anaerobic methods for materials recovery and treatment – Energy recovery – biogas generation and cleaning– Incinerators. Landfills: Site selection, design and operation, drainage and leachate collection systems.

Designated waste landfill remediation

15 Hours

Unit III

Hazardous Waste Management

Hazardous Waste Management:Definition and identification of hazardous wastes-sources and characteristics – hazardous wastes in Municipal Waste – minimization of Hazardous Waste-compatibility, handling and storage of hazardous waste-collection and transport, e-waste - sources, collection, treatment and reuse.

Hazardous waste regulations

14 Hours

Unit IV

Technologies in Hazardous waste treatment

Hazardous waste treatment technologies - Design and operation of facilities for physical, chemical and thermal treatment of hazardous waste – Solidification, chemical fixation and encapsulation, incineration. Hazardous waste landfills: Site selection, design and operation.

Remediation of hazardous waste disposal sites

15 Hours

Total 60 Hours

Textbook (s)

1. Rao, M.N., R. Sultana, S. H. Kota,, Solid and Hazardous Waste Management: Science and Engineering,, Elsevier, Butterworth-Heinemann, 2016
2. Integrated Solid Waste Management: Engineering Principles and Management Issues by George Tchobanoglous , Hilary Theisen, Samuel A Vigil. McGraw-Hill Series in Water Resources and Environmental Engineering

References

1. Environmental Engineering by Howard S.Peavy, Donald R.Rowe and George Tchobanognous, McGraw Hill Publishing Company.
2. Hazardous Waste Management, Charles A. Wentz; McGraw Hill Publication
3. Municipal Solid Waste Management by P Jayaramireddy, BSP Books PVT Ltd.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2(%)	Open Book Exam (%)
Remember	60	40	50
Understand	40	60	50
Apply	-	-	-
Analyze	-	-	-
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Sample Question (S)

Remember

1. Define solid waste.
2. List various unit operations used for separation and processing.
3. List the types of solid waste.
4. What is meant by incineration?
5. What are the requirements of leachate collection systems?
6. A landfill area of (150 m x 100 m) is available for handling 25 years' municipal solid waste (MSW) for a town of 5,00,000 people. Out of the total landfill area only 80% is
   actually available for land fill and other is used for auxiliary services. Assuming that average per capita MSW discard per year in town is 0.05 tonne, landfill density is 500 kg/m^3, and that the 15 percent of the actual landfill cell volume is used for soil cover, estimate
   (a) the landfill lift in one year.
   (b) number of years for which the land fill can be used if the landfill can't be increased
   beyond 25 m. (Open Book Examinations)

Understand

1. Explain the necessity Solid Waste Management.
2. Discuss in breif about Site selection for a Landfill.
3. Explain in detail about handling and storage of hazardous waste.
4. Differentiate between encapsulation and incineration.
6. Outline the process for identification of hazardous wastes.
7. To maximize the life span of the landfill, local waste management agency has proposed to set up a waste combustion facility next to the existing landfill which has 1.500.000 m3 remaining capacity.

   i. Determine how many days the life span of the landfill is increased by combusting the MSW instead of landfilling it directly.
   ii. 1900 tons/day MSW will be combusted assuming 82% weight reduction and the combustion residue (ash) will be landfilled.
   iii. Specific weights of combustion residue and compacted MSW in the landfill are 600 and 800 kg/m3, respectively. **(For Open Book Examination not for end examination)**

19CEM14 Ecology and Environmental Assessment

4 0 0 4

Course Objectives:

1. To understand the basics of Ecology
2. To know the Environmental Education and Assessment
3. To prepare the Environmental Impact Assessment Statement and Management Plan
4. To know the Strategic Environmental Assessment and Life cycle assessment
5. To understand the EIA regulations in India
6. To prepare the Risk assessment for a project and hazard identification and assessment

COs – POs Mappings

COs	PO1	PO3	PO6	PO7
1	3	2	2	2
2	3	2	1	2
3	2	3	3	1
4	2	3	3	1
5	3	2	2	2
6	3	3	2	1

3-Strongly linked | 2-Moderately linked | 1-Weakly linked

Unit I

Basics of Ecology & Environmental education

Basics of Ecology: Concept and ideas on environment: Definition, Components;
Environmental education: Primary objectives, Types and guiding principles; Environmental ethics,
Environmental awareness in India

15 Hours

Unit II

Environmental impact assessment (EIA)

Environmental impact assessment (EIA): definitions, introduction and concepts; rationale and historical development of EIA; Impact identification and prediction; baseline data collection; Environmental Impact Statement (EIS), Environmental Management Plan (EMP): principles, problems and strategies
Scope and methodologies of EIA

15 Hours

Unit III

Strategic Environmental Assessment

Strategic Environmental Assessment; Social Impact Assessment; Cost-Benefit analysis; Life cycle assessment; environmental appraisal; environmental planning; environmental audit; Principles of Internal Standard Organization
EIA regulations in India; status of EIA in India; current issues in EIA; case study of hydropower projects/ thermal projects
Characterization of Internal Standard Organization

15 Hours

Unit IV

Risk assessment

Risk assessment: Introduction and scope; Project planning; exposure assessment; toxicity assessment; hazard identification and assessment; risk characterization; risk communication; environmental monitoring; legal and regulatory framework; human and ecological risk assessment
Community involvement in Risk assessment

15 Hours

Total: 60 Hours

Textbooks:

1. Fundamentals of Ecology: M C Dash, McGraw Hill Publishers
2. Elements of Ecology: Smith and Smith, Pearson Publishers
3. Barrow, C.J. 1900. Social Impact Assessment: An Introduction. Oxford University Press.

References:

1. Glasson, J., Therivel, R., Chadwick, A. 1994. Introduction to Environmental Impact Assessment.
2. London, Research Press, UK. 3. Judith, P. 1999. Handbook of Environmental Impact Assessment.
3. Blackwell Science. 4. Marriott, B. 1997. Environmental Impact Assessment: A Practical Guide. McGraw-Hill, New York, USA.
4. Environmental Studies—Prof S.V.S Rana. --Rastogi Publication.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2(%)	Open Book Exam (%)
Remember	60	40	50
Understand	40	60	50
Apply	-	-	-
Analyze	-	-	-
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Sample Question (S)

Remember

1. What is Ecology?
2. What are the objectives of Environmental education?
3. Define EIA.
4. Define Life cycle Assessment.
5. List the principles of EMP.
6. Prepare a detailed impact assessment for new (planned) 350 MW gas fired plant (gas/steam turbine) which will supply up to 250 MW of district heat. With an efficiency of up to 86% (power and heating combined), it will be one of the most modern and efficient plants in operation: older power plants reach an efficiency of around 40%.The new block complements the existing blocks in three major power stations, including Simmering (5 blocks with a total of 1050 MW electrical, and heat capacity of up to 630 MW) and with 155 MW electrical and 170 MW thermal.**(For Open Book Examination not for end examination)**

Understand

1. Discuss guiding principles of Environmental education.
2. Explain Cost-Benefit analysis.
3. Explain about legal and regulatory framework in Risk assessment
4. Discuss principles/characterization of Internal Standard Organization.
5. Explain in detail about Impact identification and prediction.
6. Prepare the assessment process of project area of wetland with effect to ecological balance, details listed in table with necessary screening and evaluation of environmental impact potentiality and the proper mitigation measurements

Land Use	Area (in hectare)
Substantially water body	5852.14
Agricultural area	4718.56
Productive farming area	602.78
Urban/rural settlement area	1326.52 (91.53 ha urban + 1234 ha rural)
Total area	12,500

(For Open Book Examination not for end examination)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

AR19 MINOR COURSES

Minors for other Departments offered by Computer Science and Engineering

Stream I (Artificial Intelligence & Machine Leaning)

Preamble: B.Tech. – Minors in Artificial Intelligence and Machine Learning (AI&ML) focusses on integrating AI and Machine Learning skills to all core engineering students to enhance their employability skills. The prime objective of this Programme is to develop students to excel in Machine Learning specific areas by exposing them to understand mathematical, statistical, and biologically inspired computational models with engineering and scientific principles to devise solutions for societal and business problems. As the business world witnesses the power of data-driven decision making, there is a lot of demand for professionals who can build and execute mathematical and statistical models/algorithm. To harness the power of data, effective methodologies are required for extracting hidden patterns from the data. This Programme focusses more on algorithmic aspects of AI and Machine Learning where students study various statistical and machine learning algorithms, neural network architectures, methods to build ML stack, and required technologies for building and hosting ML models. The courses in this Minor degree designed to introduce the students to core skills such as foundations of Artificial Intelligence, Machine learning, Feature Engineering for ML, Data Analytics and Deep learning architectures and its applications.

Key Features: This Minor degree covers a spectrum of courses ranging from foundations to modern techniques of AI and Machine Learning, Feature Engineering for ML , Data Analytics and Deep Learning & its applicationsCareer Prospects: The undergraduates of this Minor degree can aspire for portfolios where they need to build and execute business intelligent tasks like, Machine Learning Engineer, Data Scientist, Data Engineer, ML Architect, MLOps Engineer and etc. Students can also purse multi-disciplinary research-oriented studies at eminent institutes.

Artificial Intelligence & Machine Learning							
No	**Course Code**	**Course**	**POs**	**Contact Hours**			
				L	**T***	**P**	**C**
1	19CSM11	Fundamentals of AI & Machine Learning	1,12	4	-	-	4
2	19CSM12	Feature Engineering for Machine Learning	1,2,3	4	-	-	4
3	19CSM13	Exploratory Data Analytics	1,4	4	-	-	4
4	19CSM14	Deep learning	1,2, 4	4	-	-	4

Stream II (Cyber Security)

Preamble: This course aims at providing skills to all core engineering students to enhance their employability skills with respect to security domain. The prime objective of this Programme is to develop students to excel in Cyber Security specific areas by exposing them to understand information security, network security, web security, forensics, cryptography, secure protocols, authentication and scientific principles to devise solutions for societal and business problems. As the cyber security domain expands and develops further, there is a lot of demand for cyber security professionals in every organization due to the prior importance of data security. This course helps the students implement technical strategies, tools, IT Infrastructure and techniques to secure data and information for the organization. The course enlightens the students to analyze and monitor the potential threats and attacks, devising security architecture and implement the security solutions. Also, the students will gain the knowledge towards the information security from national, legal perspective and security in cloud computing architecture in depth.

Key Features: This Minor degree covers a spectrum of courses ranging from foundations to modern techniques of Cyber Security i.e. Fundamentals of security, Management of Information Security, Cyber Security and Cloud Security

Career Prospects: The undergraduates of this Minor degree can aspire for portfolios where they need to build and execute business intelligent tasks, like, Security Analyst, Security Engineer, Security Architect, Security Software Developer, Cryptographer, Cyber Security Consultant, Computer forensics , Penetration tester, Security code auditor and Security Administrator.

Cyber Security							
No	**Course Code**	**Course**	**POs**	**Contact Hours**			
				L	**T***	**P**	**C**
1	19CSM21	Fundamentals of Security	1,2	4	-	-	4
2	19CSM22	Management of Information Security	3,6,7	4	-	-	4
3	19CSM23	Cyber Security	1,3,4	4	-	-	4
4	19CSM24	Cloud Security	2,3	4	-	-	4

Stream III (Data Science & Analytics)

Preamble: B.Tech. – Minors in Data Science and Analytics focuses on integrating AI and Data Analytics to all core engineering students to enhance their employability skills. The prime objective of this minor degree is to develop students to excel in Data Science specific areas by exposing them to understand mathematical and statistical models with engineering and scientific principles to devise solutions for societal and business problems. As the business world witnesses the power of data-driven decision making, there is a lot of demand for the workforce with data modelling and analytics skills. The curriculum of this Programme is designed to introduce the students to data-oriented skills like programming languages, data structures and algorithms for data science, data analytics and predictive analytics frameworks for intelligent decision making etc.

Key Features: This Programme covers a spectrum of courses ranging from foundations to modern techniques of Data Science with strong emphasis on Data Analytics i.e. Fundamentals of Data Science, Data Cleaning, Data Engineering, Text Analytics, Social Networks Analytics

Career Prospects: The undergraduates of this degree can aspire for portfolios where they need to build and execute business intelligent tasks like, Data Scientists, Data Engineer, Data Warehouse Architect, Business Intelligent Analysts, Big Data Architects etc. Students can purse multidisciplinary research-oriented studies at eminent institutes.

No	**Course Code**	**Course**	**POs**	**Contact Hours**			
				L	**T***	**P**	**C**
1	19CSM31	Data Cleaning	2,3,4	4	-	-	4
2	19CSM32	Data Engineering	1,2,3,4	4	-	-	4
3	19CSM33	Text Analytics	1,2,4	4	-	-	4
4	19CSM34	Social Network and Semantic Analysis	2, 4	4	-	-	4

Stream IV (Computer Systems Programming)

Preamble: B.Tech. – Minors in Computer Systems Programming helps the non CSE and IT students to understand the fundamentals of some of the core subjects of Computer Science. It enhances the coding skills in programming languages such as C and Python. It also introduces the concepts in Data Structures & Algorithms, Database Management Systems, Computer Networks and finally Operating Systems which are key components in Computer System Programming. In effect, by undergoing this Minors in B. Tech, the student is equipped with fundamentals of Computer System Programming, and it enhances the Placements opportunities in IT Industries. In other words the students who are not from CSE/IT can easily compete with CSE/IT students for their placements in IT industries, which is the major source of placements in Engineering.

Key Features: This Programme covers a spectrum of fundamental courses from programming languages to some core courses of Computer Science and Engineering, i.e. Programming Fundamentals (C & Python), Data Structures and Algorithms, Fundamentals of Database, Fundamentals of Computer Networks and Operating Systems.

Career Prospects: The undergraduates of this Minor degree can be easily placed in MNCs such as TCS, Wipro, CTS, HCL, Infosys etc. It also makes easier to pursue higher studies in Computer Science.

No	**Course Code**	**Course**	**POs**	**Contact Hours**			
				L	**T***	**P**	**C**
1	19CSM41	Programming Fundamentals	1,2,3	4	-	-	4
2	19CSM42	Data Structures & Algorithms	1,2,3,4	4	-	-	4
3	19CSM43	Fundamentals of Databases	1,4	4	-	-	4
4	19CSM44	Fundamentals of Computer Networks & Operating Systems	1,2,3	4	-	-	4

19CSM11 Fundamentals of Artificial Intelligence and Machine Learning

4 0 0 4

Course Outcomes

1. Illustrate the scope of Artificial Intelligence in the real world
2. Demonstrate various machine learning algorithms and its preliminaries
3. Summarize and learn various supervised learning algorithms
4. Describe and apply the concepts of classification and regression
5. Summarize and learn various unsupervised learning algorithms
6. Demonstrate and resolve complex clusters using ML Algorithms

CO-PO Mapping:

COs	PO1	PO12
1	3	2
2	3	2
3	1	3
4	1	2
5	1	3
6	1	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit -I: **14 Hours**

Artificial Intelligence Foundation to AI, Problem Solving- State Space Search, Constraint Satisfaction Problems, AI Problems and Agents, Expert Systems – Rule based system, Model & Hybrid Based System. Reasoning in uncertain environment. Math for Machine Learning- Linear Algebra, Multi-Variable Calculus and Vectors
AI Models and Types AI Bots, Applications of AI, Applied AI

Unit -II: **15 Hours**

Machine Learning Foundation for Machine Learning – Types of Machine Learning, Machine Learning Process, Preliminaries of Machine Learning, Data Pre-processing- Importing Libraries, Importing Datasets, Missing Data and Dependent Variables, Feature Selection, Machine Learning Applications.
Rules of Probability, Bayes Theorem, Bias, Variance and Co-variance.

Unit -III: **16 Hours**

Supervised Learning Classification- Naïve Bayes, Support Vector Machines, Extension to SVM, K-Nearest Neighbours. Decision Tree- Classification and Regression Tree, Linear Regression and Logistic Regression
Margins and Vectors, Continuous and Discrete variables

Unit -IV: **15 Hours**

Unsupervised Learning Clustering- Iterative Distance based Clustering, Association Rule Learning, K- Means Clustering and Hierarchical Clustering, Measure of Quality Clustering.
Similarity and Distance Measures, Gaussian and Normal Deviation

Total: 60 Hours

Text Book (s)

1. Russel and Norvig, Artificial Intelligence A modern Approach, 4th Edition, Pearson Education 2021
2. Stephen Marsland- Machine Learning – An Algorithmic Perspective – 2nd Edition – Chap Man & Hall CRC Press, 2015
3. Raschka, Sebastian and Mirjalili, Vahid, Python Machine Learning, 3rd Edition, Packt Publishing., 2019
4. Tom M. Mitchell, —Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.
5.

Reference (s)

1. E. Rich K. Knight and B.Nair – Artificial Intelligence– Third Edition – Tata McGraw Hill, 2017
2. Sebastian Rascchka, Vahid Mirjaalli -- Python Machine Learning – Third Edition –Packt, 2019

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam [5] (%)
Remember	25	20	-
Understand	35	40	30
Apply	40	40	40
Analyze	-	-	30
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Sample Question (s)

Remember

1. Define entropy.
2. What is pruning?
3. Define hypothesis

Understand

1. What is Machine Learning?
2. How KNN is different from K- means Clustering?
3. Explain confusion matrix with an example

Apply

1. Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set.
2. Apply *k*-Nearest Neighbour algorithm to classify the iris data set and print both correct and wrong predictions in it.
3. Write a program to demonstrate the working of the decision tree based ID3 algorithm.
4. Assuming a set of documents that need to be classified, use the naïve Bayesian Classifier model to perform this task.

Analyze

1. Implement the non-parametric locally weighted regression algorithm in order to fit data points.
2. Select appropriate data set for your experiment and draw the relevant graphs
3. Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using *k*-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program

Open Book Question(s)

1. The issue of the possibility of self-improvement of the system of artificial intelligence, which gained autonomy, got out of human control and by downloading data from the Internet it is becoming an increasingly powerful and threatening system for humans since the 1990s in science fiction literature and film. With each subsequent year, the technology of artificial intelligence is developed and improved.
   a) Justify the detailed steps involved for getting the above scenario w.r.t. human brain and computer vision.
   b) Is it possible now or in the future to create an artificial intelligence that will draw knowledge directly from the analysis of Internet resources and learn this knowledge?
2. A large room is filled with mousetraps, arranged in a grid. Each mousetrap is loaded with two ping-pong balls, carefully placed so that when the mousetrap goes off they will be flung, land on other mousetraps and set them off. The walls of the room are sticky, so any balls that hit the walls of the room are effectively absorbed. Every mousetrap that gets hit sends the two ping-pong balls in the same way: their movement is determined by a X and Y displacement relative to the launching mousetrap. You then decide to launch a single ping-pong ball into the room. It hits a mousetrap, setting it off, and launching its two balls. These two balls then set off two more mousetraps, and now four balls fly off... When the dust settles, many of the mousetraps have been set off, but some have been missed by all the flying balls.
   a) Identify the attributes and the mousetraps which are involved in this process
   b) Justify and predict the common set offs in the process and identify which learning suits the above scenario.

19CSM02 Feature Engineering in Machine Learning

4 0 0 4

Course Outcomes

1. Outline the fundamental concepts of feature engineering
2. Develop models that Deals with missing values
3. Develop models that Deals outliers using various techniques
4. Explain various types of Feature Selection Techniques
5. Apply various feature transformation techniques for the dimensionality reduction
6. Choose suitable algorithm for feature extraction from Text and Images.

CO–PO Mapping

CO	PO1	PO2	PO3
1	3	2	2
2	2	2	3
3	2	2	3
4	2	2	3
5	2	2	3
6	2	2	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit 1: **15 Hours**

Introduction to Feature Engineering: Why feature engineering, feature understanding, feature improvement, feature selection, feature construction, feature transformation, feature learning, feature extraction., Evaluation Metrics, cross validation, ML Cycle, Feature Engineering Cycle, Exploratory data analysis, Error analysis,

Unit 2: **16 Hours**

Data Preparation: Problems with data, types of data features, standardizing and Normalizing Features using different techniques, Discretization and Binning, Descriptive Features, Dealing with missing values and outliers using various techniques, Imputing categorical features, Encoding categorical variables.

Unit 3: **13 Hours**

Feature Selection: Measuring correlations, types of feature selection, Feature selection using various types of filters, wrappers and embedded techniques, feature transformation: dimensional reduction, PCA, LDA

Unit 4: **16 Hours**

Feature Extraction: Representing images as matrices and image processing techniques, feature detection and extraction from images, feature extraction from text: Bag of words, count vectorizer, TF-IDF vectorizer; tokenization and visualizing frequency distributions, creating feature vectors from text data, images, extracting features from images, detecting key points and descriptors from to perform image matching, extracting text from images using OCR, extracting features from dates, working with geospatial features

Text Books:

1. Sinan Ozdemir and Divya Susarla, Feature Engineering Made Easy, Packt Publishing Ltd.,2018
2. Pablo Duboue, The Art of Feature Engineering, Cambridge University Press,2020
3. Alice Zheng & Amanda Casari, Feature Engineering for Machine Learning, O'Reilly Media, Inc,2018

Reference Books:

1. Guozhu Dong and Huan Liu, Feature Engineering For Machine Learning And Data Analytics, CRC Press,2018
2. Soledad Galli, Python Feature Engineering Cookbook, Packt Publishing Ltd,2020
3. Max Kuhn, Kjell Johnson, Feature Engineering and Selection, CRC Press,2020.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam [5] (%)
Remember	25	20	-
Understand	35	40	30
Apply	40	40	40
Analyze	-	-	30
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

19CSM13 Exploratory Data Analysis

4 0 0 4

Course Outcomes

1. Explain the Data Analysis Fundamentals
2. Illustrate various data Visual aids
3. Categorise different data transformation and descriptive statistics
4. Identify different Correlation and Inferences from statistical tests
5. Make use of the concept Hypothesis Testing
6. Classify different Multivariate Analysis techniques

CO–PO Mapping

CO	PO1	PO4
1	3	2
2	3	3
3	3	2
4	2	3
5	3	3
6	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Exploratory Data Analysis Fundamentals **15 Hours**

Understanding data science, significance of EDA, steps in EDA. types of analysis (univariate, bivariate, multivariate). Making sense of data: Numerical data-Discrete&continuous data,categorical data, Measurment scales-Nominal, Ordinal,Interval, Ratio. Comparing EDA with classical and Bayesian analysis, getting started with EDA: Numpy, Pandas,Scipy, and Matplotlib.

Grouping data: groupby mechanics, rearranging, reshaping data structures, data aggregation methods, and cross-tabulation methods.

Unit II

Visual aids for EDA **16 Hours**

Line chart, Bar charts,Box plot,residual plot, Scatter plot-bubble chart, scatterplot using seaborn, Area plot, stacked plot, and stem-and-leaf plot, pie chart, table chart, polar chart, histogram, lollipop chart, choosing the best chart.

Data transformation and descriptive statistics

Transformation techniques- performing data deduplication,replacing values, handling missing data, renaming axis indexes, outlier detection and filtering. Permutation and random sampling, computing indicators/dummy variables, string manipulations.

Descriptive statistics: Understanding statistics, distribution function (uniform, normal, exponential, binomial), cumulative distribution function, measure of central tendenacy, measure of dispersion (standard deviation, variance, skewness, kurtosis, percentiles, quartiles)

Unit III

Correlation and Inferences from statistical tests : **16 Hours**

Introducing correlation, covariance, Pearson's Correlation, Spearman's Rank Correlation.

Hypothesis Testing: Testing a difference in mean, testing a correlation, chi-squared tests, errors, power. Model development and evaluation with regression techniques.

Unit IV **13 Hours**

Multivariate Analysis: overview, Factor Analysis, Cluster Analysis, Discriminant analysis, EDA Case Study

Total: 60 Hours

Textbook (s)

1. Daniel J. Denis: Univariate, Bivariate, and Multivariate Statistics Using R: Quantitative Tools for Data Analysis and Data Science, Wiley,2020
2. Mukhiya Suresh Kumar Mukhiya, Ahmed Usman Ahmed: Hands-On Exploratory Data Analysis with Python: Perform EDA techniques to understand, summarize, and investigate your data, Packt, 2020
3. Downey, Allen. Think stats: exploratory data analysis. " O'Reilly Media, Inc.", 2014.
4. Neil H. Spencer: Essentials of Multivariate Data Analysis, CRC Press,2014

Reference (s)

1. Wes McKinney : Python for Data Analysis 2nd Edition,Wiley,2013.
2. Glenn J. Myatt, Wayne P. Johnson: Making Sense of Data I: A Practical Guide to Exploratory Data Analysis and Data Mining, 2nd Edition, Wiley, 2014.

3. Wendy L. MartinezAngel R. MartinezJeffrey L. Solka: Exploratory Data Analysis with MATLAB, 2nd Edition,CRC Press,2011.
4. Radhika Datar, Harish Garg : Hands-On Exploratory Data Analysis with R , Packt,2019.
5. Joseph F Hair, Barry J. Babin, Rolph E. Anderson, William C. Black: Multivariate Data Analysis Cengage, 2018.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	50	40	--
Understand	30	40	--
Apply	20	20	50
Analyze	--	--	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Sample Question (S)

Remember

1. What is data science.
2. Define purpose of different data visualization aids
3. List any two steps involved in EDA.

Understand

1. Explain different data representation
2. Explain the role of various data grouping methods
3. Explain purpose of hypothesis testing in detail

Apply

1. Apply various visual aids to identify behaviour of data
2. Make use of Multivariate Analysis methods for data analysis
3. Examine data with various distribution function

Analyze

1. Compare and contrast various data grouping methods.
2. Distinguish various methods to address problems with dummy variables
3. Examine various string handling methods

Evaluate

1. Evaluate the statistics of a given dataset
2. Justify the importance of data skewness
3. Measure data dispersion methods on a dataset

Open Book Exam Questions

Question 1:

Perform below analysis on a house price prediction dataset.

a. Univariate Analysis
    i. Analysis of a numerical feature
    ii. Analysis of a categorical feature
b. Bivariate Analysis
    i. Relationship of a numerical feature with another numerical feature
    ii. Relationship of a numerical feature with a categorical feature

Question 2:

Perform below analysis on weather prediction dataset.

a. Correlation Analysis
    i. Correlation Heat Map
    ii. Zoomed Heat Map
b. Investgation of missing values
    i. What's missing? to what extent?
    ii. Visualizing missing values in a dataframe.

19CSM21 Fundamentals of Security

4 0 0 4

Course Outcomes

1. Explain the fundamental concepts of information security
2. Illustrate the use of cryptography and its functions
3. Identify different types of Cryptography methods
4. List out different types of Security Threats and Vulnerability
5. Make use of the concept of network security
6. Outline transport and network layer security

CO–PO Mapping

CO	PO1	PO2
1	3	1
2	3	3
3	1	2
4	2	3
5	3	2
6	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Security concepts **15 Hours**

What is security, Data vs Information vs Cyber security, Goals of Information Security, Computer Security Concepts, threats, attacks and assets, security functional requirements, fundamental security design principles, computer security strategy, networking, benefits of networking.

Unit II

Cryptography **15 Hours**

Introduction to cryptography, Cryptographic functions(Authentication, Nonrepudiation, confidentiality, integrity), Cryptanalysis. Types of Cryptography: Symmetric key and Asymmetric Key Cryptography, Message Integrity, Encryption and Decryption Techniques, Digital Signatures, Email Standards: MIME and PGP

Unit III

Security Threats and Vulnerabilities **15 Hours**

Overview of Security Threats and Vulnerability: Types of attacks on Confidentiality, Integrity and Availability, Types of malware, Buffer Overflow

Security Counter- Measures: Passwords, Access Control (Authenticating users, Handling User Access), Antivirus Software, Firewalls, Intrusion Detection Systems and IPS.

Unit IV

Network Security **15 Hours**

TCP/IP Suite, DNS, MITM, Attacks on TCP and DNS, VPN, Application layer security (PGP, S/MIME), Transport layer security (TLS), Network layer security (IPSec) Anonymous networks: Tor,I2P.

Total: 60 Hours

Textbook (s)

1. William Stallings, Lawrie Brown, Computer Security Principle sand Practice,3rd Edition,2015
2. Nihad A. Hassan, Rami Hijazi, Digital Privacy and Security Using Windows: A Practical Guide, Apress, 2017

Reference (s)

1. Michael T. Goodrich and Roberto Tamassia, Introduction to Computer Security, Addison Wesley, 2011.
2. Ross Anderson, Security Engineering: A Guide to Building Dependable Distributed, 3rd Edition, John Wiley & Sons Inc, 2021.
3. Kozierok, Charles M. The TCP/IP guide: a comprehensive, illustrated Internet protocols reference, 2005
4. Harris, Shon, "CISSP all-in-one exam guide." Sixth edition (2013).

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	50	40	--
Understand	30	40	--
Apply	20	20	50
Analyze	--	--	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

SAMPLE QUESTION (S)

Remember

1. What is security?
2. Define cyber security.
3. List any four computer security concepts.
4. Define threat.
5. Define intrusion.

Understand

1. Explain Cryptographic functions.
2. Explain the role of Symmetric key cryptography.
3. Illustrate hashing techniques.
4. Outline the purpose of digital signatures.

Apply

1. RSA algorithm with example.
2. Digital signature.
3. Build a firewall mechanism to protect laptop.

Analyze

1. Compare and contrast RSA and ECC.
2. Distinguish differences between Symmetric and Asymmetric key cryptography.
3. Examine the key sharing techniques in both Symmetric and Asymmetric key cryptography techniques

Evaluate

1. Justify the ECC is best public key cryptosystem than other public key approaches.
2. Explain the importance of IPSec protocol.
3. Explain the importance of I2P protocol

Open Book Exam Questions

Question 1:

In a public-key system using RSA, you intercept the ciphertext C=10 sent to a user whose public key is e=5, and n=35. What is the plaintext M? and Perform encryption and decryption using the RSA algorithm for the following: 1. P=3; q=11, e=7; M=5. 2. P=17; q=31, e=7; M=2.

Question 2:

Suppose we have a set of blocks encoded with the RSA algorithm and we don't have the private key. Assume n=pq, e is the public key. Suppose also someone tells us they know one of the plaintext blocks has a common factor with n. Does this help us in any way?

19CSM22 Management of Information Security

4 0 0 4

Course Outcomes:

1. Explain the basic requirement of managing security
2. Outline the strategies of planning of security system
3. Define the Security policies.
4. Develop and implement the security programs in an organization
5. Identify a proper framework of security management
6. Define the risk management and ethics of the security management for an organization.

COs–POs Mapping

COs	PO3	PO6	PO7
1	3	1	
2	3	2	3
3	2	2	
4	3	1	2
5	1	1	1
6	1	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

UNIT-1 **16 Hours**

Introduction to ISMS: what is Security and management definition, Principles of information security management; Project management, applying project management to security; Project management tools.

Planning for Security*:* Introduction, the role of planning; Precursors to planning; Strategic planning; Information security governance; Planning for information security implementation.

UNIT-2 **14 Hours**

Planning for contingencies: Introduction, Fundamentals and Components of contingency planning. **Information Security Policy:** I*ntro*duction, Why policy? EISP; ISSP, SSSP, Guidelines for effective policy.

UNIT-3 **16 Hours**

Developing the Security Program: Organizing for security: Placing for information security within an organization, Components of the security program; Information security roles and titles; Implementing Security Education, Training and Awareness Programs.

Security Management Models: Blueprints, Frameworks, and Security Models**,** Access Control Models, Security Architecture, and management Models.

UNIT-4 **14 Hours**

Risk-Management: Risk management, Identification and assessment, Documenting the Results of Risk Assessment*;* Risk control strategies, managing risk; Feasibility and cost benefit analysis, Recommended risk control practices.

Laws and Ethics: InfoSec and the Law, Ethics in InfoSec, Professional Organizations and their Codes of Ethics, Organizational Liability and the Need for Counsel, Managing Investigations in the Organization.

Total: 60 Hours

Text Book:

1. Management of Information Security, Fourth Edition, Michael E. Whitman and Herbert J. Mattord, Cengage Learning.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	40	40	--
Understand	50	40	--
Apply	10	20	50
Analyze	--	--	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

19CSM23 Cyber Security

4 0 0 4

Course Outcomes

1. Explain the fundamental concepts of Cyber security
2. Demonstrate the web security and different attacks
3. Identify different network scanning and security measures
4. List out different types of Intrusion detection.
5. Model different types of Intrusion prevention systems
6. Outline different cybercrimes, IT laws and acts.

CO–PO Mapping

CO	PO1	PO3	PO4
1	3	3	1
2	3	3	1
3	1	2	3
4	3	1	1
5	1	3	3
6	1	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Introduction to Cyber Security **14 Hours**

What is Cyber Security, its need, cyber-threats, Cyber Warfare-Cyber Crime-Cyber Terrorism-Cyber Espionage, Career Growth, Statistics, Inferences, Need for a Comprehensive Cyber Security Policy, Classification of Cyber Crimes, kinds of cybercrimes, Reasons for Cyber Crimes, Cyber Security Tools : Nmap, Metasploit, wireshark, tcpdump, snort.

Unit II

Web security **15 Hours**

Same origin Policy, Cross Origin Resource Sharing, DDOS, SQL Injection, XSS, Homograph, Generating and storing session tokens.

Networking Scanning & Security Measures: Packet Sniffing and spoofing, Network scanning types, port scanning & its tools, and Network Architecture

Security Measures : IPtables(firewalls) , Webservers (Nmap & Metasploit for securing webservers), Cyber Threats and Attacks (Malware, DOS, MITM, Social engineering attacks, Spoofing, Phishing)

Unit III

Intrusion Detection System **15 Hours**

Intruders, Intrusion Detection, Analysis Approaches, Network-Based IDS, Host-Based IDS, signature based IDS, anomaly based IDS, advantages and disadvantages of NIDS and HIDS

Intrusion Detection Tools, snort architecture, snort rules, case studies of intrusion detection systems, Intrusion detection exchange format.

Honeypots, different types of honeypots, benefits and dangers of honeypots

Unit IV

Cyber Laws and Digital Forensics **16 Hours**

Digital Forensics: Introduction to Digital Forensics, historical background of digital forensics, Forensic Software, and Hardware, need for computer forensics science, special tools and techniques digital forensic life cycle, challenges in digital forensic.

Law Perspective: Introduction to the Legal Perspectives of Cybercrimes and Cybersecurity, Cybercrime and the Legal Landscape around the World, Why Do We Need Cyber laws, The Indian IT Act, Cybercrime Scenario in India, Digital Signatures and the Indian IT Act.

Total: 60 Hours

Textbook (s)

1. Wenliang Du, Computer & Internet Security: A Hands-on Approach, (2019)
2. William Stallings, Lawrie Brown, Computer Security Principle sand Practice,3rd Edition,2015

3. Sunit Belapure and Nina Godbole, Cyber Security: Understanding Cyber Crimes, Computer Forensics And Legal Perspectives, Wiley India Pvt. Ltd, 2011.
4. Nelson Phillips and Enfinger Steuart, "Computer Forensics and Investigations", Cengage Learning, New Delhi

Reference (s)

1. Pande, Jeetendra. "Introduction to Cyber Security.", (2017)
2. Pavan Duggal, Cyber frauds, cybercrimes & law in India.
3. Ali A. Ghorbani, Network intrusion detection and prevention concepts and techniques, Springer, 2010
4. Roberto Di Pietro, Luigi V. Mancini (2008), Intrusion Detection System, Springer
5. Dafydd Stuttard and Marcus Pinto. The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws, Wiley Publication

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	50	40	--
Understand	30	40	40
Apply	20	20	40
Analyze	--	--	20
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	--

SAMPLE QUESTION (S)

Remember

1. What is cyber security?
2. Define security policy.
3. List classification in cyber security.
4. Define network scanning.
5. What is digital forensics?

Understand

1. Explain security policy for password protection.
2. Explain reasons for cybercrime.
3. Outline SQL injection attack.
4. Classify different approaches for packet filtering using firewall.
5. Explain IP Spoofing.

Apply

1. Apply IPS methods to prevent introduter.
2. Apply snort rules to detect intrusion
3. Identify open ports in a network using namp.
4. Plan to filter unauthorized packets using iptables
5. Build host based IPS.

Analyze

1. Compare and contrast iptables and snort.
2. Compare and contrast different tools to address DOS.
3. Examine different post scanning methods.
4. Distinguish nmap and metasploit.
5. Compare different tools related to digital forensics

Open Book Exam Questions
Question 1:

	Source Address	Source Port	Dest Address	Dest Port	Action
1	Any	Any	192.168.1.0	> 1023	Allow
2	192.168.1.1	Any	Any	Any	Deny
3	Any	Any	192.168.1.1	Any	Deny
4	192.168.1.0	Any	Any	Any	Allow
5	Any	Any	192.168.1.2	SMTP	Allow
6	Any	Any	192.168.1.3	HTTP	Allow
7	Any	Any	Any	Any	Deny

The above table shows a sample of a packet filter firewall ruleset for an imaginary network of IP address that range from 192.168.1.0 to 192.168.1.254. Describe the effect of each rule.

Question 2:
Perform following activities using nmap tool:

a. Write an nmap command to check/find list of open ports for “gmrit.org” website.
b. Nmap to reveal open services and ports by IP address as well as by domain name(Note: IP number is of your choice).
c. Nmap command to scan multiple hosts at once.
d. Nmap command to find OS information of a host(host IP address is of your choice).
e. Nmap command to check firewall settings of a host(host IP address is of your choice).

19CSM31 Data Cleaning

4 0 0 4

Course Outcomes:

1. Explain workflow of data cleaning
2. Compare various Outlier Detection methods
3. Illustrate various data Deduplication techniques
4. Utilize ETL tools for performing Data Transformation
5. Choose an appropriate normalization and visualization techniques for the given data
6. Make use of data cleaning in Machine Learning applications

COs–POs Mapping

COs	PO2	PO3	PO4
1	3	1	1
2	3	1	2
3	3	3	3
4	3	3	3
5	3	3	3
6	3	2	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit 1: **15 Hours**

Introduction, Data Cleaning Workflow, Outlier Detection: Statistics-Based Outlier Detection, Distance-Based Outlier Detection, Model-Based Outlier Detection, Outlier Detection in High-Dimensional Data.

Unit 2: **16 Hours**

Data Deduplication: Similarity Metrics, Predicting Duplicate Pairs, Clustering, Blocking for Deduplication, Distributed Data Deduplication, Record Fusion and Entity Consolidation, Human-Involved Data Deduplication, Data Deduplication Tools.

Unit 3: **16 Hours**

Data Transformation: Syntactic Data Transformations, Semantic Data Transformations, ETL Tools. Data Cleanup: Normalizing and Standardizing Your Data, Data Formatting, Visualization of data.

Uni4: **13 Hours**

Machine Learning and Probabilistic Data Cleaning: ML for Data Deduplication, ML for Data Repair, Data Cleaning for Analytics and Machine Learning.

Total: 60 Hours

Textbooks:

1. Ihab F. Ilyas and Xu Chu, Data Cleaning, ACM, 2019
2. Jacqueline Kazil & Katharine Jarmul, Data Wrangling with Python, O'Reilly Media, Inc, 2016.

References:

1. Tye Rattenbury, Joseph M. Hellerstein, Jeffrey Heer, Sean Kandel, Connor Carreras, Principles of Data Wrangling, O'Reilly Media, Inc, 2017

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	40	40	--
Understand	50	40	--
Apply	10	20	50
Analyze	--	--	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

19CSM32 Data Engineering

4 0 0 4

Course Outcomes

1. Explain the stages of KDD process and detailed architecture of Data Warehouse and data preprocessing
2. Discover and measure interesting patterns from different kinds of databases
3. Use association rule mining algorithms to generate association rules
4. Select an appropriate classification technique for a given dataset
5. Choose a clustering technique for a given dataset
6. Demonstrate capacity to perform a self-directed piece of practical work that requires the application of data mining techniques

COs–POs Mapping

COs	PO1	PO2	PO3	PO4
1	2	3	1	1
2	3	3	1	2
3	2	3	3	3
4	2	3	3	3
5	2	3	3	3
6	2	3	2	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I **15 Hours**

Introduction to Data Mining and Warehousing

Overview of Data Warehouse-Data Warehouse Architecture-Introduction to Data Mining-Basic Data Mining Tasks Data Mining Issues-Data Mining Metrics-Different sources of Data Mining-Data Mining and KDD-Types of Data, Data Pre-processing-Statistical Perspective on Data Mining-Similarity Measures-Examples of Proximity Measures Issues in Proximity Calculations-Selection of the Right Proximity Measure

Unit II **16 Hours**

Mining Association Rules in Large Databases

Association Rule Mining-Mining Single-Dimensional Boolean Association Rules from Transactional Databases-Mining Multilevel Association Rules from Transaction Databases-Mining Multidimensional Association Rules from Data sources-From Association Mining to Correlation Analysis-Constraint-Based Association Mining

Unit III **13 Hours**

Classification of Data

Preliminaries-General Approach to Solving Classification Problem-Decision Tree Induction-Rule-based ClassifierNearest-Neighbor Classifiers-Bayesian Classifiers-Artificial Neural Network

Unit IV **16 Hours**

Cluster analysis

Cluster analysis – types of clustering – Types of clusters - K-means-Agglomerative Hierarchical Clustering– DBSCAN-Prototype-based Clustering-Cluster Evaluation-Characteristics of Data, Clusters and clustering algorithms – Prototype clustering – Density based clustering

Total: 60 Hours

Textbook (s)

1. Pang, Ning Tan, Michael Steinbach, Vipin Kumar Introduction to Data Mining, 1st Edition, Pearson Addison Wesley, 2005
2. Jiawei Han & Micheline Kamber, Data Mining Concepts and Techniques, 2nd Edition, Morgan Kaufmann, 2006

Reference (s)

1. Margaret H Dunham, Data Mining Introductory and advanced topics, 2nd Edition, Pearson Education, 2004
2. Arun K Pujari, Data Mining Techniques, 2nd Edition, University Press, 1999.
3. Ian H. Witten, Eibe Frank, Mark A. Hall, Data Mining:Practical Machine Learning Tools and Techniques,3rd Edition, Morgan Kaufmann Publishers, 2011

Internal Assessment Pattern

Cognitive Level	Internal Test 1 (%)	Internal Test 2 (%)	Open Book Examination (%)
Remember	35	15	--
Understand	30	25	--
Apply	20	30	50
Analyze	15	30	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Sample Question (S)

Remember

1. What are the steps in the data mining process?
2. What is Descriptive and predictive data mining?
3. What is Data Generalization?
4. What is clustering?
5. Define Spatial Databases.

Understand

1. What are the requirements of clustering?
2. How is association rules mined from large databases?
3. What is the classification of association rules based on various criteria?
4. Explain the various OLAP operations.
5. Explain data reduction
6. Explain Data mining Primitives
7. Explain the data mining functionalities

Apply

1. Find some of the data mining applications
2. Show the various social impacts of data mining?
3. Demonstrate the different types of data repositories on which mining can be performed
4. Choose some specific application-oriented databases.

Analyze

1. Identify the different types of data repositories on which mining can be performed
2. Compare the parametric methods and non-parametric methods of reduction
3. Differentiate the types of data in cluster analysis.
4. Justify Additional themes in data mining
5. Criticize over the data quality is so important in a data warehouse environment

19CSM33 Text Analytics

4 0 0 4

Course Outcomes

1. Explain the basics of Natural languages, text corpora
2. Explain concepts related to Natural Language Processing
3. Explain the processing of text through text tokenization
4. Illustrate the concepts of text syntax and structure
5. Understand and Apply Text classification algorithms on sample data
6. Outline the process of feature extraction

CO–PO Mapping

CO	PO1	PO2	PO4
1	3	2	2
2	3	2	3
3	3	2	2
4	2	2	3
5	3	2	3
6	3	2	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I **15 Hours**

Introduction to Natural Language Basics

Natural Language: What Is Natural Language? The Philosophy of Language, Language, Acquisition and Usage. Linguistics, **Language Syntax and Structure:** Words, Phrases, Clauses, Grammer, Word Order Typology, **Language Semantics:** Lexical Semantic Relations, Semantic Networks and Models, Representation of Semantics, **Text Corpora:** Corpora Annotation and Utilities, Popular Corpora, Accessing Text Corpora,

Natural Language Processing: Machine Translation, Speech Recognition Systems, Question Answering Systems, Contextual Recognition and Resolution, Text Summarization, Text Categorization, Text Analytics.

Unit II **15 Hours**

Processing and Understanding Text

Text Tokenization: Sentence Tokenization, Word Tokenization.

Text Normalization: Cleaning Text, Tokenizing Text, Removing Special Characters, Expanding Contractions, Case Conversions, Removing Stopwords, Correcting Words, Stemming, Lemmatization

Understanding Text Syntax and Structure: Installing Necessary Dependencies, Important Machine Learning Concepts, Parts of Speech (POS) Tagging, Shallow Parsing, Dependency-based Parsing, Constituency-based Parsing

Unit III **15 Hours**

Text Classification: What Is Text Classification? Automated Text Classification, Text Classification Blueprint, Text Normalization, Feature Extraction, Bag of Words Model, TF-IDF Model, Advanced Word Vectorization Models

Classification Algorithms: Multinomial Naïve Bayes, Support Vector Machines; Evaluating Classification Models, Building a Multi-Class Classification System, Applications and Uses.

Unit IV **15 Hours**

Text Summarization: Text Summarization and Information Extraction , Important Concepts: Documents , Text Normalization, Feature Extraction , Feature Matrix ,Singular Value Decomposition. Text Normalization, Feature Extraction, Key phrase Extraction: Collocations , Weighted Tag–Based Phrase Extraction.

Topic Modeling: Latent Semantic Indexing, Latent Dirichlet Allocation, Non-negative Matrix Factorization, Extracting Topics from Product Reviews, **Automated Document Summarization**: Latent Semantic Analysis, Text Rank, Summarizing a Product Description.

Total: 60 Hours

Textbook (s)

1. Dipanjan Sarkar, Text Analytics with Python, A Practical Real-World Approach to Gaining Actionable Insights from Your Data,, by Apress, 2016.

Reference (s)

1. Murugan Anandarajan Chelsey Hill Thomas Nolan, Practical Text Analytics, Maximizing the Value of Text Data, by Springer, Volume 2, 2019.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	40	40	--
Understand	50	40	--
Apply	10	20	50
Analyze	--	--	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

19CSM41 Programming Fundamentals

4 0 0 4

Course Outcome(s)

1. Explain and illustrate the aspects of the problem-solving using algorithms and flowcharts
2. Demonstrate the conditional, iterative statements, arrays and pointers to write programs
3. Illustrate and utilize the concepts of structures, unions, strings and functions
4. Demonstrate the basic Concepts of Data Structures
5. Compare and utilize the concepts of list, tuples to write programs
6. Utilize the concepts of strings, dictionaries, and sets

COs – POs Mapping

CO	PO1	PO2	PO3
1	2	2	3
2	2	2	3
3	3	2	3
4	2	2	3
5	2	2	3
6	2	2	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

UNIT -1 **15 Hours**

History of C, Definition of algorithm, flowchart, program, syntax, compiler vs. interpreter, header files, main method, input and output, Data Types, Variables, Declaration, Keywords, Type casting, Operators. **Conditional statements:** If, if else, else if, switch, ternary. **Iterative statements:** while, do while, for. **Arrays:** Definition, one-dimensional array initialization, accessing arrays, modifying, looping arrays, nested arrays (multi–dimensional).

UNIT – 2 **15 Hours**

Functions: Definition, creation, parameters and return type, global and local scope, 4types of functions, Recursion. **Pointers:** Definition, Types of pointers and its usage. **Structures and Unions:** Definition, Declaration, Accessing. Dynamic Memory Allocations, **Strings:** Definition, Declaration, Initialization, Applications, and Built in methods.

UNIT -3 **15 Hours**

Introduction of Python**, Basics of Python:** Variables, Data types, input and output, Operators, Control statements, Functions, Default argument functions. **Python Data structures: Lists**: Initialization, Negative indexing, looping lists, appending, removing, modifying, slicing and sorting of lists, List comprehension, and nested lists. **Tuples:** List vs. Tuple, accessing, updating, unpacking and tuple methods. Immutability.

Unit – 4 **15 Hours**

Python Data structures**, Strings:** initialization, modifying, concatenation, slicing, formatting and string methods, lists with strings, **Dictionary:** definition, creation, accessing, modifying and removing elements, looping dictionaries, dictionary methods, dictionaries with list, tuples and strings, nested dictionaries. **Sets:** definition, creating, union, intersection, difference, list to sets, sets methods.

Total: 60 Hours

Text Books

1. Byron Gottfried, Programming with C, 3rd Ed., Tata McGraw Hill, 2017
2. R. G. Dromey, How to Solve it by Computer, Pearson Education India, 2008
3. Richard L. Halterman, Fundamentals of Python Programming, Southern Adventist University, 2019
4. Kenneth A. Lambert, Fundamentals of Python: First Programs, 2nd Edition, Publisher: Cengage Learning, 2018

Internal assessment pattern:

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book (%)
Remember	30	30	,,
Understand	50	40	30
Apply	20	30	40
Analyze	-	-	30
Evaluate	-	-	-
Create	-	-	-
Total (%)	100	100	100

Remember

1. Define Algorithm
2. List any four types of operators of C – Language
3. What are the benefits of using Python?
4. What is an Interpreted language?

Understand

1. What is Structured programming?
2. Differentiate linear and nonlinear data structures
3. List any four string handling functions
4. What are lists and tuples? What is the key difference between the two?
5. What are Dict and List comprehensions?

19CSM42 Data Structures and Algorithms

4 0 0 4

Course Outcomes

1. Understand the fundamentals for analyzing time and space complexity of algorithms
2. Describe the operations and implementation of List ADT (Understand)
3. Comprehend the operations and implementation of Stack and Queue (Understand)
4. Illustrate the applications of linear data structures (Apply)
5. Describe the operations and implementation of hash table (Understand)
6. Comprehend the operations and implementation of tree data structure (Understand)

CO–PO Mapping

CO	PO1	PO2	PO3	PO4
1	3	2	2	2
2	3	2	2	2
3	2	3	3	2
4	2	3	3	2
5	3	2	2	3
6	2	3	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Linear Data Structures – List **13 Hours**

Abstract Data Types (ADTs) – List ADT – Array-based implementation – Linked list implementation –Singly linked lists- Circularly linked lists- Doubly-linked lists – Applications of lists –Polynomial Manipulation – All operations (Insertion, Deletion, Merge, Traversal) - Searching - Linear Search – Binary Search

Unit II

Linear Data Structures – Stack and Queue **16 Hours**

Stack ADT – Array implementation – Linked list implementation – Applications of Stack – infix to postfix conversion, evaluation of postfix expression – Queue ADT – Array implementation – Linked list implementation – Application of Queue – Ticket counter

Unit III

Sorting, Hashing Techniques and Trees **15 Hours**

Sorting – Bubble Sort – Selection Sort – Insertion Sort – Shell Sort – Radix Sort – Quick Sort – Merge Sort - Hashing - Hash Functions – Separate Chaining – Open Addressing – Rehashing

Trees: Introduction, Terminology, Binary Trees, Representation of Binary Trees using arrays and linked lists, Binary tree traversals

Unit IV

Introduction to Algorithms **16 Hours**

Fundamentals of algorithmic problem solving – Analysis framework - Performance Analysis: - Space complexity, Time complexity - Growth of Functions: Asymptotic Notation- Big oh notation, Omega notation, Theta notation, little oh, little omega. Mathematical Analysis of Non-recursive algorithms – Mathematical Analysis of Recursive algorithms - Brute Force: Bubble sort – Sequential search – String Matching

Total: 60 Hours

Textbook (s)

1. Introduction to The Design and Analysis of Algorithms, 3rd Edition, Anany Levitin, Pearson Education, 2017
2. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, Pearson Education, 2002.
3. Michael Main, Walter Savitch, Data Structures and other objects using C++, 4th Edition, Addison Wesley, 2018.

Reference (s)

1. Design and Analysis of algorithms, Aho, Ullman and Hopcroft,Pearson education.
2. S. Tanenbaum, Y. Langsam and M.J. Augenstein,, Data Structures using C and C++, 2nd Edition, Pearson Education, 2015
3. R. F. Gilberg, B. A. Forouzan, Data Structures A Pseudocode Approach with C, 2nd Edition, CENGAGE Learning, 2005.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	40	40	--
Understand	40	40	--
Apply	20	20	50
Analyze	--	--	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Sample Question (S)

Remember

1. What are abstract data types?
2. List any 2 disadvantages of array.
3. Define linked list.
4. Define data structure.
5. List any 2 applications of queue.

Understand

1. Compare linked list with array.
2. Explain Bubble Sort Process with an example.
3. Demonstrate with neat diagram and algorithm to insert a node before the given key.
4. Explain Deletion process using an example binary search tree.
5. Explain why the selection sort is more efficient than the bubble sort.
6. Explain with suitable example of LL rotation after inserting a new node into an AVL tree.
7. Demonstrate the application of singly linked lists for the addition of the polynomials P_1 and P_2

Apply

1. Develop an algorithm to concatenate two single linked lists.
2. Construct a priority queue and implement all basic operations to demonstrate priority queue.
3. Build a recursive procedure to count the number of nodes in a binary tree.

Open Book Exam Questions

Apply

1. Select appropriate data structure to simulate the operations of a Music Player – Songs in music player are linked to previous and next song. you can play songs either from starting or ending of the list.
2. A bracket is considered to be any one of the following characters: (,), {, }, [, or]. Two brackets are considered to be a matched pair if the an opening bracket (i.e., (, [, or {) occurs to the left of a closing bracket (i.e.,),], or }) of the exact same type. There are three types of matched pairs of brackets: [], {},and (). A matching pair of brackets is not balanced if the set of brackets it encloses are not matched. For example, {[(])} is not balanced because the contents in between { and } are not balanced. The pair of square brackets encloses a single, unbalanced opening bracket, (, and the pair of parentheses encloses a single, unbalanced closing square bracket,]. By this logic, we say a sequence of brackets is balanced if the following conditions are met: It contains no unmatched brackets. The subset of brackets enclosed within the confines of a matched pair of brackets is also a matched pair of brackets. Given n strings of brackets, determine whether each sequence of brackets is balanced. If a string is balanced, return YES. Otherwise, return NO.
3. You are given a stack of N integers such that the first element represents the top of the stack and the last element represents the bottom of the stack. You need to pop at least one element from the stack. At any one moment, you can convert stack into a queue. The bottom of the stack represents the front of the queue. You cannot convert the queue back into a stack. Your task is to remove exactly K elements such that the sum of the K removed elements is maximized.
4. Vikas is given a bag which consists of numbers (integers) blocks, Vikas has to organize the numbers again in the same order as he has inserted it into the bag, i.e. the first number inserted into the bag by Vikas should be picked up first followed by other numbers in series. Help Vikas to complete this work in O(n) time complexity with the condition to use one extra bag to complete the work (assume that the bags are compact and is in the form of a stack structure and has the same width as that of the number blocks and is large enough to fill the bag to the top and the number taken from bag is in reverse order).

19CSM43 Fundamentals of Database Systems

4 0 0 4

Course Outcomes:

1. Explain the fundamental concepts of data base and data models
2. Illustrate the use of Relational Algebra and integrity constraints in databases
3. Design a Database using ER Modelling and SQL
4. Select normalization on database design to eliminate anomalies
5. Make use of the concept of transaction management and recovery system in databases
6. Choose ACID properties to control database transactions

CO–PO Mapping

CO	PO1	PO4
1	3	2
2	3	3
3	3	2
4	2	3
5	3	3
6	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I **15 Hours**

Introduction to DBMS and ER Model

Introduction-Database System Applications, Purpose of Database Systems, View of Data - Data Abstraction, Instances and Schemas, Data Models, Database Languages - DDL, DML, Database Architecture, Database Users and Administrators, History of Data base Systems.

Introduction to Data base design , ER diagrams, Beyond ER Design, Entities, Attributes and Entity sets, Relationships and Relationship sets, Additional features of ER Model, Conceptual Design with the ER Model, Conceptual Design for Large enterprises.

Unit II **16 Hours**

Introduction to Relational Model and Basic SQL Queries

Relational data Model and Language: Relational Data Model Concepts, Integrity Constraints, Entity Integrity, Referential Integrity, Keys Constraints, Domain Constraints, Relational Algebra, Relational Calculus, Tuple and Domain Calculus. Introduction on SQL: Characteristics of SQL, Advantage of SQL. SQl Data Type and Literals. Types of SQL Commands. SQL Operators and Their Procedure. Tables, Views and Indexes. Queries and Sub Queries.

Unit III **16 Hours**

Normalization and Transaction Management

Aggregate Functions: Insert, Update and Delete Operations, Joins, Unions, Intersection, Minus;

Data Base Design & Normalization: Functional dependencies, normal forms, first, second, third normal forms, BCNF, inclusion dependence, loss less join decompositions, normalization using FD, MVD, and JDs, alternative approaches to database design.

Unit IV **13 Hours**

Transactions and Recovery

Transaction Management - Transaction Concept - Transaction State - Implementation of Atomicity and Durability - Concurrent - Executions - Serializability - Recoverability - Implementation of Isolation - Anomalies Associated with Concurrent Schedules (RW - WR - and WW Conflicts) - Testing for serializability.

Total: 60 Hours

Textbook (s)

1. Raghurama Krishnan & Johannes Gehrke, Database Management Systems, TATA McGraw-Hill, 3rd Edition, 2003
2. Silberschatz Korth, Database System Concepts, McGraw hill, 7th Edition, 2019

Reference (s)

1. Elmasri & Navatha, Fundamentals of Database Systems, Pearson Education, 7th Edition, 2016
2. C.J.Date, An Introduction to Database Systems, Pearson Education, 8th Edition, 2006

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	50	40	--
Understand	40	50	70
Apply	10	10	30
Analyze	--	--	--
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Sample Question (S)

Remember

1. List any four applications of DBMS.
2. Define data model.
3. List any four applications for triggers.
4. Define functional dependency.
5. List the 4 properties of Transaction.

Understand

1. Explain E-R Model with suitable example.
2. Explain the role of integrity constraints in database design.
3. Illustrate the working principle of 'write a head log' protocol.
4. Differentiate 3NF and 4NF.
5. Explain the importance of Locking in DBMS.

Apply

1. When multiple transactions are being executed by the operating system in a multiprogramming environment, there are possibilities that instructions of one transaction are interleaved with some other transaction. Apply the suitable concept to overcome the problem.
2. Classify various normal forms according to their applicability.
3. Give some real-world applications of Normalization.
4. Illustrate the Commit and Rollback operations of Transaction Control.
5. Give some real-world applications for Database transactions.

Open Book Exam Questions

Question 1: Anitha has a large CD collection. Her friends like to borrow her CD's, and she has to keep track of who has what. She maintains a list of friends, identified by unique FID's and a list of CD's, identified by CID's. With each friend are the name and telephone numbers which she can call to get the CD back. With each CD is actor name and title. Whenever a friend borrows a CD, She will enter that fact into her database along with the date borrowed. Whenever the CD gets returned that fact, too, gets noted along with the date returned. Anitha wants to keep a complete history of her friends' borrowing habits so that she can ask favors of the heavy borrowers.
Draw an ER diagram to figure out the above situation and identify types of attributes and cardinality. Represent this database as a collection of 3NF relational tables.
Question 2: The relational scheme R(A, B, C, D, E, F) and set of functional dependencies AB -> D, E -> C, AF -> B. From this, find out all super keys for this relation, and which of these super keys form a key.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

AR19 MINOR COURSES

Minors for other Departments offered by Electrical and Electronics Engineering

Digital IC Design

Preamble:
This course provides an introduction to the design and implementation of VLSI circuits for complex digital systems and the focus is on CMOS technology. In this course, students will get exposure to the fundamental concepts and structures of designing digital VLSI systems that include CMOS devices and circuits, Combinational Circuit Design, Sequential circuits and design, CMOS chip layout, simulation and testing, low power techniques, design tools and methodologies, VLSI architecture & VHDL.

Prospects:
The electronics industry worldwide is rapidly approaching another revolutionary leap in the global market scenario. Semiconductor technology has crossed the quarter-micron threshold, making tens of millions of transistors available on a single chip equipped with the powerful arm of VLSI design. This imparts the electronics industry a potential to create designs of incredible densities and lightning speeds while utilizing batteries to power them. This has had a phenomenal impact on widespread applications ranging from consumer electronics, communications, and defense to just about everything. As part of Electronics India program by Govt. of India, most of the electronic products and semiconductor ICs are planning to make in India.

Placement Opportunities:
The course is designed to help you gain the essential skills to have a successful career in VLSI design industry. VLSI Physical Design Engineer to enable new Electronics graduates/post graduates or working engineers in electronic industries to the concepts used in IC Design, which involves processing, Layout, System Design Methods using Cadence tool. The course will benefit VLSI Engineers seeking lateral shift to a back end job. Engineers looking to work for Block level Physical Design Implementation, Place and Route job domains. This will take VLSI Engineers to a new level known as Physical Design Engineer. The Physical Design Engineer is responsible for converting the circuit design to a geometric representation for manufacturing the integrated circuit (IC).

19ECM11 Fundamental of VLSI Design

Course Outcomes **4 0 0 4**

1. Explain the operation and characteristics of MOS transistor
2. Interpret various MOS transistor fabrication techniques
3. Implement Boolean functions in CMOS technology and realize the same in layout diagrams
4. Summarize the effects of parasitics and scaling
5. Classify various programmable ASICs
6. Interpret different levels of testing of IC

COs – POs Mapping

COs	PO1	PO2	PO3
1	2	-	-
2	2	-	2
3	3	2	2
4	2	2	-
5	2	2	-
6	2	2	1

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I
Introduction to IC technology and Basic Electrical properties of MOS circuits

Introduction to RTL, DTL, TTL, ECL logic families, Introduction to IC technology, Basic MOS transistors, Enhancement and depletion modes of transistor action, Ids-Vds relationships, Aspects of MOS Transistor,

Threshold voltage, MOS Transistor conductance and output conductance, MOS transistor figure of merit, Pass transistors, nMOS inverter , Determination of pull up to pull down ratio for an nMOS inverter driven by another nMOS inverter and for an nMOS inverter driven through one or more pass transistors, Alternate forms of pull up, CMOS inverter, BiCMOS Inverters.

Static power dissipation, Dynamic Power dissipation in CMOS circuits

16 Hours

Unit II

IC Fabrication process and Gate level Design

MOS and CMOS Fabrication processes, Bi-CMOS Technology, comparison between CMOS & Bipolar technologies, Latch up in CMOS circuits, MOS Layers, Stick diagrams (nMOS design style), CMOS design style, Design rules, Layout diagrams of CMOS inverter, NAND & NOR gates

Realization of gates using CMOS technology, other complex gates, Switch logic (pass transistor and transmission gates) and design examples using transmission gates.

Layout diagram of 10T full adder and CMOS full adder

14 Hours

Unit III

Basic circuit concepts and Scaling of MOS Circuits

Sheet resistance , Sheet resistance concept applied to MOS transistors and inverters, Area capacitance of layers , standard unit of capacitance, some area capacitance calculations, The delay unit , inverter delays, Driving large capacitance loads, Propagation delays, wiring capacitances, Fan-in and Fan-out characteristics, Choice of layers,CMOS steady state electrical behavior, CMOS dynamic electrical behavior

Scaling of MOS Circuits, Scaling models and scaling factors, Scaling factors for device parameters, Limitations of scaling (qualitative treatment only).

Drain Induced Barrier Lowering (DIBL) effect, Sub threshold conduction

15 Hours

Unit IV

Programmable ASICs & IC testing

Introduction, FPGA Design flow, ASIC Design flow ,Types of ASICs-Full custom, standard cell based Asics, Gate array based ASICs, PLDs, FPGAs, Programmable ASICs- anti-fuse, SRAM, EPROM and EEPROM technology

Manufacturing test principles, Design for testability (DFT) - Adhoc testing, Scan design, Built in self-test (BIST).

Xilinx3000Series, FPGAarchitecture, Boundaryscan

15 Hours
Total: 60 Hours

Textbook (s)

1. Kamran eshragian, Douglas.A.Pucknell and Sholeh Eshragian, Essentials of VLSI circuits and systems,Prentice Hall of India Private Ltd, 3rd Edition, 2005
2. Weste and Eshraghian, Principles of CMOS VLSI Design, Pearson Education, 3rd Edition, 1999
3. Michael john Sebastian smith, Application specification integrated circuits, Addition Wesley,1st Edition,1997
4. John.P.Uyemura, Introduction to VLSI Circuits & Systems, John Wiley 1st Edition, 2009

Reference (s)

1. Wayne Wolf, Modern VLSI Design, Pearson Education, 3rd Edition, 1997
2. Jan M Rabaey, A. Chandrakasan, B.Nikolic, Digital Integrated Circuits, Pearson, 3rd Edition, 2008
3. Richa Jain, Amrita Rai , Principles of VLSI and CMOS Integrated Circuits, S.Chand & Co Ltd, 1st Edition, 2012
4. John F. Wakerly, Digital Design Principles & Practices, PHI/ Pearson Education Asia, 3rd Ed., 2005

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	30	30	--
Understand	40	40	--
Apply	30	30	70
Analyse	--	--	30
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Sample Question (S)

Remember

1. What are the scaling models?
2. Why switch logic is better than pass transistor logic?
3. Show that pull up to pull down ratio of an nMOS inverter driven by another nMOS inverter is 4:1
4. How the delay varies with number of inputs for different fabrication processes?
5. Show that 11 is the best test vector for AND gate if there is a SA0 fault on one node

Understand

1. Explain briefly about nMOS pass transistor
2. Compare Stick diagram and Layout
3. Explain about based design rules in detail
4. Classify possible wiring capacitances in VLSI fabrication process
5. Explain about programming technologies of SPLD and CPLDs

Apply

1. Construct CMOS inverter having pull up to pull down ratio of 1:1 if n channel sheet resistance is 10k and pchannel sheet resistance is 25k
2. Construct layout for 2-input NAND gate
3. Classify ASICs with neat sketch
4. Demonstrate your answer , If the disturbance is created at the output then there exist low resistancepath between supply rails of CMOS inverter, is that disturbance creates problem in the CMOS inverter,
5. Construct Enhancement load and depletion load nMOS inverters
   [Open Book Question]

Analyze

1. Distinguish ASICs and PLDs with examples
2. Contrast CMOS and Bipolar technologies
3. Analyse CMOS inverter with the help of transfer characteristics
4. Differentiate FPGA with Programmable ASICs
5. Justify why scaling factors are greater than unity?
   [Open Book Question]

19ECM12 Digital Design using HDL

4 0 0 4

Course Outcomes

1. Interpret the concepts of Verilog HDL constructs
2. Implement gate level Verilog HDL models for combinational and sequential circuits
3. Execute dataflow and switch level models for combinational and sequential circuits
4. Organize behavioral level Verilog HDL models for combinational and sequential circuits
5. Choose appropriate Verilog HDL constructs for RTL coding
6. Implement the combinational and sequential circuits in FPGA

COs – POs Mapping

CO	PO1	PO2	PO3
1	1	-	-
2	3	2	2
3	3	2	2
4	3	2	2
5	3	2	2
6	3	2	2

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I

Verilog Language Constructs and Gate Level Modeling

Verilog as HDL, Levels of design description, Concurrency, Simulation and Synthesis, Functional verification, System tasks, Programming Language Interface (PLI), Module, Simulation and Synthesis tools, Test benches, Keywords, Identifiers, White space characters, Comments, Numbers, Strings, Logic values, Strengths, Data types, Scalars and Vectors, Parameters, Memory, Operators, System tasks, AND gate primitive, Module structure, Other gate primitives, Tristate gates, Array of instances of primitives, Delays, Strengths and Contention Resolution, Net Types, Design of basic circuits.

Design of Flip-flops with Gate Primitives, adders

15 Hours

Unit II

Behavioral, Data Flow and Switch Level Modeling

Operations and Assignments, Functional Bifurcation, Procedural constructs: Initial, Always, Assignments with delays, Wait, Multiple always blocks Designs at Behavioral level, Blocking and Non-blocking assignments, Case statement, Simulation flow, Conditional statements and loops- if, if-else, repeat, for, while, forever, parallel blocks, force-release, Event, Continuous assignment structures, Delays and Continuous assignments, Assignment to Vectors, Operators, Basic transistor switches, CMOS switch, Bi-directional gates, Time delays with switch primitives, Instantiations with Strengths and Delays, Strength contention with Tri-reg Nets.

Behavioral level modeling of all flip-flops, 4 bit counter

15 Hours

Unit III

System Tasks, Functions and UDP Introduction, Parameters, Path delays, Module parameters, System Tasks and Functions, File based tasks andFunctions, Compiler directives, Hierarchical access, User-Defined Functions, Tasks and Primitives-Introduction, Function, Tasks, User- Defined Primitives.

Implementation of two bit multiplication using tasks and functions

15 Hours

Unit IV

Verilog HDL Models: Decoders, encoders, multiplexers and de-multiplexers, comparators, adders & subtractors, Latches and flip-flops, counters, shift register, Internal structure of ROM, Static RAM.

Design examples (using Verilog HDL) - Barrel shifter, floating point encoder

15 Hours

Total: 60 Hours

Textbook (s)

1. T.R. Padmanabhan and B. Bala Tripura Sundari, Design through Verilog HDL, Wiley-IEEE Press, 2004
2. John F. Wakerly, Digital Design Principles & Practices, PHI/ Pearson Education Asia, 3rd Edition,2005

Reference (s)

1. Stephen. Brown and ZvonkoVranesic, Fundamentals of Logic Design with Verilog, TMH, 2005

2. Michael D. Ciletti, Advanced Digital Design with Verilog HDL, PHI, 2005
3. J. Bhaskar, A Verilog Primer, BSP, 2nd Edition, 2003
4. Charles H Roth, Digital Systems Design using VHDL, Jr. Thomson Publications, 2004

Sample Question (S)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	20	20	--
Understand	55	40	--
Apply	25	40	60
Analyze	--	--	40
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. Define the Verilog Syntax for the case, for loop and if-else statements
2. List out the tri-state gate primitives with syntax
3. List out the Verilog operators
4. List out bidirectional gates with their syntax in Verilog
5. List out two system tasks with syntax
6. State the Procedural Constructs in Verilog

Understand

1. Illustrate the strengths and contention in Verilog HDL
2. Explain the following
   i) Simulation and synthesis ii) Functional verification
3. Explain the concept of concatenation of vectors with an example
4. Illustrate Verilog primitives. Explain Verilog gate level primitives with suitable example
5. Explain User-Defined Primitives with syntax. Give an example of 4-to-1 multiplexer using UDPs

Apply

1. Implement all logic gates using Verilog HDL
2. Design a nibble adder using Verilog HDL
3. Implement the half Subtractor in different levels of design description
4. Design an OR gate using multiplexer
5. Implement one bit comparator using Verilog
6. Construct the RTL design to implement digital circuit (with minimum gates and flip flops) that could control a coin operated vending machine to dispenses a candy under following conditions:
   (a) The machine accepts only Rs. 5 coin and other than Rs. 5 coin it should not accept.
   (b) It takes Rs. 15 for a piece of candy to be released from the machine
   i. Develop a state table and state diagram.
   ii. Draw the architecture in terms of control path and data path.
   iii. Construct the RTL to implement the above architecture.

[Open Book Examination Question]

Analyze

1. Compare and contrast between blocking and non-blocking assignments
2. Differentiate continuous assignment and procedural assignment statements with an example
3. Resolve the concept of contention with Tri-reg Nets in Verilog HDL
4. Compare the gate level implementation of D flip-flop and JK flip-flop
5. Compare if and while constructs in Verilog HDL
6. Integrate a simplified traffic-light controller that switches traffic lights on a crossing where a north-south (NS) street intersects an east-west (EW) street. The input to the controller is the WALK button pushed by pedestrians who want to cross the street. The outputs are two signals NS and EW that control the traffic lights in NS and EW directions. When NS or EW is 0, the red light is on and when they are 1, the green light is on. When there are no pedestrians, NS=0 and EW=1 for 1 minute,

followed by NS=1 and EW=0 for 1 minute and so on. When a WALK button is pushed, NS and EW both come 1 for a minute when the present minute expires. After that the NS and EW signals continue alternating. For the traffic-light controller:

i. Develop a state table and state diagram.
ii. Draw the architecture in terms of control path and data path
iii. Construct the RTL to implement the above architecture

[Open Book Examination Question]

19ECM13 FPGA Technology

4 0 0 4

Course Outcomes

1. Illustrate design metrics for various IC technologies and PLDs
2. Explain the general architecture, routing resources and programming elements of FPGA and FPGA design flow using CAD tools
3. Demonstrate the implementation of logic in FPGA
4. Summarize the architecture of Xilinx SRAM programmable FPGA
5. Illustrate the architecture of Actel Anti-Fuse programmable FPGA
6. Outline the techniques to implement an application

COs – POs Mapping

COs	PO_1	PO_2
1	2	-
2	2	-
3	3	2
4	3	2
5	2	-
6	3	-

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I

Introduction to Programmable Logic Devices

Design metrics, merits and demerits of various IC technologies, Introduction, Simple Programmable Logic Devices – Read Only Memories, Programmable Logic Arrays, Programmable Array Logic, Programmable Logic Devices/Generic Array Logic; Complex Programmable Logic Devices, various programing elements i.e mask ROM, ROM, EPROM, EEPROM.

16 Hours

Unit II

Field Programmable Gate Arrays

Organization of FPGAs, FPGA Programming Technologies, Programmable Logic Block Architectures, Programmable Interconnects, and Programmable I/O blocks in FPGAs, Dedicated specialized Components of FPGAs, and Applications of FPGAs. Front end design tools for FPGA and FPGA design flow.

14 Hours

Unit III

SRAM and Anti-Fuse Programmable FPGAs

SRAM and Anti-Fuse Programmable FPGAs: Introduction, Programming Technology, Device Architecture, The Xilinx XC2000, XC3000 And XC4000 Architectures.

Anti-Fuse Programmable FPGAs: Introduction, Programming Technology, Device Architecture, The Actel ACT1, ACT2 and ACT3 Architectures.

18 Hours

Unit IV

Design Applications

General Design Issues, Counter Examples, vending machine using One-Hot design method, A position Tracker for a Robot Manipulator, Designing Counters with ACT devices, Designing Adders and Accumulators with the ACT Architecture.

12 Hours

Total: 60 Hours

Text Book (s):

1. Stephen M. Trimberger, "Field Programmable Gate Array Technology", Springer International Edition, 1st Edition, 1994.
2. John V. Oldfield, Richard C. Dorf, "Field Programmable Gate Arrays", Wiley India Pvt. Ltd,1995

Reference Book (s):

1. Pak K. Chan, Samiha Mourad, "Digital Design Using Field Programmable Gate Arrays", Pearson Low Price Edition, 1st Edition, 2009
2. Wayne Wolf, "FPGA based System Design", Prentice Hall Modern Semiconductor Design Series, 2004.

Sample Question (S)
Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	20	20	--
Understand	50	50	--
Apply	30	30	50
Analyse	--		50
Evaluate	--	--	
Create	--	--	--
Total (%)	100	100	100

Remember

1. Recall the full form of (a) ASIC (b) VHDL
2. List are the outputs generated by Synthesis tool and Place & Route tool?
3. Recognize the plane which is programmable in PLA?

Understand

1. How parallel processing can be useful in the reduction of power dissipation of a circuit?
2. Explain the switching power dissipation in CMOS circuits.
3. Illustrate various sources of power dissipation in CMOS circuits.
4. Why leakage power dissipation has become an important issue in deep submicron technology?
5. Explain charge recycling in low power VLSI.

Apply

1. Implement the logic of two input XNOR gate in a FPGA having three input LUTs only.
2. "A system can perform the operation of two input XOR logic as well as two input XNOR logic. A switch is used to select the XOR and XNOR logic operation. If the switch is at '0' then XOR operation is to be performed and when the switch is at '1' then XNOR operation is to be performed". Implement the required system in PLA.
3. Implement the given function in two input LUT
   $Y = (A \cdot B) \cdot (C + D)$
4. Determine the reduced state table and corresponding state diagram of state table shown in Table Implement the logic of reduced state table by using one-hot encoding.

Present -State	Next-State		Output(Y)	
	X =0	X = 1	X = 0	X = 1
A	F	B	0	0
B	D	C	0	0
C	F	E	0	0
D	G	A	1	0
E	D	C	0	0
F	F	B	1	1
G	G	H	0	1
H	G	A	1	0

Table (i)

[Open Book Examination Question]
Analyze

1. Compare and contrast the SRAM and Anti-Fuse Programmable FPGAs technologies.
2. Designing a controller for an elevator. The elevator can be at one of three floors: Ground, First or Second. There are two buttons S1 and S0 that control the elevator. Also, there are three lights in the elevator that indicate the current floor. At each time step, the controller checks the current floor and current input, changes floors and lights in the obvious way. During designing make suitable assumptions.

[Open Book Examination Question]

19ECM14 Analog and Mixed Signal Design

4 0 0 4

Course Outcomes

1. Explain the mixed signal processing fundamentals
2. Outline the MOS models and differential amplifiers
3. Organize the Op-amp internal circuits using current mirrors
4. Demonstrate the switched capacitor circuits
5. Organize continuous and discrete time filters
6. Outline the data conversion circuits

COs – POs Mapping

COs	PO1	PO2
1	2	-
2	3	2
3	3	2
4	2	-
5	3	2
6	3	2

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I

Basics of Analog and Mixed Signal Design

Introduction analog and discrete-time signal processing, MOS device models, Second order effects, Differential amplifiers: single ended differential amplifier, basic differential pair, common mode response, and differential pair with MOS loads

Advanced MOS Modelling, Single Stage Amplifiers

14 Hours

Unit II

Design of Current mirrors and op-amp

Current Mirrors: simple CMOS current mirrors, Cascode and active current, high output impedance current mirrors. Operational Amplifiers: one stage and two stage op-amps, gain boosting, comparison,common mode feedback, input range limitation, slew-rate, power supply rejection, noise in op-amp, fully differential Op-amp, Frequency compensation in Op amp

Time and frequency domain noise analysis of amplifiers

16 Hours

Unit III

Switched capacitors and filters

Introduction to the switched capacitor circuits, Non-idealities in switched-capacitor filters, Basic building blocks, basic operation and analysis, sampling switches, Filters: Introduction Analog continuous time filters, passive and active filters; Basics of analog discrete-time filters, First order, Bi- quad, charge injection, Gain circuits

Switched-capacitor filter applications

16 Hours

Unit IV

Data converters

Basics of data converters; Analog to Digital converters: Integrating, Algorithmic, Two step, Folding,Pipeline, Interpolating ADCs; Decoder based DACs, Hybrid DACs

Basics of PLL, Analog PLLs, Digital PLLs

14 Hours
Total: 60 Hours

Textbook (s)

1. Tony Chan Carusone, David Johns, Kenneth Martin: Analog Integrated Circuit Design, 2nd Edition, John Wiley Publications, 2011.

2. Behzad Razavi , Design of Analog CMOS Integrated Circuits, 2nd Edition, McGraw-Hill, 2017
3. R. Jacob Baker, CMOS mixed-signal circuit design, Wiley India, IEEE press, reprint 2008
4. Rudy V. dePlassche, CMOS Integrated ADCs and DACs, Springer, Indian edition, 2005

Reference (s)

1. Philip E. Allen & Douglas R. Holberg, CMOS Analog Circuit Design, Oxford University Press, 2002
2. M. Burns et al., An introduction to mixed-signal IC test and measurement by, Oxford university press, first Indian edition, 2008
3. R. Jacob Baker, CMOS circuit design, layout and simulation, Revised second edition, IEEE press, 2008
4. Arthur B. Williams, Electronic Filter Design Handbook, McGraw-Hill, 1981
5. R. Schauman, Design of analog filters, Prentice-Hall, 1990

Sample Question (S)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	20	20	--
Understand	50	50	--
Apply	30	30	50
Analyse	--		50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. Recall the analog signal processing.
2. Recall the discrete-time signal processing
3. Reproduce the sampling theory
4. Reproduce the basic differential pair
5. List any two analog continuous time filters
6. Recall the basics of analog discrete-time filters.

Understand

1. Explain the single ended differential amplifier circuit.
2. Abstract the second order effects in MOS FET.
3. Explain the basic differential amplifier
4. Illustrate the MOS models
5. Illustrate the MOS modelling

Apply

1. Construct a cascode current mirror using CMOS
2. Demonstrate the non-idealities in switched capacitor circuits
3. Demonstrate high output impedance current mirrors
4. Demonstrate the applications of switched capacitor filter.
5. Demonstrate a simple CMOS current mirror circuit.

Analyze

1. Outline the circuit for Successive approximation ADCs.
2. Outline the circuit for Dual slope ADCs.
3. Organize the Flash ADCs.
4. Outline a Pipeline ADC circuit.
5. Organize the High-resolution DACs

Industrial Automation

Preamble:
B.Tech minors in industrial automation is consisting of four courses namely Microcontrollers and Interfacing, Sensors and Data Acquisition System, Fundamentals of Labview and Medical Robotics. At the end of the course, the learners will be able to demonstrate the microcontrollers application for the industrial application. The learners will understand the role of sensors and data acquisition system in tracking different signals, operating principles, and their coordination. The learner will be able use Labview programming skills for various applications. Also, the learners can understand the preliminaries concepts of robotics in medical industry.

Prospects:
Industrial automation is on the threshold of a new revolution, moving through rapid technology changes, adoption of new systems, networking architectures, and looking toward interoperability of devices and systems. The industrial space has been impacted with incremental technology changes, rapid adoption of new systems and augmented networking architectures over the last decade. Industrial technologies such as Microcontrollers and Interfacing, Sensors and Data Acquisition System, Fundamentals of Labview and Medical Robotics are becoming increasingly pervasive. Given the proliferation of large-scale, continuous and parameterized industrial devices digitization has fostered, this need will turn into an obligation.

Placement Opportunities:
The course is designed to help you gain the essential skills to have a successful career in industry. You will get to work alongside our experts on some of the most advanced technology used for industrial automation. The course will enhance the chances to get selected in Manufacturing, Process Industries, Chemical, Food and Beverages, Oil Gas, Transport, Machine Tools, Automobile, Textile, IT and Design, etc.

19ECM21 Microcontroller and Interfacing

4 0 0 4

Course Outcomes

1. Explain the architecture of 8051 microcontroller
2. Explain the pin details of 8051 microcontroller
3. Implement assembly language programs of 8051 microcontroller
4. Implement assembly language programs for in-built peripherals of 8051 microcontroller
5. Explain the working of various I/O peripherals
6. Carry-out the interfacing of I/O peripherals with 8051 microcontroller

COs – POs Mapping

COs	PO_1	PO_2	PO_3
1	2	-	-
2	3	2	2
3	3	2	2
4	2	-	-
5	3	2	2
6	3	2	3

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I

8051 Microcontroller

Comparison between microprocessor and microcontroller, 8051 family microcontroller, RAM architecture of 8051, Integrated Development Environment (IDE), Pin description of 8051 microcontroller, Machine cycle.
Hex file **14 Hours**

Unit II

Instruction Set of 8051 Microcontroller

Instruction set of 8051: Data transfer instructions, Arithmetic instructions, Logical Instructions, Stack related instructions and Branching instructions, Addressing Modes, assembly language programming examples.
Study of LST file **16 Hours**

Unit III

Internal Peripherals of 8051 Microcontroller

Timers programming and applications, Interrupts programming and applications, Universal Asynchronous Receiver Transmitter (UART) programming and applications.
Features of ARM processor

14 Hours

Unit IV

External Peripheral Interfacing with 8051 Microcontroller

Interfacing with 8051 microcontroller with: Keypad matrix, LCD, Seven segment displays, L293D Motor driver, Stepper motor, Analog to Digital Converter (804), Digital to Analog Converter (808), sensors.

Interface LM35 with 8051 microcontroller

16 Hours

Total: 60 Hours

Textbook (s)

1. Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinlay, The 8051 Micro controller and Embedded systems: using assembles and C, Pearson, 2nd Edition,2007
2. Kenneth J Ayala, The 8051 Microcontroller Architecture, Programming and Applications, Thomson Publishers, 3rd Edition, 2004

Reference (s)

1. N. Sentil Kumar, M Sarvanan, S Jeevananthan, Microprocessors and Microcontrollers, Oxford University Press, 1st Edition, 2010

Sample Question (S)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	20	20	--
Understand	50	50	--
Apply	30	30	50
Analyse	--		50
Evaluate	40	40	--
Create	--	--	--
Total (%)	--	--	100

Remember

1. State the significance of Reset pin of 8051 microcontroller.
2. List four differences between 8051 family of microcontroller.

Understand

1. Explain the consequences of execution of MOV IP, #14H instruction of 8051 microcontroller.
2. Explain the structure of internal RAM of 8051 microcontroller.
3. Explain the significance of each bit of TMOD register of 8051 microcontroller.

Apply

1. Write a program for 8051 microcontroller in assembly language to generate a square wave of 10KHz from pin P2.1. Assuming frequency of crystal attached to the microcontroller is 12MHz.
2. Develop a program in assembly language for 8051 microcontroller using interrupt to generate a 10KHz square wave from pin P2.0 and 25KHz square wave from pin P2.1 of 8051 microcontroller. Make suitable assumptions.
3. Interface a seven-segment display with 8051 microcontroller and develop a program in assembly language to display even numbers from 0 to 9.
4. Interface a LCD with 8051 microcontroller and develop a program in assembly language to display a message in 1st row of LCD.

[Open Book Examination Question]

19ECM22 Sensors and Data Acquisition System

4 0 0 4

Course Outcomes

1. Illustrate various digital data acquisition systems
2. Assess various data transfer techniques
3. Demonstrate the working principle of serial interface
4. Demonstrate the working principle of various digital instruments
5. Interpret various signal condition techniques
6. Outline various Remote data Acquisition techniques

COs – POs Mapping

COs	PO_1	PO_2
1	2	-
2	3	2
3	3	2
4	3	2
5	2	-
6	3	3

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I

Data Acquisition systems & control

Use of signal conditioners, scanners, signal converters, recorders, display devices, A/D & D/A circuits in digital data acquisition, Instrumentation systems: Types of Instrumentation systems, Components of an analog Instrumentation Data – Acquisition system. Multiplexing systems, Uses of Data Acquisition Systems, Use of Recorders in Digital systems, Digital Recording systems, Modern Digital Data acquisition system, Analog Multiplexed operation, operation of sample Hold circuits.

sample & hold circuits- specifications and design considerations.

15Hours

Unit II

Data Transfer Techniques:

Interfacing To PC: Expansion Buses- ISA Bus, EISA Bus, PCI Bus. Plug in data Acquisition and Control Boards: Functions of Plug in DAQ boards, Design of General purpose DAQ boards, Design of DAQ boards for PCI Bus. Data Acquisition using Serial Interface: Serial Interface Standards Rs 232, USB-Features of USB, USB system, USB Transfer, USB Descriptors, GPIB/IEEE-488, LAN, Universal serial bus, HART protocol, Zigbee and Bluetooth.

Foundation Field bus, ModBus **15Hours**

Unit III

Digital Instruments

Digital voltmeters (DVMs): working principle, construction, operation, salient features, range selection– Ramp type, dual slope integrating type, successive approximation type, Digital Frequency Meter: working principle, construction (block diagram), range selection and operation of, time period meter, frequency ratio meter, Recorders: The working principle, construction, operation and salient features of X-t strip chart recorder, Introduction to PLC

X-Y strip chart recorder and Magnetic type recorder. **15Hours**

Unit IV

Sensors

Resistive Sensors, Inductive Sensors, Capacitive Sensors, Optical Sensors, Electro Magnetic Sensors, *Thermal Sensors*

15 Hours

Total: 60 Hours

Text Books

1. Di Paolo Emilio, Maurizio , “Data Acquisition Systems From Fundamentals to Applied Design”, Springer; 2013.
2. S. Gupta, J.P. Gupta, PC Interfacing for Data Acquisition and Process Control, ISA, 1994, 2nd Edition
3. Bell David A, “Electronic Instrumentation and Measurement”, PHI, Inc, New Delhi (1994).
4. Tocci Ronald J , “Digital Systems Principles and Applications”, PHI, New Delhi (2002)

Reference Books

1. A. D. Helfrick and W.D. Cooper, “Modern Electronic Instrumentation and Measuring Techniques”, Pearson, 1st Edition, 2015.
2. R. K. Jain , “Mechanical & Industrial Measurements”, Khanna pub.

3. Chennakesava R Alavala, “Principles of Industrial Instrumentation and control systems”, Cengage publ.

Sample Question (S)
Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open book Examination (%)
Remember	20	20	--
Understand	50	50	--
Apply	30	30	50
Analyse	--		50
Evaluate	--		--
Create	--		--
Total (%)	100	100	100

Remember

1. List the Converter Characteristics and explain them
2. Discuss the objectives of DAS.
3. Explain the following terms in detail (i) Resolution (ii)Non-linearity (iii)settling time (iv) Monotonicity

Understand

1. Draw the circuit diagram of Polynomial converter and explain its operation in detail
2. Explain the concept of Digital signal processing system in Digital Acquisition System along with circuit diagram
3. Define Error? Explain the different Error sources present in ADC and DAC systems in detail

Apply

1. Design a digital Voltmeter of range 0 to 20 v
2. Determine the working principal of HART protocol
3. Construct a digital frequency meter
4. Analyze various data loggers
5. Justify the working principal of Machine vision-based inspection system. IC engine data
6. Compare Various Remote data Acquisition using Internet

[Open Book Examination Question]

19ECM23 Fundamentals of Labview

4 0 0 4

Course Outcomes

1. Interpret basic building blocks of virtual instrumentation
2. Execute various graphical programming environment in virtual instrumentation
3. Asses various applications based on loops and error handling techniques
4. Execute various functions and I/O files
5. Implement Various applications on DAQ
6. Assess various real communications and interfacing

COs – POs Mapping

COs	PO_1	PO_2
1	2	-
2	3	2
3	3	2
4	3	2
5	3	2
6	3	2

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I

Introduction of LabVIEW and Basic Programming:

LabVIEW Environment, Parts of VI, Front panel designing and working environment, Definitions of Control and Indicators, Types of Control and Indicators, Explanations of Controls Palette, Explanations Block Diagram and its working, Terminals, Functional Platte, Status Bar or Window tool bar, How to use Numerical functions, Designing of Boolean operations, Comparator applications

15 Hours

Unit II

Implementing a VI and Programming Loops

About For loops, How to use Shift registers, while loop designing, Flat Sequences, Applications based on Loops-Average Temperature VI, Temperature Multiplot VI, Square root VI, Arrays, Auto-Indexing of arrays, Array Functions and different array operations, Polymorphism and Polymorphic Vis, Clusters & Cluster Functions, creating cluster, bundle and unbundle operations on Cluster, Error Clusters to capture and merge errors while running a VI, String Functions for formatting and manipulating strings

15 Hours

Unit III

File I/O and Customizing Vis

File I/O VIs and Functions, High-Level File I/O Vis , Low-Level File I/O VI and Functions , Formatting Spreadsheet Strings Configuring the Appearance of Front Panels, Opening Sub VI Front Panels when a VI Runs, Keyboard Shortcuts for Controls, Editing VI Properties, Customizing the Controls and Functions Palettes

` **15 Hours**

Unit IV

Data Acquisitions Process and Instrument Control based on Embedded Controllers:

MAX and VISA explanations, GPIB communications, Serial communications and interfacing methods, acquiring the real time digital data to the LabVIEW User interface, controlling the LED operations, Acquiring of real time analog sensor values, controlling the Motors.

15 Hours
Total: 60Hours

Textbook (s)

1. Gary W. Johnson, Richard Jennings, 'Lab-view Graphical Programming', McGraw Hill Professional Publishing, 2001.
2. Lisa K Wells, Lab view for Everyone||, Prentice Hall of India.

Reference (s)

1. Barry Paton, —Sensor, transducers and Lab view||, Prentice Hall of India 2000.
2. Buchanan, W. —Computer buses||, CRC Press 2000

Sample Question (S)
Internal Assessment Pattern

Cognitive Level	Int. Test 1(%)	Int. Test 2 (%)	Open book Examination
Remember	25	10	--
Understand	40	45	--
Apply	35	45	50
Analyse	--	--	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. Draw and explain the graphical and VI models with design flow
2. Explain the essential need for Virtual Instrumentation and compare it with the traditional instruments.
3. Explain the role of different hardware's and software's in VI.

Understand

1. Explain the three parts of LabVIEW with three floating palette.
2. Discuss in detail about While and For Loops with Examples
3. Discuss in detail about different structures with examples
4. Describe in detail about various file types and File I/O functions

Apply

1. What are the NI-IMAQ and IMAQ vision functions used to acquire and display images?
2. Show the process how DAQ Assistant is used to acquire and generate signals with procedure for creating, configuring, Test and generate Lab VIEW code using DAQ Assistant.
3. Design a VI for pulse rate measuring in LabVIEW
   [Open Book Examination Question]

19ECM24 Medical Robotics

4 0 0 4

Course Outcomes

1. Describe the types of medical robots and the concepts of navigation and motion replication
2. Discuss about the sensors used for localization and tracking
3. Summarize the applications of surgical robotics
4. Outline the concepts in Rehabilitation of limbs and brain machine interface
5. Classify the types of assistive robots
6. Explore various applications of Robots in Medicine

COs – POs Mapping

COs	PO_1	PO_2	PO_3
1	2		
2	2		
3	3	2	2
4	3	2	2
5	2		
6	2		

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I

Introduction to medical robots

Types of medical robots - Navigation - Motion Replication - Imaging - Rehabilitation and Prosthetics - State of art of robotics in the field of healthcare limit. Localization And Tracking - Position sensors requirements - Tracking - Mechanical linkages - Optical - Sound-based - Electromagnetic - Impedance-based - In-bore MRI tracking - Video matching - Fiber optic tracking systems .

Hybrid systems

14 Hours

Unit II

Control Modes and Rehabilitation

Radiosurgery - Orthopedic Surgery - Urologic Surgery and Robotic Imaging - Cardiac Surgery – Neurosurgery – case studies. Rehabilitation for Limbs - Brain-Machine Interfaces

Steerable Needles – case studies

16 Hours

Unit III

Robots Vision in Medical Care

Robot Vision Image representation, Template matching, Polyhedral objects, Shane analysis, Segmentation – Thresholding, region labeling, Shrink operators, Swell operators, Euler numbers, Perspective transformation, Structured illumination, Assistive robots –types of assistive robots – case studies.

Camera calibration

16 Hours

Unit IV

Design of Medical Robots and Applications

Characterization of gestures to the design of robots- Design methodologies- Technological choices - Security. Applications in Biomedical Engineering – Bio Engineering Biologically Inspired Robots, Neural Engineering, Application in Rehabilitation – Interactive Therapy, Bionic Arm, Clinical and Surgical – Gynaecology, Orthopaedics,

Neurosurgery

14 Hours

Total: 60 Hours

Text Book (s):

1. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, “Robot Modeling and Control”, Wiley Publishers, 2006.
2. Robert Schilling, Fundamentals of Robotics-Analysis and control, Prentice Hall, 2003.

Reference Book (s):

1. J.J.Craig, Introduction to Robotics, Pearson Education, 2005.
2. Paula Gomes, "Medical robotics- Minimally Invasive surgery", Woodhead, 2012.
3. AchimSchweikard, Floris Ernst, “Medical Robotics”, Springer, 2015.
4. Jocelyne Troccaz, “Medical Robotics”, Wiley-ISTE, 2012.
5. VanjaBonzovic, ”Medical Robotics”, I-tech Education publishing,Austria,2008.
6. Daniel Faust, “Medical Robots”, Rosen Publishers, 2016.
7. Jocelyne Troccaz, “Medical Robotics”, Wiley, 2013

Sample Question (S)
Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember			--
Understand	70	25	--
Apply	30	75	50
Analyse	--		50
Evaluate	--	--	
Create	--	--	--
Total (%)	100	100	100

Understand

1. Explain about different types of medical robots.
2. Explain the Localization And Tracking in medical robots.
3. Illustrate Fiber optic tracking systems in in medical robots..
4. Why camera calibration has become an important issue in robotic surgery?
5. Explain Brain-Machine Interfaces.

Apply

1. Access the importance robotic surgery?
2. Assess the Assistive robots performance in surgeries.
3. Demonstrate Interactive Therapy with the help of suitable example.
4. Design a Bio Engineering Biologically Inspired Robots logically.
5. Implement the Bionic Arm.

[Open Book Examination Question]

Analyse

1. Compare and contrast various gestures to the design of robots .
2. Organize different approaches to design a Assistive robots.
3. Differentiate between Shrink operators and Swell operators.
4. Outline the Urologic Surgery and Robotic Imaging?
5. Outline the impact of Steerable Needles in robotic surgery.

[Open Book Examination Question]

Communications and Networking

Preamble:

B.Tech minors in Communications and Networking is consisting of four courses namely Principles of communications, Coding Theory and Practice, Ad-hoc and wireless sensor Networks, Fundamentals of Multimedia networking. At the end of the course, the learners will be able to demonstrate the Multimedia networking and communication for the real time application. The learners will understand the role of the field of networking and communication which includes the analysis, design, implementation, and use of local, wide-area, and mobile networks that link computers together.

Prospects:

Communications and Networking is on the threshold of a new revolution, moving through rapid technology changes, adoption of new systems and networking architectures. Coding theory is the study of the properties of codes and their respective fitness for specific applications. Codes are used for data compression, cryptography, error detection and correction, data transmission and data storage. Ad hoc networks are multi-hop networks consisting of wireless autonomous hosts, where each host may serve as a router to assists traffic from other nodes. Sensors provide service to monitoring stations.

Placement Opportunities:

The course is designed to help you gain the essential skills to have a successful career in industry opportunities. You will get to work alongside our experts on some of the most advanced technology used for Communications and Networking. The course will enhance the chances to get selected in in variety of sectors such as Telephone Industries, Civil Aviation, Defence, NPHIL, Railways, Power Sector, Hardware Manufacturing Industries, Television Industries, Research and Development Organisations with job titles as Service Engineers, Software Analyst, Technical Director, Field Test Engineer, Network Planning Engineer, Customer Support Engineer, Electronics and Communication Consultant, Research and Development Software Engineer and so on.

19ECM31 Principles of Communications

4 0 0 4

Course Outcomes

1. Understand the sampling and quantization
2. Understand waveform coding techniques to represent digital data
3. Explain source coding techniques
4. Explain error detection and correction codes
5. Demonstrate transmission of digital data over a baseband channel
6. Outline the techniques to combat the inter symbol interference

Cos - POs Mapping

COs	PO1	PO2
1	2	-
2	2	-
3	2	-
4	2	-
5	3	2
6	3	2

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit – I

Model of Digital Communication Systems

Digital Representation of Analog Signal, Certain Issues in Digital Transmission, Advantages of Digital Communication Systems, Sampling Theorem, Types of Sampling – Impulse Sampling, Natural Sampling , Flat – Top Sampling. Introduction to Baseband Sampling. Waveform Coding Techniques: PCM Generation and Reconstruction, Quantization Noise, Non Uniform Quantization and Companding, DPCM, Adaptive DPCM, DM and Adaptive DM

Noise in PCM, Noise in DM.

16 Hours

Unit – II

Information theory

Information and Entropy, Conditional Entropy and Redundancy, Shannon-Fano Coding Mutual information, Information Loss due to Noise, Source coding Huffman Code, Variable Length Coding, Lempel-ziv coding, Source coding to increase average information per bit, Lossy Source coding, Hartley Shannon Law.

Bandwidth-S/N Trade off, Mutual Information

14 Hours

Unit-III

Error Control Codes

Linear Block Codes: Matrix Description of Linear Block Codes, Error Detection and Error Correction Capabilities of Linear Block Codes. Cyclic Codes: Algebraic Structure, Encoding, Syndrome Calculation, Decoding. Convolution Codes: Encoding, Decoding

Receiver design of linear block codes, convolutional codes

16 Hours

Unit – IV

Baseband Pulse Transmission

Introduction, Matched Filter, Error Rate Due to Noise, intersymbol interference Nyquist's criterion for Distortionless Baseband Binary Transmission, Correlative -Level Coding Baseband M-Array PAM Transmission PAM Transmission, Digital subscriber Lines, Optimal Liner Receiver

Adaptive Equalization, Eye patterns

14 Hours

Total: 60 Hours

Text book(s)

1. S. Haykin, Communications system, Wiley, 4th Edition, 2009
2. Sam Shanmugam, Digital and Analog Communication Systems, John Wiley, 2005.

Reference(s)

1. Herbert Taub, Donald L Schiling, Goutam Saha, Principles of Communication Systems, 3rd Edition, McGraw-Hill, 2008
2. Wayne Tomasi, Electronic communication systems, Pearson, 5th Edition, 2008
3. R. P. Singh , S. Sapre, Communication Systems, Analog and Digital, McGraw-Hill Education, 2012
4. John G. Proakis, Masoud Salehi , Digital Communications, 5th Edition, McGrawHill, 2008

Sample Question (S)
Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam(%)
Remember	10	10	
Understand	50	40	
Apply	40	50	50
Analyse			50
Evaluate			
Create			
Total (%)	100	100	100

Remember

1. Define PCM
2. List the two advantages of sampling
3. Define DPCM

Understand

1. Explain how encoding is done by convolution codes with a suitable example
2. Explain matched filter and derive the expression for probability of error
3. Explain tree diagram, trellis diagram and state transition diagram of convolution codes

Apply

1. Implement a (2, 1) convolutional coder with constraint length 6. Draw the tree diagram, state diagram and trellis diagram for the assumed coder. Find the (7,4) linear systematic block code word corresponding to 1101.Assume a suitable generator matrix **[Open book question]**
2. Predict the parameter which is called a figure of merit of a digital communication system and why?
3. Execute the channel synchronization method in PCM systems

Analyze

1. Consider the convolutional code with g (1) = (111) and g(2) = (110):

   (i) Draw the encoder block diagram.

   (ii) Draw the Code Tree and state diagram.

   (iii) Decode the following sequence 00001110 using Viterbi Decoding Algorithm

   [Open Book question]

2. A TV signal with bandwidth of 4.2 MHz is Transmitted using binary PCM .The number of quantization levels is 512. Calculate (i) Code word length (ii)Final bit rate (iii)S/N Outline Convergence of the weight vector of LMS Algorithm

   [Open book question]

3. Outline the signal space diagram of quadrature amplitude modulation and its differences with respect to QPSK. Analyze different ways of increasing the efficiency of steam power plant by giving appropriate justification

19ECM32 Coding Theory and Practice

4 0 0 4

Course Outcomes:

1. Exemplify the basic communication process.
2. Explain the information theory concepts and Shannon theorem.
3. Demonstrate channel capacity and discrete memoryless channels.
4. Construct various source coding techniques.
5. Summarize the channel coding techniques.
6. Outline the encoding and decoding structure of convolutional codes.

COs-POs Mapping

COs	PO1	PO2
1	2	1
2	2	1
3	3	2
4	2	1
5	2	1
6	3	2

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I

Communication process

The communication process, primary communication resources, sources of information, communication networks, communication channels, modulation process, analog and digital types of communication, sampling process, pulse-amplitude modulation, digital communication problem.

Noise, Gaussian process

15 Hours

Unit II

Fundamental limits in Information theory

Uncertainity, Information, Entropy: marginal, conditional, joint and relative entropies, relation among entropies, Mutual information, information rate, channel capacity, redundancy and efficiency of channels, Discrete memoryless channels, Shannon's theorem.

Probability of error, Matched filter

15 Hours

Unit III

Source coding

Need for encoding, Instantaneous codes, construction of instantaneous codes, Kraft's inequality, coding efficiency and redundancy, source coding theorem. construction of basic source codes, Shannon Fano coding, Huffman coding and examples.

Rate-distortion function, Quantization

15 Hours

Unit IV

Channel coding

Examples of the use of error control codes, basic notions, coding gain, comparison of uncoded and coded systems. Linear block Codes, Cyclic Codes, Convolution Codes: Convolution encoders, structural properties of convolution codes, Trellis Diagrams, Viterbi Algorithm, Applications: Concatenated Codes, Interleavers, The Compact Disc, Codes for Magnetic recording

BCH Code, RS code

15 Hours

Total: 60 Hours

Textbook (s)

1. Stephen.B.Wicker, Error Control Systems for Digital Communication and storage, Prentice Hall,1995.
2. Bernard Sklar, Digital communications: Fundamentals and applications, 2nd Edition, Prentice Hall,2001.
3. Simon Haykin, Communication Systems, 4th Edition, John Wiley and Sons, 2001.

Reference (s)

1. John G.Proakis, Digital communication, 4th Edition, McGraw Hill, 2001.
2. R.P. Singh, SP Sapre, Communication Systems, 3rd Edition, TMH, 2017.

Sample Question (S)
Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	25	20	--
Understand	50	40	--
Apply	25	25	80
Analyse	--	15	20
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. Define sampling
2. State information
3. List any two block codes
4. List any two source code techniques
5. Define maximum likelihood probability
6. List any two applications of convolutional codes

Understand

1. Explain various types of error channels.
2. Illustrate the structure of Shannon fano coding.
3. Compare Shannon fano and Huffman coding.
4. Illustrate the detection of cyclic codes.
5. Represent the Viterbi decoding algorithm and explain the steps in decoding.
6. Explain the applications of convolutional codes.

Apply

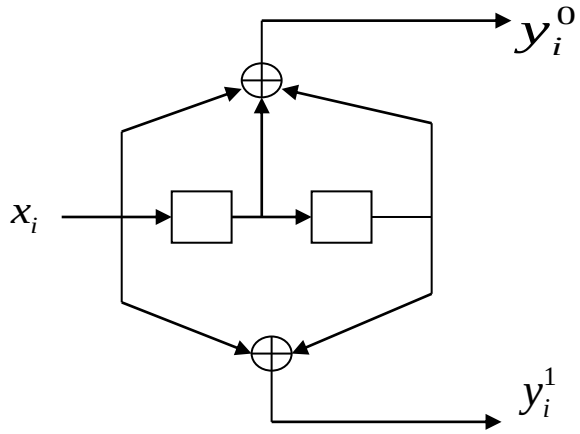
1. A source emits a sequence of symbols having probabilities given below.
   {0.4, 0.2, 0.12, 0.08, 0.08, 0.08, 0.04}.
   a) Using Shannon-fano algorithm find out the average code word length, entropy and efficiency of the source for single-partitioning.
   b) Determine the same by performing Huffman-coding algorithm
2. Consider a (7, 4) Code whose Generator matrix is given below.
   a) Find all the codewords of the code. What is $d_{\min}$?
3. A discrete memoryless source has an alphabet of seven symbols having probabilities of occurrence as {0.25,0.25,0.125,0.125,0.125,0.0625,0.0625}.Compute the Huffman code for this source, moving a "combined" symbol as high as possible. Show that the efficiency of source code is 100 percent.
   [Open Book Examination Question]
4. Design a feedback shift register encoder for an (8, 5) cyclic code with a generator. Use the encoder to find the codeword for the message 10101 in systematic form.

   [Open Book Examination Question]

Analyse

1. For the convolutional encoder shown below, determine the following:
   a) Output sequence for message sequence x_i ={1 0 0 1 1} in both time domain and transform domain approach.
   b) Construct the state diagram for corresponding encoder.
2. Prove the Statement "The mutual information of a channel is related to the joint entropy of the channel input and channel output"
3. a) The generator polynomial of a (15,11) hamming code is defined by g(X) =1+X+X^4 develop the encoder and syndrome calculator for the code.
   b) Encode the 1 0 1 in systematic form using polynomial division and the generator g(X) = 1+X+X^2+X^4.
   [Open Book Examination Question]

4. For the convolutional encoder shown below, determine the following:
   a) Output sequence for message sequence x_i ={1 0 1 0 1} in both time domain and transform domain approach.
   b) Draw the state diagram for corresponding encoder.



[Open book Examination Question]

19ECM33 Ad-hoc and Wireless sensor networks

4 0 0 4

Course Outcomes

1. Exemplify wired and wireless networks for real time applications.
2. Summarize sensor network architectures for various application.
3. Interpret various operations in sensor node and transceiver design.
4. Classify suitable medium access protocols, routing protocols, security protocols and radio hardware.
5. Implement Prototype sensor networks using commercial components.
6. Differentiate various infrastructure management and sensor network platform tools

COs – POs Mapping

COs	PO_1	PO_2	PO_3
1	2	-	-
2	2	-	-
3	3	2	2
4	3	2	2
5	2	-	-
6	2	-	-

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I

Power Dissipation in CMOS

Key definitions of WSN, Advantages of sensor Networks, Unique constraints and challenges, Driving Applications, Enabling Technologies for WSNs. Single node architecture – Hardware Components, Energy consumption of sensor nodes, Operating system and execution environment, Network architecture-Sensor network scenarios. Optimization goals.

Gate way concepts, Figures of merits **14 Hours**

Unit II

Power Optimization Using Special Techniques

Physical layer, Transceiver design considerations, Personal area Networks (PANs), Hidden Node and Exposed node Problem, Topologies of PANs, Topologies of MANETs, Topologies of WANETs. Issues in designing a MAC protocol for WSNs, Design goals of a MAC protocol for WSNs.

Classification of MAC Protocols, Contention based protocols **16 Hours**

Unit III

Design of Low Power Circuits

Introduction, Issues in designing a routing protocol for ad-hoc wireless networks, Classification of routing Protocols, Table-driven routing protocols, On-demand routing protocols, Hybrid routing Protocols, Routing Protocols with efficient flooding mechanism, Hierarchical routing protocols , Power aware routing Protocols, Proactive routing. Issues in designing Transport layer for ad-hoc wireless Networks, Design goals of Transport layer for ad-hoc wireless Networks.

Classification of transport layer solutions, TCP over ad-hoc wireless networks

16 Hours

Unit IV

Power Estimation

Topology control, Clustering, Time Synchronization, Localization, Positioning, Sensor Tasking and Control, Security in ad-hoc wireless networks, Network security requirements, Issues and Challenges in security provisioning, Network security attacks, Key management, Security Routing in ad-hoc wireless networks. Sensor node hardware-Berkely motes, Programming challenges, Node level software platforms.

Node level simulators, State centric programming

14 Hours

Total: 60 Hours

Text Book (s):

1. Ad Hoc Wireless Networks: Architectures and Protocols - C. Siva Ram Murthy and B.S.Manoj, 2004, PHI
2. Wireless Ad- hoc and Sensor Networks: Protocols. Performance and Control – Jagannathan Sarangapani, CRC Press
3. Holger Karl & AndreasWillig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2005.

Reference Book (s):

1. KazernSohraby, Daniel Minoli, &TaiebZnati, "Wireless Sensor Networks- Technology, Protocols and Applications", John Wiley, 2007.

2. Feng Zhao & Leonidas J. Guibas, "Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.
3. Ad- Hoc Mobile Wireless Networks: Protocols & Systems, c.K. Toh ,Ied, Pearson Education.
4. Wireless Sensor Networks - C. S. Raghavendra, Krishna M. Sivalingam,2004, Springer
5. Wireless Sensor Networks - S Anandamurugan , Lakshmi Publications

Sample Question (S)
Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	15	15	--
Understand	50	50	--
Apply	35	35	50
Analyse	--	--	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. List any three advantages of wireless sensor networks
2. List any two Enabling Technologies for WSNs

Understand

1. Explain the sensor network architectures for various applications
2. Illustrate various operations in sensor node and transceiver design

Apply

1. Implement Prototype sensor networks using commercial components.
   [Open Book Examination Question]

Analyze
1. Differentiate various infrastructure management and sensor network platform tools
[Open Book Examination Question]

19ECM34 Fundamentals of Multimedia Networking

4 0 0 4

Course Outcomes

1. Explain the basics of multimedia
2. Demonstrate the digitization of sound
3. Summarize the fundamental concepts in video
4. Classify lossy and lossless data compression
5. Outline the transform coding techniques
6. Demonstrate multimedia networks

COs – POs Mapping

COs	PO_1	PO_2	PO_3
1	2	-	-
2	2	-	-
3	3	2	2
4	3	2	2
5	2	-	-
6	2	-	-

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I

Introduction to Multimedia

Components of Multimedia, Multimedia and Hypermedia, World Wide Web: History of the WWW, Hyper Text Transfer Protocol (HTTP), Hyper Text Markup Language (HTML), Extensible Markup Language (XML), Synchronized Multimedia Integration Language (SMIL), Graphics/Image Data Types: 1-Bit Images, 8-Bit Gray-Level Images, Image Data Types.

24-Bit Color Images, 8-Bit Color Images

14 Hours

Unit II

Basics of Digital Audio, Image and Video

Digitization of Sound: Digitization, Nyquist Theorem, Signal-to-Noise Ratio (SNR), Signal-to-Quantization-Noise Ratio (SQNR), Linear and Nonlinear Quantization, Audio Filtering, Audio Quality versus Data Rate, Synthetic Sounds. Fundamental Concepts in Video: Types of Video Signals, Component Video.

Composite Video, S-Video

16 Hours

Unit III

Multimedia Data Compression

Lossless Compression Algorithms: Basics of Information Theory, Run-Length Coding, Variable-Length Coding (VLC), Shannon-Fano Algorithm, Huffman Coding. Lossless Image Compression: Differential Coding of Images, Lossless JPEG. Lossy Compression Algorithms: Distortion Measure, The Rate-Distortion Theory.

Transform Coding: Discrete Cosine Transfonn (DCT), Karhunen-Loeve Transform

14 Hours

Unit IV

Computer and Multimedia Networks

Basics of Computer and Multimedia Networks: OSI Network Layers, TCP/IP Protocols. Multiplexing Technologies: Basics of Multiplexing, Integrated Services Digital Network (ISDN), Synchronous Optical NETwork (SONET), Asymmetric Digital Subscriber Line (ADSL). LAN and WAN: Local Area Networks (LANs), Wide Area Networks (WANs), Asynchronous Transfer Mode (ATM).

Gigabit and 10-Gigabit Ethernets

16 Hours

Total: 60 Hours

Text Book (s):

1. Ze-Nian Li and Mark S. Drew “Fundamentals of Multimedia”, Pearson Education, 2004.
2. Fred Halsall, “Multimedia Communications: Applications, Networks, Protocols and Standards”, Pearson publication, 2009.

Reference Book (s):

1. Multimedia Communication Systems- K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, Pearson Education, 2004. ISBN -9788120321458.
2. Multimedia over IP and Wireless Networks: Compression, networking, and Systems, by Mihaela vander Schaar. And Philip Chou, Academic Press, 2007.

Sample Question (S)
Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	30	20	--
Understand	60	70	--
Apply	10	10	50
Analyse	--		50
Evaluate	--	--	
Create	--	--	--
Total (%)	100	100	100

Remember

1. Define Cognitive System in human communication model.
2. Define Signal-to-Quantization-Noise Ratio (SQNR).
3. List any two Lossless Compression Algorithms.

Understand

1. Explain the different types of video signals.
2. Compare Shannon-Fano coding and Huffman Coding
3. Interpret ITU-T standardization.
4. As a variation of FDM, WDM is used for multiplexing over fiber-optic channels. Compare WDM with FDM.

Apply

1. Suppose eight characters have a distribution A:(1), B:(l), C:(l), D:(2), E:(3), F:(5), 0:(5), H:(lO). Draw a Huffman tree for this distribution.
2. Both ISDN and ADSL deliver integrated network services, such as voice, video, and so on, to home users or small-office users. Assess the advantages of ADSL over ISDN?
3. Your task is to think about the transmission of smell over the Internet. Suppose we have a smell sensor at one location and wish to transmit the Aroma Vector (say) to a receiver to reproduce the same sensation. You are asked to design such a system. List three key issues to consider and two applications ofsuch a delivery system. Hint: Think about medical applications.

[Open Book Examination Question]

Avionics

Preamble:

B.Tech minors in Avionics consists of four courses namely Principles of Aerodynamics, Aircraft Electrical Systems, Aircraft Instrument Systems and Aircraft Communication & Navigational systems. Avionics means Aviation Electronics, which deals with aircraft dynamics integrated with various systems. At the end of the course, the learners will be able to understand basics of aerodynamics staring from lift production and ending with an overall view of flight dynamics. The learners will understand the basic concepts of electrical systems including tracing of wiring diagram which helps to lay a foundation for snag rectification. Operating principles of various instruments of aircraft are also dealt in this course to make the learners to understand overall operation. Also the learner will be able to appreciate the communication and navigation systems integrated with the instrumentation.

Prospects:

In India, Aviation industry is the most popular field and there are great career prospects for students willing to pursue this course and make their careers in Avionics. As there is an expectation for rise in demand for Air services in future, career opportunities will be more for the students. It is one of the fastest developing streams and has great opportunities to offer to qualified professionals both in India and abroad. As there are wide varieties of jobs in aviation industry, this course will be used as a bridge course for further courses.

Placement Opportunities:

The course is designed to help the learners to gain the basic and essential skills to have a successful career in aviation industry. As the jobs in aviation industry demands specialized knowledge, this course will fulfill the pre requisite knowledge to get a wide range of job opportunities such as Technical Manager, Avionics Engineer, Test Engineer and Engineering Trainees

19ECM41 Principles of Aerodynamics

4 0 0 4

Course Outcomes

1. Explain air flow characteristics aero foils
2. Predict the operation of primary and secondary flight controls
3. Explain the operation of different types of flight control systems
4. Explain aircraft performance and stability
5. Explain aircraft stability
6. Select appropriate type of wings for transonic and supersonic flights.

COs – POs Mapping

COs	PO_1	PO_2
1	3	-
2	3	2
3	3	-
4	3	-
5	3	-
6	3	2

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I

Air flow characteristics

International Standard Atmosphere, Division of atmosphere, variation of properties of air with altitude, pressure, density, temperature. Aero foils – Parts, types and features, Pressure distribution over aerofoils. Stagnation, centre of pressure, angle of attack, wash in, wash out, fineness ratio, aspect ratio.

Bernoulli's theorem, Boundary layer, laminar and turbulent flow, free stream flow, relative airflow, vortices, Types of drags – profile (parasite) drag, induced drag. Thrust, Weight, Generation of lift and drag, Lift coefficient, Drag coefficient, polar curve, separation point, stalling angle, stalling speed, Types of wings.

up wash and downwash, Aerodynamic Resultant

15 Hours

Unit II

Primary and Secondary Flight Controls

Primary flight control – ailerons, elevators, rudder, Secondary Flight controls – Flaps, slats, spoilers, Movement and operation of the controls giving control about the axes of an aircraft, trim systems, Operation of a manually operated flight control system, Operation of electro-mechanically operated flight control system, Operation of hydraulically operated flight control system, Operation of a fly by wire control flight system

Trimming methods – trim tabs, variable incidence tail place, mach trim

15 Hours

Unit III

Aircraft Performance and Stability

Forces involved - Take off, climbing, leveling, descent and landing, radius of turn, rate of turn, rate of climb, Influence of load factor. Types of flight - steady, gliding, turning and climbing. Limitations on turn, pull up and push over, V-N diagrams.

Aircraft control and manoeuvres, Types of stability – Longitudinal stability, lateral stability and directional stability (active and passive), Dutch Roll, Divergence – Spiral divergence, directional divergence. side slip, Forces and moments and their effects

flight envelope and structural limitations

15 Hours

Unit IV

Transonic Flight and supersonic flight

Effects of wing fences; saw tooth leading edges; Boundary layer control using - vortex generators, Stall ,wedges or leading edge devices; Speed of sound, subsonic& transonic flight

Mach number, critical Mach number, compressibility buffet, area rule; Factors affecting airflow in engine intakes of high speed aircraft; Effects of sweepback on critical Mach number , delta wings, wind tunnels

shock wave, aerodynamic heating

15 Hours

Total: 60 Hours

Text Book (s):

1. Fundamental of Flight: Basic Aerodynamics Vol -I Lalit Gupta EBS
2. Flight without Formulae A.C. Kermode Pearson

Reference Book (s):

1. Understanding Flight David F Anderson and Scott Eberhardt Mc Graw Hill
2. Aircraft Engineering Principles L Dingle & M Tooley Elsevier publisher

Sample Question (S)
Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	15	15	--
Understand	50	50	--
Apply	35	35	50
Analyse	--	--	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. Define aspect ratio.
2. State Bernoulli's theorem.
3. Recall wash in and washout.
4. State types of drags.

Understand

1. Explain pressure distribution over an aerofoil.
2. Explain centre of pressure of an aircraft.
3. Explain types of wings.
4. Compare profile drag and induced drag.

Apply

1. Show how the lift is generated.
2. Assess the performance of different types of wings.
3. Assess the aircraft performance during takeoff.
4. Select the appropriate flight controls required for turning of an aircraft.
5. As a pilot of the aircraft, select the appropriate publication to know the operating flight strength limitations and discuss about those diagrams.
   [Open Book Examination Question]

19ECM42 Aircraft Electrical Systems

4 0 0 4

Course Outcomes

1. Explain about DC power supplies of an aircraft
2. Explain different AC power supplies of an aircraft
3. Select appropriate circuit controlling and protection devices
4. Explain power distribution in the aircraft
5. Explain different power utilization systems
6. Carryout snag analysis with the help of circuit tracing

COs – POs Mapping

COs	PO_1	PO_2
1	3	-
2	3	-
3	3	2
4	3	-
5	3	-
6	3	2

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I

DC and AC Power Supplies

Principle of DC Generator, Interpoles and Compensating windings, Auxiliary interpoles, Spark suppression, Brush wear at high altitude, Vibrating contact regulator, Carbon pile voltage regulation, Solid state voltage regulator, Paralleling and load sharing, Indications of fully charged batteries, Thermal runaway, Parallel and series connection of batteries, Battery charger control circuit

Operation of CSD unit, under drive phase , overdrive phase, Excitation of Frequency wild generator, Constant frequency generator, Voltage regulation, Real load sharing, Reactive load sharing, Synchronization between generators, Power conversion equipment

Battery charging from external power, In situ battery charging system

15 Hours

Unit II

Circuit Controlling and Protection Devices

Switches- types (Toggle switch, Push switch, Rocker button switch, Rotary switch, Micro switch, Time switch, Pressure switch, Thermal switch,) Relays, Attracted- core heavy duty relay, Polarized armature relay, Slugged relay, Breakers, Three pin receptacle system, Fuses, Limiting resistors, Current Limitters, Circuit Breakers, Protection against reverse current, Reverse current cut out relay, Switched reverse current relay, Reverse current circuit breaker, Over voltage protection dc generating system, Over voltage protection ac generating system, Differential current protection.

External ac power receptacle and control panel

15 Hours

Unit III

Power Distribution and Measuring Instruments

GPU, Multiple DC bus bar system, APU, Split bus bar system, Combinations of Parallel operation, Wires and Cables, Pressure bung Assembly, Earthing, Cable terminations, Crimped terminals, Inline connectors, Polarizing key positions, Static discharge vicks.

Ammeters – Types and extension of range, Volt meters – types and extension of range, Ohm meters – types, Watt meters, Instrument transformers, Magnetic indicators, CRO – constructional details and applications

Screening, Bonding **15 Hours**

Unit IV

Power Utilization Systems and Circuit tracing

Lighting system, Engine starting system, Magneto Ignition System, High Energy Ignition System, Fire detection and extinguishing system, Ice and rain protection system, Anti skid control system, Types of bus bars, Inter connection of bus bars, Bus tie contactors, Main systems, Stand by systems, Emergency systems, Circuit protection, Circuit tracing

Wind shield Wiper system, Rain Repellent system **15 Hours**

Total: 60 Hours

Text Book (s):

1. Aircraft Electrical Systems EHJ Pallet Himalayan Books
2. Basic Electricity Dale Crane

Reference Book (s):

1. Aviation Electronics Vol.1 by John M. Ferrara
2. Aircraft Electricity and Electronics by Bent Mekinley

Sample Question (S)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	15	15	--
Understand	50	50	--
Apply	35	35	50
Analyse	--	--	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. State indications of fully charged batteries
2. Define real and reactive load sharing
3. Recall any four types of switches
4. State the purpose of bonding

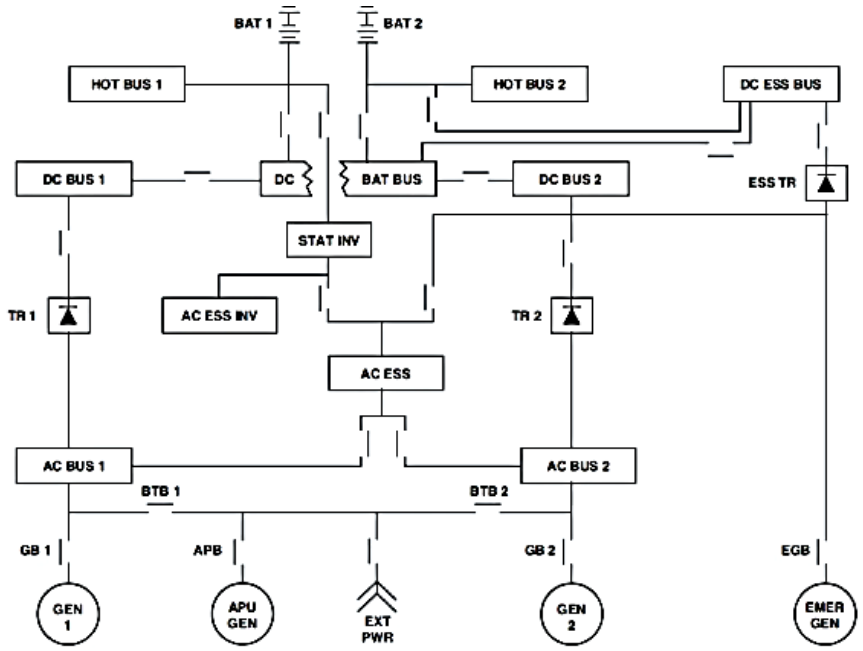
Understand

1. Explain reverse current cut-out relay
2. Explain anti-skid control system
3. Explain different types of bus bars in the aircraft
4. Explain insitu battery charging system

Apply

1. Show how the power is distributed inside the aircraft with schematic diagram
2. Predict the consequences in case of complete ac power failure
3. Assess the performance of multiple DC bus bar system
4. Predict the probable causes for failure of fire detection system
5. After going through the given split bus power distribution system, find the relevant actions during normal and emergency flight

[Open Book Examination Question]



19ECM43 Aircraft Instrument Systems

4 0 0 4

Course Outcomes

1. Explain air data instruments and their settings
2. Explain gyroscopic instruments
3. Find appropriate instruments for engine parameters
4. Explain cockpit pressurization and air-conditioning system
5. Explain inertial navigation system
6. Select the appropriate instruments for navigation

COs – POs Mapping

COs	PO_1	PO_2
1	3	-
2	3	-
3	3	2
4	3	-
5	3	-
6	3	2

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I

Air data and Gyroscopic instruments

Pitot static system, Altimeter, Air speed indicator, Vertical speed indicator, Types of Airspeeds, Mach indicator, Air temperature indicator, Barometric pressure setting, Q code for altimeter setting, Cabin altimeter

Introduction to gyroscopic theory, Directional gyro, Gyro horizon, Remote reading artificial horizon, Electrical type artificial horizon, Turn and slip indicator

Air speed indicator color coding, outside air temperature gauge

15 Hours

Unit II

Propulsion system instruments

Engine RPM indicator, Measurement of temperature, Fuel and oil system, Thermocouple, Engine oil pressure indicating system- Pressure gauge, Remote reading pressure gauge, Vibration monitoring system, Fuel pressure warning instruments, EPR measurement, Torque monitoring, EICAS – Engine data display

Engine oil temperature indicating system, torque indicator

15 Hours

Unit III

Cockpit pressurization Oxygen Equipments

Introduction to cockpit pressurization system, Cockpit pressurization and air conditioning system

Oxygen installation, Introduction to Oxygen equipment set, Introduction to Emergency oxygen system, Engine oxygen system, Introduction to liquid oxygen system, Oxygen charging regulator Methods of Oxygen Supply ; Testing and servicing of one oxygen system

Safety precautions during the servicing of oxygen system and during installation

15 Hours

Unit IV

Navigation Instruments

Inertial Navigation System Units of INS, navigation fundamentals, navigation terms, Transport and earth rate compensation

Liquid compass, Magnetic influence of various elements in aircraft, Compass swinging, Flight directional system, Compass error, Horizontal situation indicator, Radio magnetic indicator, Automatic direction finder

Drawbacks of liquid compass and magnetic compass

15 Hours

Total: 60 Hours

Text Book (s):

1. Aircraft Instruments by EHJ Pallet Himalayan Books
2. Aircraft Instruments by C.A. Williams

Reference Book (s):

1. Aviation Electronics Vol.1 by John M. Ferrara
2. Aircraft Electricity and Electronics by Bent Mekinley
3. Civil Aviation Inspection Procedures (CAP 459) PartI: Basic, Part II: Aircraft (2Vols)
4. Aircraft Oxygen System by Robert Scheppler and Dale Crane

Sample Question (S)
Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	15	15	--
Understand	50	50	--
Apply	35	35	50
Analyse	--	--	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. State the purpose of ASI and altimeter
2. State the different colours of the scale of ASI as a part of standard colour coding
3. Recall any four types of air data instruments
4. State the difference between calibrated air speed and true air speed

Understand

1. Explain the principle of operation of Air speed indicator
2. Explain the construction of Altimeter
3. Explain safety precautions during the servicing of one oxygen system
4. Explain EICAS- Engine data display

Apply

1. Find the reasons for failure of a pitot static system
2. Find the list of instruments effected by blockage of static system
3. Find the instruments which makes use of earth's magnetic field
4. Carryout the corrections for variation and deviation in the correct sequence
5. Select the instruments which are very important for flying and discuss the steps to be taken by the pilot in case of failure of these instruments
   [Open Book Examination Question]

19ECM44 Aircraft Communication and Navigation Systems

4 0 0 4

Course Outcomes

1. Explain HF and VHF communication
2. Explain navigation equipment
3. Select appropriate landing system
4. Explain different types of navigation
5. Explain FMS system
6. Find appropriate equipment required for ATC system

COs – POs Mapping

COs	PO_1	PO_2
1	3	-
2	3	-
3	3	2
4	3	-
5	3	-
6	3	2

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I

HF and VHF communication

DSB modulation, SSB modulation, Channel spacing, Depth of modulation, Compression, Squelch HF range and propagation, SELCAL, HF data link, HF radio Equipment, HF antennas and coupling units, VHF range and propagation, ACARS, VHF radio equipment, PA System, HF and VHF system description, Flight interphone system, voice recorder, ELT

Frequency range spectrum, types of wave propagation

15 Hours

Unit II

Navigation Equipment and Landing Systems

Navigation terminology, ADF – Introduction, Principle, Equipment, Operational aspects, VOR – Principle, Airborne equipment, Operational aspects, DME – Operation, Equipment

ILS – System overview, Ground equipment, Airborne equipment, Low range radio altimeter, Operational aspects of ILS; MLS – System overview, Principles, Aircraft Equipment, Ground equipment

Types of landing systems, types of transponders

15 Hours

Unit III

Types of Navigation

Doppler Effect, Doppler navigation principles, Airborne equipment, Hyperbolic position fixing, LORAN-C operation, LORAN airborne and ground equipment

RNAV overview, RNAV equipment, INS- principle, operation, Alignment, Accuracy GPS – Satellite navigation principles, GPS Segments, Operation

Types of navigation systems, significance of waypoints

15 Hours

Unit IV

FMS and ATC systems

FMS – Over view, System Initialization, FMCS and its operation

ATC systems – ATCRBS, ATS basic principle, ATC transponder – modes, dual control panel, mode S replies, System block diagram, Operation, TCAS equipment and operation, TCAS overview.

IFF and different types of advisories

15 Hours

Total: 60 Hours

Text Book (s):

1. Aircraft Communications and Navigation Systems by Mike Tooley and David Wyatt - Butterworth-Heinemann publishers

Reference Book (s):

1. Aircraft Radio Systems by Powell
2. Aviation Electronics Vol.1 by John M. Ferrara

Sample Question (S)
Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	15	15	--
Understand	50	50	--
Apply	35	35	50
Analyse	--	--	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. State the purpose of ELT
2. State the purpose of voice recorder
3. Recall types of landing systems
4. State the difference between TCAS and ACAS

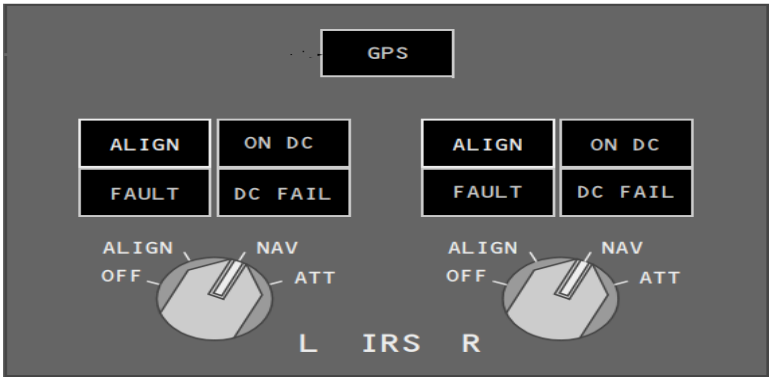
Understand

1. Explain LORAN-C operation
2. Explain the operation of DME
3. Explain GPS segments
4. Explain the Doppler effect

Apply

1. Select appropriate ground equipment for ILS
2. Select appropriate ground equipment for MLS
3. Find the instruments responsible for navigation
4. Predict when the following lights will illuminate

[Open Book Examination Question]



Geographic Information System

Preamble:

A geographic information system (GIS) is a conceptualized framework that provides the ability to capture and analyse spatial and geographic data. GIS applications (or GIS apps) are computer-based tools that allow the user to create interactive queries (user-created searches), store and edit spatial and non-spatial data, analyze spatial information output, and visually share the results of these operations by presenting them as maps. Geographic information science (or, GIScience)-the scientific study of geographic concepts, applications, and systems is commonly initialized as GIS, as well.

Geographic information systems are utilized in multiple technologies, processes, techniques and methods. They are attached to various operations and numerous applications that relate to: engineering, planning, management, transport/logistics, insurance, telecommunications, and business. For this reason, GIS and location intelligence applications are at the foundation of location-enabled services that rely on geographic analysis and visualization.

Placement Opportunities:

People working in many different fields use GIS technology. GIS technology can be used for scientific investigations, resource management, and development planning. Many retail businesses use GIS to help them determine where to locate a new store. Marketing companies use GIS to decide to whom to market stores and restaurants, and where that marketing should be. Scientists use GIS to compare population statistics to resources such as drinking water. Biologists use GIS to track animal-migration patterns. There is no limit to the kind of information that can be analysed using GIS technology.

19ECM51 Sensors and Sensing Technology

4 0 0 4

Course Outcomes

1. Explain properties of semiconductor as sensors
2. Illustrate the working principle of different sensors
3. Demonstrate the characteristics of sensors
4. Explain the challenges in biomedical sensors
5. Illustrate the challenges in textile sensors
6. Outline the biomedical and textile sensors

COs – POs Mapping

COs	PO_1	PO_2
1	2	-
2	2	-
3	3	2
4	2	-
5	2	-
6	3	2

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit – I

Introduction to Sensors

Electronic and Optical properties of semiconductor as sensors, LED, Semiconductor lasers, Fiber optic sensors, Thermal detectors, Photo multipliers, photoconductive detectors, Photo diodes, Avalanche photodiodes, CCDs. Strain gages, strain gage beam force sensor, piezoelectric force sensor, load cell, torque sensor, Piezo-resistive and capacitive pressure sensor, optoelectronic pressure sensors, vacuum sensors.

14 Hours

Unit-II

Principle of Sensors

Strain gages, strain gage beam force sensor, piezoelectric force sensor, load cell, torque sensor, Piezo-resistive and capacitive pressure sensor, optoelectronic pressure sensors, vacuum sensors. Potentiometric and capacitive sensors, Inductive and magnetic sensor, LVDT, RVDT, eddy current, transverse inductive, Hall effect, magneto resistive, magneto strictive sensors. Electromagnetic velocity sensor, Doppler with sound, light, Accelerometer characteristics, capacitive, piezo-resistive, piezoelectric accelerometer Flow sensors: pressure gradient technique, thermal transport, ultrasonic, electromagnetic and Laser anemometer. microflow sensor, coriolis mass flow and drag flow sensor

15 Hours

Unit – III

System Design using Sensors

Introduction-Systems design - Challenges in chemical and biochemical sensing - Application areas -Wearable inertial sensors - obtained parameters from inertial sensors - Applications for wearable motion sensors - Practical considerations for wearable inertial sensor - Application in clinical practice and future scope

15 Hours

Unit – IV

Textile Sensors

From fibers to textile sensors - Interlaced network -Textile sensors for physiological state monitoring - Biomechanical sensing - Noninvasive sweat monitoring by textile sensors and other applications. FBG sensor in Intelligent Clothing and Biomechanics. Introduction, Components of RFID systems, hardware and software components, RFID standards, RFID applications.

16 Hours

Text Book (s):

1. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York.
2. Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland
3. Michael J. McGrath, Cliodhna Ni Scanaill, Dawn Nafus, "Sensor Technologies: Healthcare, Wellness and Environmental Applications", 201, 1st Edition , Apress Media LLC, New York.
4. William S. Wong, Alberto Salleo, Flexible Electronics: Materials and Applications, 2011, 1st Edition, Springer, New York.
5. Finkenzeuer Klaus, "RFID Handbook", 2011, 3rd edition, John Wiley and Sons, New Jersey

Reference Book (s):

1. Gerd Keiser,"Optical Fiber Communications", 2012, 4th edition, McGraw-Hill Science, Delhi.
2. John G Webster, "Measurement, Instrumentation and sensor Handbook", 2014, 2nd edition, CRC Press, Florida.
3. Eric Udd and W.B. Spillman, "Fiber optic sensors: An introduction for engineers and scientists", 2013, 2nd edition, Wiley, New Jersey

Sample Question (S)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	15	15	--
Understand	50	50	--
Apply	35	35	50
Analyse	--	--	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. List any three sensors
2. State the purpose of ultrasonic sensor

Understand

1. Explain the working of pressure sensor
2. Explain the operation of inductive sensor

Apply

1. Demonstrate the characteristics of optical sensor
2. Demonstrate the characteristics of biochemical sensor

[Open Book Examination Question]

Analyze

1. The biomedical and textile sensors

[Open Book Examination Question]

19ECM52 Geographic Information Systems

4 0 0 4

Course Outcomes

1. Explain the Fundamentals of GIS
2. Identify the components of GIS
3. Demonstrate the Spatial data models
4. Illustrate different data input formats of GIS
5. Represent different topologies used in GIS
6. Outline the applications of GIS

COs – POs Mapping

COs	PO_1	PO_2
1	2	-
2	2	-
3	3	2
4	2	-
5	2	-
6	3	2

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I

Fundamentals of GIS

Introduction to GIS - Basic spatial concepts - Coordinate Systems - GIS and Information Systems – Definitions – History of GIS - Components of a GIS – Hardware, Software, Data, People, Methods – Proprietary and open source Software - Types of data – Spatial, Attribute data- types of attributes – scales/ levels of measurements.

16 Hours

Unit II

Spatial data models

Database Structures – Relational, Object Oriented – ER diagram - spatial data models – Raster Data Structures – Raster Data Compression - Vector Data Structures - Raster vs Vector Models- TIN and GRID data models - OGC standards - Data Quality. **14 Hours**

Unit III

Data input and topology

Scanner - Raster Data Input – Raster Data File Formats – Vector Data Input –Digitiser –Topology - Adjacency, connectivity and containment – Topological Consistency rules – Attribute Data linking – ODBC – GPS - Concept GPS based mapping **16 Hours**

Unit IV

Applications

GIS Applicant - Natural Resource Management - Engineering - Navigation - Vehicle tracking and fleet management - Marketing and Business applications - Case studies.

14 Hours

Total: 60 Hours

Text Book (s):

1. Kang – Tsung Chang, Introduction to Geographic Information Systems, McGraw Hill Publishing, 2nd Edition, 2011.
2. Ian Heywood, Sarah Cornelius, Steve Carver, Srinivasa Raju, An Introduction Geographical Information Systems, Pearson Education, 2nd Edition,2007.

Reference Book (s):

1. Lo.CP., Albert K.W. Yeung, Concepts and techniques of Geographic Information systems, Prentice hall, India, 2006.

Sample Question (S)
Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	15	15	--
Understand	50	50	--
Apply	35	35	50
Analyse	--	--	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. List any three components of GIS
2. State the types of GIS data

Understand

1. Explain the Database Structures of GIS
2. Represent different topologies used in GIS

Apply

1. Demonstrate the Spatial data models
2. Demonstrate the characteristics of biochemical sensor

[Open Book Examination Question]

Analyze

1. Outline the applications of GIS

[Open Book Examination Question]

19ECM532 Digital Image Processing

4 0 0 4

Course Outcomes

1. Interpret fundamental concepts of digital image processing
2. Infer image transforms
3. Exemplify image enhancement and color image processing
4. Assess image restoration techniques
5. Summarize line, point, threshold and region based segmentation for digital images
6. Attribute various compression models and compression techniques for digital images

COs – POs Mapping

COs	PO 1	PO 2
1	2	-
2	2	-
3	2	-
4	3	2
5	2	-
6	3	2

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I

Digital Image Fundamentals

Fundamental steps in Digital image processing, Components of an Image processing system, Elements of visual perception, Image sampling and quantization, basic relationships between pixels, An introduction to mathematical tools in digital image processing.

Image transforms**:** 2D DFT and its properties, Discrete cosine transform, Discrete Wavelet Transform.

Walsh Transform, Hadamard Transform

17 Hours

Unit II

Image Enhancement and Color Image Processing

Enhancement in spatial domain: Intensity transformations, Histogram Processing, smoothing and sharpening, ImageEnhancement in Frequency Domain: Smoothing and Sharpening Filters

Color fundamentals, Color models, Pseudo color Image Processing, Full Color Image Processing, color transformations.

Color Image Enhancement in spatial and frequency domain

17 Hours

Unit III

Image Restoration

Image Degradation/Restoration model, Noise models, Restoration using spatial filtering, Periodic noise reduction byfrequency domain filtering, Linear Position-Invariant Degradations, Inverse filtering, Minimum Mean Square Error Filtering, Constrained Least squares filtering.

Estimating the degradation function, Geometric Mean filter

12 Hours

Unit IV

Image Segmentation and Compression

Image segmentation: Fundamentals, point, Line and Edge detection, Thresholding, Region based Segmentation, Image Compression: Fundamentals, Image Compression Models, Lossless Compression, Lossy Compression,Transform coding and JPEG compression standard.

Watershed algorithm

14 Hours

Total: 60 Hours

Textbook (s)

1. Rafel C.Gonzalez and Richard E.Woods, Digital Image Processing, Pearson Education, 3rdEdition 2011
2. S.Sridhar, Digital Image Processing, Oxford publishers, 2nd Edition, 2016

Reference (s)

1. Anil K. Jain, Fundamentals of Digital Image Processing, Pearson Education, 1st Edition, 2015
2. S.Jayaraman, S.Esakirajan, T.Veerakaumar, Digital Image Processing, McGraw Hill publishers, 2011
3. M.Sonka,V. Hlavac, R. Boyle, Image Processing, Analysis and Machine Vision, Vikas Publishing House, 2001

Sample Question (S)
Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	15	15	--
Understand	50	50	--
Apply	35	35	50
Analyse	--	--	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. List the 6 components of digital image processing system
2. Define image enhancement
3. Define image segmentation
4. State the lossy compression
5. List out the 3 color models

Understand

1. Interpret the process of image sampling and quantization
2. Summarize the fundamental steps in digital image processing
3. Represent RGB color model
4. Explain the properties of 2D Discrete Fourier Transform
5. Illustrate contrast stretching transformation function to increase the dynamic range of the gray levels in theimage

Apply

1. Consider the image segment shown below. Compute N4, N8 distances

   3 1 2 1 (q)
   2 2 0 2
   1 2 1 1
   (p) 1 0 1 2
2. Compute histogram equalization for a given 8x8 image
3. Compute the efficiency of Huffman Coding for the given symbols

Symbol	a1	a2	a3	a4	a5	a6
Probability	0.1	0.4	0.06	0.1	0.04	0.3

[Open Book Examination Question]

4. Implement segmentation on given image using bimodal thresholding
5. Show that a linear, spatially –invariant degradation system with additive noise can be modeled in the spatialdomain as the convolution of the degradation function with an image followed by addition of noise

Analyse

1. Differentiate between image enhancement and restoration in terms of processing and applications
2. Compare lossy and lossless compression methods in terms of entropy, applications and transforms used
3. Is image enhancement a subjective approach? Justify your answer
4. Is lossless compression preferred to lossy compression? Justify your answer
5. Differentiate region based segmentation and thresholding based segmentation in terms of approach andapplications

   [Open Book Examination Question]

19ECM54 Lidar Systems

4 0 0 4

Course Outcomes

1. Interpret fundamental concepts of Lidar
2. Demonstrate the architecture of Lidar
3. Illustrate the data inversion and error analysis procedure
4. Illustrate the Aerosol/Cloud and Constituent Measurements using Lidars
5. Assess the applications of Lidar
6. Outline Lidar Performance Analysis

COs – POs Mapping

COs	PO_1	PO_2
1	2	-
2	3	2
3	2	-
4	2	-
5	3	2
6	3	2

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit I

Fundamentals of Lidar Remote Sensing

Concept and classification of remote sensing , Overview of lidar remote sensing , Laser Basics , General picture of lidar remote sensing , General lidar equation , Physical processes involved in different lidars , General lidar architecture, Classification of lidars.

20 Hours

Unit II

Lidar Equation, Data Inversion and Error Analysis

General solutions of lidar equation, physical parameters using lidar equation , General data inversion procedure, General error analysis procedure

10 Hours

Unit III

Topical Lidars and Their Applications

Lidars for Aerosol/Cloud Measurements ,Lidars for Constituent Measurements , Lidars for Temperature Measurements , Lidars for Wind Measurements, Lidars for Solid Target Detection , Laser Range Finding / Laser Altimeter , CW-Laser Imaging Lidars

16 Hours

Unit IV

Lidar Design and Performance Analysis

Overall Considerations, Transmitter Considerations , Receiver and Data Acquisition Considerations , Lidar Performance Analysis and Simulation

14Hours

Total: 60 Hours

Text Book (s):

1. Raymond M. Measures, "Laser Remote Sensing: Fundamentals and Applications, " WileyInterscience, 1984.
2. Takshi Fujii and Tetsuo Fukuchi, Published by CRC Press, "Laser Remote Sensing"Taylor & Francis Group, 2005. Gary Yeap, "Practical low power digital VLSI design", Kluwer, 1998

Reference Book (s):

1. Claus Weitkamp "idar: Range-resolved optical remote sensing of the atmosphere" Springer, 2005

Sample Question (S)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	15	15	--
Understand	50	50	--
Apply	35	35	50
Analyze	--	--	50
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Remember

1. List any three applications of Lidar.
2. Recall the error analysis procedure.

Understand

1. Explain the fundamental concepts of Lidar
2. Illustrate the Aerosol/Cloud and Constituent Measurements using Lidars

Apply

1. Demonstrate the architecture of Lidar
2. Assess the General data inversion procedure

[Open Book Examination Question]

Analyze

1. Outline the applications of Lidar

[Open Book Examination Question]

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

AR19 MINOR COURSES

Minors for other Departments offered by Electrical and Electronics Engineering

Stream 1: Electric Vehicles Technology

Prospectus:
The Indian automotive industry is the fifth largest in the world, with a goal of becoming the third largest by 2030. The cost of oil imports, rising pollution, and international commitments to combat global climate change are just a few of the factors driving India's recent policies to accelerate the transition to electrical vehicle technology. Over the next few years, electric-based propulsion systems for commercial vehicles are likely to capture a significant share of the commercial vehicle market, threatening to displace internal combustion engines, today's dominant power source. This is the most revolutionary development in the automobile industry. The transition to electric power will almost certainly necessitate significant changes in adaptation on the part of current industry participants, while opening the door to new entrants.

Growth Prospects:
Electric mobility offers serviceability a distinct occasion to grow earnings through the increased trade of power. But, it's the posterior access to detailed consumption data for each connected charging and consumption point that can offer fresh paths for growth. Still, this combination of increased demand and data access can have significant goods on a mileage's trading geste as it seeks to optimize and hedge its portfolio, if gauged up.

Placement Opportunities:
In line with the growing relinquishment of electric vehicles, India is anticipated to have 30% of the vehicles on its roads to be electric vehicles by 2030. Presently India has about 23 crore vehicles. One third of the vehicles by 2030 could amount to about 10 crore vehicles. The increasing vehicle population means a huge ecosystem of original equipment manufacturers and component companies. Electric mobility can thus create millions of local, green, and highly skilled jobs. According to the estimate of the Ministry of Skill Development and Entrepreneurship, the EV industry alone will create one crore jobs by 2030.
IT/CSE: These engineers apply the theories of computer science and mathematical analysis to create and evaluate software applications and systems. Modern vehicles are extensively computer-controlled, and software developers create the software that controls these vehicles.
ECE: These engineers design, develop, and test electronic components and systems for vehicles along with control systems and additional electronic components for the vehicle.
Mechanical: These engineers design, develop, and test the tools, engines, machines, and other mechanical devices in electric vehicles and they also focus on engines, electric motors, or other mechanical devices, such as transmissions, drivetrains, or steering systems.
Chemical: These engineers apply the principles of chemistry to design or improve equipment or to devise processes for manufacturing chemicals and products. Because the batteries of electric vehicles store power through chemical processes, chemical engineers are responsible for developing new battery designs and improving current battery technologies.

19EEM11 Introduction to Electric Vehicles Technologies

4 0 0 4

Course Outcomes

1. Outline the challenges and architectures of electric vehicle
2. Analyze the different configurations of electric vehicle
3. Outline the different types of hybrid electric vehicle
4. Illustrate the safety Issues of electric vehicles
5. Outline the policies and regulations of electric vehicle
6. Outline various types of Energy Management Strategies

COs – POs Mapping

COs	PO_2	PO_3
1	2	2
2	3	3
3	2	2
4	2	2
5	2	2
6	2	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit-I Introduction to EV **15 Hours**

History of Electric Vehicles, social and environmental importance of electric vehicles, benefits, overview of EVs and challenges, components of EVs, architecture of EVs, EV market and promotion, infrastructure needs.
Advantages and disadvantages of EVs

Unit-II Types and configurations of EV **15 Hours**

Configurations of Electric Vehicles, Pure Electric Vehicles (PEV), Hybrid Electric Vehicles (HEV) and Plug-in Hybrid Electric Vehicles (PHEV), Configurations - Series and parallel HEV.
Performance of Electric Vehicles

Unit-III Environmental Impact and Safety Issues of Modern Transportation **15 Hours**

Environmental Impact- Air Pollution, Global Warming, Petroleum Resources, Importance and Development of Different Transportation technologies on environment, , Safety of the electrical system, Safety regarding the functioning of the systems, Battery safety, risks associated with hybrid and electric vehicles. Policies and Regulations, policies in India.
Payback and commercial model

Unit-IV Energy Management Strategies **15 Hours**

Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy, management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.
Electrification challenges

Total: 60 Hours

Textbook(s)

1. *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles* Mehrdad Ehsani, Texas A&M University Yimin Gao, Texas A&M University Sebastien E. Gay, Texas A&M University Ali Emadi, Illinois Institute of Technology.
2. Iqbal Hussein, *Electric and Hybrid Vehicles: Design Fundamentals*, CRC Press, 2003.
3. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, *Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design*, CRC Press, 2004.

Reference book(s)

1. *Electric Vehicle technology* by John Lowry and James Larminie.
2. James Larminie, John Lowry, *Electric Vehicle Technology Explained*, Wiley, 2003.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	40	40	---
Understand	40	40	---
Apply	20	20	50
Analyze			50
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. Outline the Electric vehicle characteristics
2. List out the challenges of Electric vehicle
3. List out the Environmental impact of Electrical vehicle

Understand

1. Explain in detail about layout of Electric vehicle
2. Explain the energy management strategies of Electric vehicle
3. Explain the plug in hybrid Electric vehicle

Apply

1. Develop the layout of Series hybrid electric vehicle
2. Develop the layout of Series hybrid electric vehicle
3. Identify the various strategies used in implementation of electric vehicle
4. Mr. Krishna, a businessman, needs to travel daily on an average covering 100km which consists of 70 km highway drive and 30 km city drive. He is currently using a diesel vehicle and wants to shift to non-polluting/less polluting vehicle. Help him identify which vehicle he can opt so that it would cater to his needs as well as reduce his vehicle carbon footprint. Justify your selection by giving a detailed layout of architecture of the proposed vehicle and by relating the driving requirements of Mr. Rahul with the operating characteristics of the vehicle.
   (For Open Book Examination and not for semester end examination)

Analyze

1. Analyze the factors and challenges in developing the less polluting vehicle

19EEM12 Electrical Drives and Controllers for Electric Vehicles

4 0 0 4

Course Outcomes

1. Outline the performance of Electric motor
2. Outline the various control strategies in Electric Vehicle
3. Analyze the performance of Electric vehicle drive system
4. Summarize the characteristics of Induction motor drive in EV application
5. Identify suitable drive for EV applications
6. Analyze the performance of BLDC motor drive in EV application

COs – POs Mapping

COs	PO_2	PO_3
1	2	2
2	2	2
3	3	3
4	2	2
5	3	3
6	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Introduction to Electric Motors and Control Strategies

Types of Motors, Selection and Sizing, RPM and Torque calculations of motor, Motor controllers and component sizing, physical locations, Mechanical and Electrical Connection of motor, Controller overview, switch controller, solid state controller, AC & DC controller.

Electronic controller **15 Hours**

Unit II

Electric Vehicle Drives

Configuration of Electric Vehicles, Performance of Electric Vehicles, Traction motor charterstics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving.

Energy Consumption **15 Hours**

Unit III

Electric Propulsion System-I

DC Motor Drive- Introduction, Construction, Principle of operation, Performance charterstics and applications.

Induction Motor Drive- Introduction, Construction, Principle of operation, Performance charterstics and applications.

Various types of starters **15 Hours**

Unit IV

Electric Propulsion System-II

BLDC Motor Drive- Introduction, Construction, Principle of operation, Performance charterstics and applications.

PMSM Drive: Introduction, Construction, Principle of operation, Performance charterstics and applications.

Classification properties of PM material **15 Hours**

Total: 60 Hours

Textbook (s)

1. Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, M. Eshani, CRC Press, 2005.
2. Hybrid Electric Vehicle System Modeling and Control - Wei Liu, General Motors, USA, John Wiley & Sons, Inc., 2017.
3. Husain, I. "Electric and Hybrid Vehicles" Boca Raton, CRC Press, 2010.

Reference (s)

1. Modern Electric Vehicle Technology, C.C. Chan and K.T. Chau, Oxford Science Publication 2001.
2. Electric and Hybrid Vehicles, Tom Denton, Taylor & Francis, 2018.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	20	20	---
Understand	20	20	---
Apply	30	30	50
Analyze	30	30	50
Evaluate	---	---	---

Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. List any two types of motors
2. Define torque
3. List any two differences between AC and DC controllers

Understand

1. Outline the various characteristics of traction motor
2. Outline the construction and principle operation of Induction motor
3. Explain the electric connection of motor used in Electric vehicle

Apply

1. Identify the suitable drive system in Electric vehicle application
2. Make use of various control strategies in EV application
3. Develop the expression for tractive effort

Analyze

1. Examine the performance of various drives used in Electric Vehicle applications
2. Analyze various control strategies used in Electric Vehicle applications

19EEM13 Charging Technology in Electric Vehicles

4 0 0 4

Course Outcomes

1. Outline energy management principles in electrical vehicles
2. Identify the role of smart charging technologies in electrical vehicles
3. Examine the state of charge and depth of discharge
4. Outline various charging methods in electrical vehicles
5. Demonstrate the current and voltage measurement techniques
6. Illustrate the charging architecture for electrical vehicles

COs – POs Mapping

COs	PO_2	PO_3
1	2	2
2	3	3
3	3	3
4	2	2
5	2	2
6	2	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Vehicle Electrification: Main Concepts, Energy Management, and Impact of Charging Strategies

Introduction and Definitions, PHEV Energy Management, Full-Electric Vehicles, PEV Charging Options and Infrastructure, Energy, Economic, and Environmental Considerations, The Role of Smart Charging Technologies and Applications

Impact of Charging Strategies

15 Hours

Unit II

Battery Technologies for Transportation Applications

Battery Parameters - Storage Capacity, Energy Density, Specific Power, Cell Voltage, Charge and Discharge Current, State of Charge, Depth of Discharge, Cycle Life, Self-discharge, Round-Trip Efficiency, over potentials. Battery Technologies - Lead Acid, Nickel-Cadmium (Ni-Cd), Nickel-Metal Hydride (Ni-MH), Lithium-Ion (Li-Ion), Fuel Cells

Super Capacitors

15 Hours

Unit III

Battery Charging

Charging Methods - Float Charge, Trickle Charge, Bulk Charge, Equalization Charge

Charging Techniques - Constant Current, Constant Voltage, Constant Current–Constant Voltage

SoC Estimation - Voltage Measurement, Specific Gravity Measurement, Current Measurement

Internal Impedance Measurement

15 Hours

Unit IV

Charging Architectures for Electric and Plug-In Hybrid Electric Vehicles

Onboard Chargers - Dedicated Converter (Slow Charging), Integrated Converter (Semi-fast Charging) Off-Board Chargers - Dedicated Off-Board DC Chargers (Fast Charging), Concept of Fast-Charging Stations, Challenges for Fast-Charging Stations

EV / PHEV charging Standards

15 Hours

Total: 60 Hours

Textbook (s)

1. Ottorino Veneri. "Technologies and Applications for Smart Charging of Electric and Plug-in Hybrid Vehicles". Springer International Publishing Switzerland 2017
2. Husain, I. "Electric and Hybrid Vehicles" Boca Raton, CRC Press, 2010.
3. Sheldon S. Williamson, "Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles", Springer, 2013

Reference (s)

1. Larminie, James, and John Lowry, "Electric Vehicle Technology Explained" John Wiley and Sons, 2012
2. Tariq Muneer and Irene IllescasGarcía, "The automobile, In Electric Vehicles: Prospects and Challenges", Elsevier, 2017

Sample question (s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	20	25	---
Understand	20	25	---
Apply	30	50	60
Analyze	30	---	40
Evaluate	---	---	---
Create	---	---	
Total (%)	100	100	100

Remember

1. Define Float charge method of charging of electric vehicles**.**
2. List any four types of battery charging measurement techniques.

Understand

1. What are different modes of charging batteries? Compare them in detail
2. Classify and explain the basic principle of Rule based energy management system. Elaborate on any one of the Rule based energy management systems

Apply

1. In a parallel hybrid electric vehicle (HEV) of hybrid-ness = 25%, has an electrical traction motor and an IC engine, both engine and motor shafts are inputs to a three-way transmission system with a total tractive power of 100kW. Assuming 95% efficiency, find the minimum size of battery in Ah, for a 20Hr drive cycle. Select battery voltage as 120V.
2. A 12V battery pack is connected to series RL load with L=100mH. The battery pack has rated capacity of 120Ah. At t=0 switch is closed and the battery begins to discharge.
    a) Calculate the plot battery discharge current i(t), if the steady state discharge is C/5.Neglect voltage drop.
    b) Calculate the plot SoC, assuming at t=0, the battery is charging to rated capacity.

Analyze

1. Analyze fuel cell and flywheel as energy source elements in electric and hybrid electric vehicle
2. Compare Voltage and current measurement of SoC Estimation.

19EEM14 Computer Vision in Electric Vehicles

4 0 0 4

Course Outcomes

1. Summarize the strengths of computer vision in terms of accuracy, precision and robustness
2. Outline the terminology related to the computer vision pertaining to electric vehicles
3. Apply the available methods to estimate the object distance and tracking
4. Understand usage of cruise control and traffic jam assistance
5. Understand usage of head lamp control and night vision
6. Examine challenges for lane departure and parking assistance

COs – POs Mapping

COs	PO_2	PO_3
1	2	2
2	2	2
3	3	3
4	2	2
5	2	2
6	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Introduction to computer vision

Traffic safety and comfort, strengths of computer vision, Generic and specific tasks, Multi module solutions, Accuracy, precision and, robustness, Comparative performance evaluation, Notation and basic definitions, Images and Videos, cameras and optimization, Visual tasks- Distance, motion, object detection and tracking. *semantic segmentation*. **15 Hours**

Unit II

Autonomous Driving

Level of autonomous, important research projects, outdoor vision challenges, Autonomous driving in cities- localization, stereo vision based perception in 3D, object recognition, Challenges- Increasing robustness. *Scene labelling, intent recognition* **15 Hours**

Unit III

Vision based advanced driver assistant systems

Forward assistance- cruise control (basic) and forward collision avoidance, traffic sign recognition, traffic jam assist (TJA), vulnerable road uses protection, intelligent headlamp control. *enhanced night vision, intelligent active suspension* **15 Hours**

Unit IV

Lateral Assistance

Lane departure warning and lane keeping system, Lane change assistance (LCA), Parking assistance, Inside Assistance- Driver monitoring and drowsiness detection, Application challenges from a birds eye view *Sewage line projects in Dehradun smart city*

15 Hours

Total: 60 Hours

Textbook (s)

1. Antonio M. López ,Atsushi Imiya Tomas Pajdla and Jose M. Álvarez, *Computer vision in vehicle technology*, Wiley international 2017.

Reference (s)

1. Achtelik M, Bachrach A, He R, Prentice S and Roy N. 2009. Stereo vision and laser odometry for autonomous helicopters in GPS-denied indoor environments. SPIE Conference on Unmanned Systems Technology, Orlando, FL, USA.
2. Achtelik MC, Doth KM, Gurdan D and Stumpf J. 2012. Design of a multi rotor MAV with regard to efficiency, dynamics and redundancy. AIAA Guidance, Navigation, and Control Conference.
3. Achtelik M, Weiss S and Siegwart R. 2011. Onboard IMU and monocular vision based control for MAVs in unknown in and outdoor environments. Proceedings of the IEEE International Conference on Robotics and Automation.

4. Adnriluka M, Roth S and Schiele B. 2008. People-tracking-by-detection and people-detection-by-tracking. Proceedings of the conference on Computer Vision and Pattern Recognition, Anchorage, AK, USA.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	25	---	---
Understand	50	25	---
Apply	25	50	50
Analyze	---	25	50
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample question (s)

Remember

1. Recall labelling function for optimization
2. List different types of cameras used in electric vehicle

Understand

1. Explain how distance is estimated using time of flight principle
2. Explain methods for object detection.

Apply

1. Analyze how the stereo is used for optical flow calculations
2. Develop a smart car system that allows for Autonomous Driving in designated areas, for example, valet parking, park and ride, and offers advanced driver support in urban environments

Stream 2: Smart City Management

Prospectus:
Smart Cities discover & polish their concepts until they attain the desired outcomes. The entire concept of these Smart Cities was implemented with a dream to improve quality of life. This improvement involves technological reforms, institutional engagements or managerial transformations and the engrossment of citizens. Ranging from Entrepreneurship to Hospitality and Engineering to Policy reform research, Smart City initiative propounds everything to get started on the path to fresh career dream.
Smart cities are an engine for job creation and economic growth. India is on the path of undertaking measures to enhance development. Creating jobs and incomes is crucial for development. Smart City initiative's innovations contribute to economic growth and employment and also promotes & contributes to sustainable development.
The contribution of Smart cities, to India's GDP will only increase. The cities accounted for 58% of the national GDP in 2008, which is expected to go up to 70% by 2030. The primary purpose behind promoting & developing smart cities is to enable the people to be more efficient and globally competitive. The need of the hour is to acquire deep insight into the character of the city and identify core economic potential that can be enhanced with the help of technology and advancement in urban infrastructure.

Growth Prospects: Growth opportunities would be immense in smart cities. As more and more construction, manufacturing and managerial workplaces are set up, need for jobs and chances of growth would keep on increasing as more and more projects are slated to be launched. With each new project, opportunities to grow and prosper would also rise.

Placement Opportunities:
Almost 1 million new jobs are expected to be created in all smart city projects combined, by the year 2030. Skilled and unskilled personnel for all departments would be required to make the projects a reality. These projects would be built across platforms that require both experience and new blood in its functioning. Experienced managers would be required to handle a team of young talents who would be the torch bearers of getting technology to work in the desired manner**.**
IT/CSE: All software-based systems (i.e., safety in cyber-attack to effective banking with various online Management and networking and IoT applications) in Smart City with proper management.
CIVIL: These engineers are working to harness the potential of latest technologies and data for our urban infrastructure, which is among the most complex system in the world. They provide sustainable, resilient and advanced means of transportation system, green building, better water management system and better waste management system. This not only develop physical infrastructure but also develop institutional & social infrastructure that enable our societies to function. Modelling these systems of systems will require managing data at an unprecedented scale.
ECE: ECE engineers' expertise in managing large scale research, conceptualizing, designing, developing and testing of the electronic equipment used in latest communication devices and other handy technological equipment, such as smartphones, tablets, processors, smart wrist watches, smart LED TV's, with Wireless Communication, Smart Communication, smart sensors applications etc.
Mechanical: Mechanical engineering plays a critical role in manufactured technologies, from automobiles sector to airplanes to refrigerators, various machinery aspects for construction design, maintenance of Smart City. It enables you to do many daily activities with ease, as it brings helpful technologies to our modern society.
Chemical: Chemical industry has a key role to play in the sustainable evolution of the smart cities. Additionally, chemistry is at the heart of all modern industries, including electronics, information technology, biotechnology and nanotechnology. Chemistry can make the smart cities project more sustainable, more energy efficient and more cost effective. There are six broad critical elements of any smart city: water management systems; infrastructure; transportation; energy; waste management and raw materials consumption. In all these elements chemistry and chemical engineering are deeply involved.

19EEM21 Fundamentals of Smart City

4 0 0 4

Course Outcomes

1. Summarize the role of smart cities in regard to sustainability goals in cities.
2. Identify the various trends in smart cities and homes.
3. Contrast the concepts related to sustainability in smart grids.
4. Survey the challenges of building smart home and smart building
5. Survey the smart initiatives for Chandigarh smart city
6. Identify the smart initiatives for Dehradun smart city

COs – POs Mapping

COs	PO_2	PO_3
1	2	2
2	3	3
3	2	2
4	3	3
5	3	3
6	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Fundamentals of Smart Cities

Definition, challenges for smart grid architecture, technical challenges of creating, operating and maintaining a smart city, new digital ecosystem, community as a smart city, challenges of envisioning and planning a true smart city, innovative smart city solutions, trends in smart cities and homes, challenges in smart cities and homes,

Survey of major key enabling technologies **15 Hours**

Unit II

Sustainability in Smart Cities

Introduction, Sustainability assessment in our cities, sustainability in smart cities, achieving balanced sustainability, improving procedural balance, improving contextual and temporal balance, City blocks as a contextual variable, improving integrational balance, current developments: sustainability information modeling, platforms.

Institutional and Governing Aspect **15 Hours**

Unit III

Smart Building Application

Foundations—from automation to smart homes, from today's technologically augmented houses to tomorrow's, smart home: past, present, and future, cps-based smart home automation and its applications, decentralized coordination and cooperation & their applications, connecting smart homes and smart cities.

Application: Ambient Assisted Living (AAL) **15 Hours**

Unit IV

Case study of Indian smart cities

Case Study of Chandigarh smart city, Latest Projects: waste water & management, Public health and waste management, Energy reforms and ICT initiatives. Public services, Cycle 4 challenge concept.

Case Study of Dehradun smart city, ABD Projects, smart toilet, water supply augmentation, smart school, smart water meter, solar energy harvesting and rain water harvesting, tree plantation and CRECHE buildings, PAN city solutions,

Sewage line projects in Dehradun smart city **15 Hours**

Total: 60 Hours

Textbook (s)

1. JN Pelton, IB Singh, "*Smart cities of today and tomorrow*," Copernicus, Cham. 2019:45, Springer International Publishing AG, part of Springer Nature 2019. https://doi.org/10.1007/978-3-319-95822-4
2. H Song, R Srinivasan, T Sookoor, S Jeschke, "*Smart cities: foundations, principles, and applications*," John Wiley & Sons; Jul 12, 2017.

Reference (s)

1. Obaidat MS, Nicopolitidis P. "*Smart cities and homes: Key enabling technologies*," Morgan Kaufmann; May 17, 2016.
2. https://www.chandigarhsmartcity.in/
3. http://smartcitydehradun.uk.gov.in/
4. https://www.india.gov.in/spotlight/smart-cities-mission-step-towards-smart-india

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	25	---	---
Understand	50	25	---
Apply	25	50	50
Analyze	---	25	50
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample question (s)

Remember

1. Define smart city.
2. What are the critical elements of a smart city in the 21st century?

Understand

1. Explain cps-based smart home automation?
2. Interpret the difference between?

Apply

1. Identify the solutions for innovative smart city?
2. Build the model of CRECHE buildings?

Analyze

1. Analyze the waste water management in Chandigarh smart city?
2. Examine the rain water harvesting in Dehradun smart city?

19EEM22 Smart City Infrastructure

4 0 0 4

Course Outcomes

1. Summarize the concepts of smart city.
2. Outline the urban transportation methodologies in a smart city.
3. Examine the food management procedure in smart city.
4. Outline the concepts related to design of smart building.
5. Summarize the concepts related to design of smart energy scenario.
6. Explain the various waste management techniques in smart city.

COs – POs Mapping

COs	PO_2	PO_3	PO_5	PO_6	PO_7	PO_{11}
1	2	2	2	2	3	2
2	2	2	2	2	3	2
3	3	3	3	3	3	3
4	2	2	2	2	3	2
5	2	2	2	2	3	2
6	2	2	2	2	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Smart cities: State of the art policies, design &agriculture management

Definition of smart city, Evolution of smart cities, Policy framework for smart cities, common flaws in planning smart cities, Government Policies Initiatives and Project management- green policies, sustainable food production and consumption, monitoring and management.

Government Planning codes for smart city **15 Hours**

Unit II

Smart urban transportation

Need of smart urban transportation, components - Physical components, Emerging concepts and strategies, ICT support of smart mobility system- automated fare collection system, intelligent signalling system, real time traffic monitoring system, parking information system, automated vehicle location system, use of electric vehicles and autonomous vehicles.

CCTV Monitoring System **15 Hours**

Unit III

Smart Energy and building:

Definition of smart energy, use of renewable energy, Intelligent energy efficient buildings-definition and objectives, smart- lighting, heating, ventilation and air conditioning, energy monitoring, metering and management system, fire safety and emergency warning systems.

Key Challenges for Smart City **15 Hours**

Unit IV

Smart waste management

Waste management changing approaches- waste collection and handling, IoT and ICT based systems for waste collection and management, automated waste collection system, indicators of solid waste management performance-core indicators and supporting indicators.

Rain water Harvesting system **15 Hours**

Total: 60 Hours

Textbook (s)

1. Sirajuddin Ahmed, S. M. Abbas, Hina Zia, "Smart Cities—Opportunities and Challenges", springer Publisher, ISBN-13: 978-9811525445, ISBN-10: 9811525447
2. Smart Infrastructure and Applications (Foundations for Smarter Cities and Societies), Springer, ISBN 978-3-030-13705-2

Reference (s)

1. Dr. N. Mani, "Smart Cities & Urban Development in India", ISBN-13 978-8177084320.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	25	25	---
Understand	50	50	---
Apply	25	25	50
Analyze	---	---	50
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample question (s)

Remember

1. Define Smart City
2. Find the key challenges for becoming smart city

Understand

1. Compare the transportation system in normal and smart city
2. Explain the need of smart city in developing India

Apply

1. Build the smart infrastructure which is required for a smart and energy efficient building
2. Identify the government Initiatives have been taken for smart cities

Analyze

1. Analyze the waste management scenario in smart cities as municipal waste and health waste.
2. Classify the various tools utilize to develop the smart cities

19EEM23 Computational Methods for Smart City Management

4 0 0 4

Course Outcomes

1. Outline the Importance of Artificial Intelligence
2. Outline the Importance of Explainable AI
3. Identify areas where we can use data mining
4. Illustrate the machine learning for STS
5. Make use of Machine learning for Smart traffic System
6. Construct the Smart Urban Traffic Management

COs – POs Mapping

COs	PO_3	PO_5
1	2	2
2	2	2
3	3	3
4	**2**	**2**
5	**3**	**3**
6	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Explainable Artificial Intelligence for Services Exchange in Smart City

Introduction, Explainable AI and Decision-Making, Big Data, and ICT for XAI Services in the Context of Smart Cities, The Smart Environment with XAI- Proposed Smart City Main Pillars and Architecture Benefits of Using XAI in Smart Cities, Addressed Challenges for XAI

Data Creation in Smart Cities **15 Hours**

Unit II

Data Mining Techniques for smart cities

Introduction, Literature Review, Methodology- Overview, KDD Process, Data Mining Methods and Implementation, Classification, Application of Internet of Things-Based Smart Cities, Explainable Artificial Intelligence for Smart Cities. Smart Model for Medical Waste Management, Architecture of Smart Solution.

Current Medical Waste Disposal Process in Morocco **15 Hours**

Unit III

An Analysis of Machine Learning for Smart Transportation System (STS)

Introduction, Evolution of Smart Transport System (STS), Process of Smart Transport System- Importance of Smart Transportation System, Working of Smart Transportation System Work, Intelligent Transportation System User Functions, Need for ML Techniques in STS, Integration of ML with IoT in Autonomous Vehicles

DL Techniques for Autonomous Vehicle Decision Making **15 Hours**

Unit IV

Smart Urban Traffic Management for an Efficient Smart City

Introduction, Smart Transport in Smart City Environment, Related Works on Urban Traffic Management UTM, Network for Urban Data Collection, Project Architecture, Approach for Urban Traffic Flow Management,

Impact of UTM on Urban Supply Chain **15 Hours**

Total: 60 Hours

Textbook (s)

1. Mohamed LahbyUtkuKose Akash Kumar Bhoi, "Explainable Artificial Intelligence For Smart Cities", First Edition published 2022 by CRC Press.
2. Stan Geertman, Qingming Zhan, "Computational Urban Planning and Management for Smart Cities", Spinger.

Reference (s)

1. Bob McQueen, "Big Data Analytics for Connected Vehicles and Smart Cities", 2017.
2. Waleed Ejaz, AlaganAnpalagan "Internet of Things for Smart Cities Technologies, Big Data and Security" Spinger.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	---	---	---
Understand	20	40	40
Apply	80	60	60
Analyze	---	---	---
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Understand

1. Outline the importance of Explainable AI
2. Illustrate the use Artificial Intelligence
3. Explain any three types of AI techniques.

Apply

1. Make use of explainable Artificial Intelligence for smart environment with any application
2. Identify the suitable Machine learning technique for the Smart Transport System.

19EEM24 Communication Technologies and Mobility for Smart City

4 0 0 4

Course Outcomes

1. Identify the communications and measurement technologies.
2. Outline the architecture and characteristics of smart grids for smart cities.
3. Contrast machine-to-machine communications.
4. Summarize transportation and environment management
5. Choose the wireless charging and methods
6. Demonstrate modes for wireless power transfer in EVs

COs – POs Mapping

COs	PO_2	PO_3
1	3	3
2	2	2
3	1	1
4	2	2
5	3	3
6	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Smart city Communications And Measurement Technology

Characteristics of smart city communication technology and communication techniques, Smart Meters, and Measurements Technologies, Wide Area Monitoring Systems (WAMS), Latest wired and wireless technologies, Introduction to Phasor Measurement Units (PMU), and Advanced Metering Infrastructure (AMI).

GIS and Google Mapping Tools Multi agent Systems (MAS) Technology **15 Hours**

Unit II

Smart grid prospective for Smart City Communications

Introduction, Architecture and Characteristics of Smart Grids for Smart Cities, Definition, Standardization, Smart Energy Sources, and consumers, Energy Service Providers, Intelligent Machine-to-Machine Communications in Smart Grids, Reference Architecture of Machine-to-Machine Interactions, Communication Media and Protocols, Layered Structure of Machine-to-Machine Communications

Interoperability Reference Model **15 Hours**

Unit III

5G and D2D Communications at the Service of Smart Cities

Introduction, Smart City communication Scenarios: Public Health, Transportation and Environment, Energy Efficiency, Smart Grid, Water Management, Disaster Response and Emergency Services Public Safety and Security, Multiple Radio Access Technologies (Multi-RAT), Virtualization, Distributed/Edge Computing, D2D Communication, Security and Privacy

Big Data for smart city communication **15 Hours**

Unit IV

Wireless Charging for Electric Vehicles in the Smart Cities:

Introduction, Review of the Wireless Charging Methods, Technologies Supporting Wireless Power Transfer for EVs, Operation Modes for Wireless Power Transfer in EVs, Electrical Effect of Charging Technologies on the Grid, Harmonics Control in EV Wireless Chargers, Power Factor Control in EV Wireless Chargers, Implementation of Bidirectionality in EV Wireless Chargers,

Scheduling Considering Charging Technologies **15 Hours**

Total: 60 Hours

Textbook (s)

1. Mouftah HT, Erol-Kantarci M, Rehmani MH, editors. Transportation and power grid in smart cities: communication networks and services. John Wiley & Sons; 2018 Nov 28.

References (s)

1. JN Pelton, IB Singh, "Smart cities of today and tomorrow," Copernicus, Cham. 2019:45, Springer International Publishing AG, part of Springer Nature 2019. https://doi.org/10.1007/978-3-319-95822-4
2. H Song, R Srinivasan, T Sookoor, S Jeschke, "Smart cities: foundations, principles, and applications," John Wiley & Sons; Jul 12, 2017

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	25	---	---
Understand	50	25	---
Apply	25	50	50
Analyze	---	25	50
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample question (s)

Remember

1. Define smart meter
2. List three effects f charging technologies on the grid
3. Define Machine-to-Machine Communications
4. Recall smart city communication scenarios

Understand

1. Explain the operation of phasor measurement units
2. Interpret intelligent machine-to-machine communications in smart grids
3. Summarize the concept of D2D Communication
4. Outline the role of Harmonics Control in EV Wireless Chargers

Apply

1. Identify the types of wired and wireless technologies
2. Organize the architecture smart grids for smart cities
3. Identify the various?

Analyze

1. Compare modes for wireless power transfer in evs
2. Contrast Charging Methods in evs
3. Analyze the power factor control in ev wireless chargers

Stream 3: Industrial Applications and Control

Preamble:
B.Tech minors in industrial applications and control is consisting of four courses namely Modeling and Simulations of Industrial Applications, Industrial Sensors and Actuators, Programmable Logic Controllers & Control Design for Industrial Applications. At the end of the course, the learners will be able to illustrate the model and simulation of the mechanical, electrical and reactor systems. The learners will understand the role of sensors and actuators in tracking different signals, operating principles, and their coordination. The learner will be able to apply their ladder logic program skill for various applications. Also, the learners can understand the preliminaries for controller design. The learners will be able to design the PLC based controller for mechanical, electrical and reactor systems.

Prospects:
Industrial automation is on the threshold of a new revolution, moving through rapid technology changes, adoption of new systems, networking architectures, and looking toward interoperability of devices and systems. The industrial space has been impacted with incremental technology changes, rapid adoption of new systems and augmented networking architectures over the last decade. Industrial technologies such as Modeling and Simulations of Industrial Applications, Industrial Sensors and Actuators, Programmable Logic Controllers and Control Design for Industrial Applications are becoming increasingly pervasive. Given the proliferation of large-scale, continuous and parameterized industrial devices digitization has fostered, this need will turn into an obligation.

Placement Opportunities:
You will be assisting with the provision of Instrumentation and/or Electrical engineering support or Industrial Control Systems (ICS) engineering on the refinery.
As an E, C & I Engineering placement student you will get the opportunity to work on a variety of real-life projects within the Instrumentation, Electrical engineering or Industrial Control field depending upon your skills or preference.
You will get to work alongside our experts on some of the most advanced technology used within the process industry sector including measurement and control systems, analysers, safety instrumented systems, electrical devices and electrical infrastructure, distributed control systems, industrial networking and cyber security.
Eventually the course is designed to help you gain the essential skills to have a successful career in industry.

19EEM31 Modelling and Simulations of Industrial Applications

4 0 0 4

Course Outcomes

1. Illustrate the modeling and simulation of the mass, spring, damping element system
2. Develop the analytical model and simulate the bicycle, Ackerman Steering and launch vehicle system
3. Develop the mathematical model and perform simulation of BLDC motor drive.
4. Illustrate the model of the semi-batch reactor and perform dynamic simulation
5. Illustrate the need of batch reactor and nuclear reactor simulation
6. Develop the mathematical model and process the dynamic simulation of nuclear reactor.

COs – POs Mapping

COs	PO_2	PO_3
1	2	2
2	3	3
3	3	3
4	2	2
5	2	2
6	3	3

3–Strongly linked | 2–Moderately linked| 1–Weakly linked

Unit-I

Modeling and Simulation of Dynamic Systems

Introduction to modeling of engineering systems, importance of modeling, dynamic models - mass, spring, damping element modeling and simulation. Off-road vehicle dynamics modeling and simulation – Basic Geometry for Ackerman Steering: Bicycle model, forces and moments on steering systems, vehicle tires, traction and slippage, modeling & simulation of launch vehicle system.

Simulation of Industrial Application of mass, spring and damping system

16 Hours

Unit-II

Electric motor modeling and simulation

Modeling and simulation of R-L-C series and parallel circuits, DC Motors and Brushless dc motor - commutation, performance characteristics, experimental model and simulation, Electrical Damping Constant, simulation and modeling of simple and cost-effective BLDC motor drives.

Linearized experimental model **15 Hours**

Unit-III

Batch Reactor modeling and simulation

Introduction, the process and the model - process description, mathematical model, application of control algorithm, dynamic simulation, mathematical model of a semi-batch reactor

Bioreactor modeling and simulation

15 Hours

Unit – IV

Nuclear Reactor modeling and simulation

Introduction, components of nuclear reactor, mathematical modeling and simulation of nuclear reactor, reactor core calculation overview, Neutron diffusion theory and nodal methods, Reactor power distribution, Simulation of a reactor core condition, Parallel processing for neutronic model.

High-performance computing in AZKIND

14 Hours

Total: 60 Hours

Textbook

1 Clarence W. de Silva, "*Modeling and Control of Engineering Systems*", 1st Edition, CRC Press, 2009.

2 Francisco Rovira Más Qin Zhang Alan C. Hansen, "*Mechatronics and Intelligent Systems for Off-road Vehicles*", Springer, 2011.

3 Amiya K. Jana, "*Chemical Process Modelling and Computer Simulation*", Second Edition, PHI Learning Pvt. Ltd., 2011.

4 Shimjith, S R, Tiwari, A P, Bandyopadhyay, B, "Modeling and Control of a Large Nuclear Reactor", Lecture Notes in Control and Information Sciences, Springer, 2013.

Reference (s)

1. Mara Tanelli, Matteo Corno, Sergio M. Savaresi, "*Modelling, Simulation and Control of Two-Wheeled Vehicles*", First Edition, John Wiley & Sons, Ltd, 2014.

2. Gh. Shokri & E. Naderi (2017), *Research on simulation and modeling of simple and cost-effective BLDC motor drives*, International Journal of Modelling and Simulation, 37:1, 15-24, DOI: 10.1080/02286203.2016.1195665

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	25	25	---
Understand	25	50	---
Apply	50	25	100
Analyze	--	--	---
Evaluate	--	--	---
Create	--	--	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. What is modeling and simulation?
2. Write the expression of electromagnetic energy of an inductor.
3. What are the advantages and disadvantages of the batch processing over the continuous operation?
4. What is yield factor?

Understand

1. Determine an expression for the dominant time constant of an armature-controlled dc motor.
2. Describe about the feedback control of dc motors.
3. Describe the process of reactor power distribution in nuclear reactor modeling.

Apply

1. Develop a mathematical model (mass and energy balance equations) for a non-adiabatic batch reactor considering convective heat loss to the atmosphere. You may assume that Te is the temperature of the environment, he is the convective heat transfer coefficient in the environment and no insulation is provided for the cooling coil outside the reactor. Assume the required conditions of this reactor.
2. Develop the mathematical model for a batch reactor where the following reactions take place:

$$A \xrightarrow{k_1} B \xrightarrow{k_2} C$$

$$A \xrightarrow{k_3} D$$

All are endothermic, first-order reactions. The reacting mixture is heated by a saturated steam, which flows through a jacket around the reactor with a rate of Q (mass/time).

19EEM32 Industrial Sensors and Actuators

4 0 0 4

Course Outcomes

1. Understand how different physical variables are measured and illustrate their working principles.
2. Identify and select proper sensors for specific applications.
3. Understand issues of implementation of different sensors including calibration and error analysis.
4. Familiar with the basics of various actuators.
5. Model linear actuators and differentiate various solenoids.
6. Explain the working principle of different types of rotary actuators.

COs – POs Mapping

COs	PO_2	PO_3
1	2	2
2	2	2
3	2	2
4	2	2
5	3	3
6	2	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Introduction to Sensors

Definition, Measurement Techniques, Classification of errors, Error analysis, Static and dynamic characteristics of transducers, Performance measures of sensors, Classification of sensors, calibration techniques.

Temperature Sensors: Thermoresistive, Resistance Temperature Detectors, Silicon Resistive, Thermistors, Semiconductor, Optical, Acoustic, Piezoelectric.

Position, Displacement and level sensors, Velocity and Acceleration Sensors.

Case study in manufacturing industries.

15 Hours

Unit II

Chemical Sensors:

Metal Oxide Chemical, ChemFET, Electrochemical, Potentiometric, Conduct metric, Amperometric, Optical Chemical, Mass Detector.

Modern Sensors:

Film sensors, micro-scale sensors, Particle measuring systems, Vibration Sensors, SMART sensors, Machine Vision, Multi-sensor systems.

Case study in processing Industries.

15 Hours

Unit III

Electrical Actuating systems

DC motors: Principle of operation, Performance, Efficiency and characteristics, Application as Actuator.
Stepper Motors: Principle of operation, Performance, Efficiency and characteristics, Application as Actuator.
Induction motors: Principle of operation, Performance, Efficiency and characteristics, Application as Actuator
Linear Actuators: Voice Coil Actuators, solenoids

Applications of Linear Actuators in industry

15 Hours

Unit IV

Pneumatic and Hydraulic actuating systems

Components of pneumatic and hydraulic systems, pumps, compressor, filter, control valves, pressure regulation, relief valves, accumulator.

Rotary Actuators: Disk Rotary Actuators, Claw Pole Rotary Actuators

Applications of Rotary Actuators in industry

15 Hours
Total: 60 Hours

Textbook (s)

1. Jacob Fraden, "Handbook of Modern Sensors, physics, design and applications", Fourth edition, Springer, 2010.
2. Patranabis D.," *Sensor and Actuators*", Prentice Hall of India (Pvt) Ltd., 2nd Edition, 2005.
3. Clarence W Silva, "*Sensors and Actuators: Control System Instrumentation*", CRC Press, 1st Edition, 2007.

Reference (s)

1. Andrzej M Pawlak, "*Sensors and Actuators in Mechatronics: Design and Applications*", CRC Press, 2006.
2. E.O. Doebelin, "*Measurement Systems: Application and Design*", McGraw Hill Higher Education, 4th Edition, 1990.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	20	20	---
Understand	40	40	---
Apply	40	40	100
Analyze	---	---	---
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. What do you mean by an actuator?
2. What are the requirements of Magnetic Speed Sensors?

Understand

1. Compare Soft Magnetic and Hard Magnetic Materials with suitable example
2. Explain about Claw Pole Rotary Actuator with necessary sketches

Apply

1. A thickness measuring transducer system has a parallel plate capacitive sensor having pair of plates of area of 200 cm2, which are separated by a distance of 0.02cm. A mica sheet of thickness 0.01±0.001 cm is begin passed between the plates. Calculate the variation of capacitance if the electric constant of mica is 8 and permittivity of air is 8.854x10-12 F/m.
2. Identify any 3 applications of Rotary and Linear Actuators in the present scenario. Construct a mathematical model for a linear actuator.

19EEM33 Programmable Logic Controllers

4 0 0 4

Course Outcomes

1. Outline the components and operation of programmable logic controller
2. Explain the instructions associated with the PLC programming languages
3. Model the ladder logic program for various applications
4. Develop the wiring diagram for various sensor and relay
5. Identify PLC program using Timer and counter for various Industrial applications
6. Model the various Industrial applications using Program control Instructions

COs – POs Mapping

COs	PO_2	PO_3
1	2	2
2	2	2
3	3	3
4	3	3
5	3	3
6	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Overview of PLC

Introduction, Parts of a PLC, Principles of Operation, PLCs versus Computers, PLC Size and Application. PLC Hardware components- I/O Section, Central Processing Unit, Memory Design, Memory Types, Programming Terminal Devices, Recording and Retrieving Data, Human Machine Interfaces.

Comparative study of Industrial PLCs.

15 Hours

Unit II

PLC Programming

Processor Memory Organization, Program Scan, PLC Programming Languages, Relay-Type Instructions, Instruction Addressing, Branch Instructions, Internal Relay Instructions, Programming Examine If Closed and Examine If Open Instructions, Entering the Ladder Diagram, Modes of Operation, Connecting PLC to computer - PLC Troubleshooting and Maintenance.

PLC Arithmetic Functions

15 Hours

Unit III

Developing Fundamental Plc Wiring Diagrams and Ladder Logic Programs

Electromagnetic Control Relays, Contactors, Motor Starters, Manually Operated Switches, Mechanically Operated Switches, Sensors, Output Control Devices, Seal-In Circuits, Latching Relays, Converting Relay Schematics into PLC Ladder Programs, Developing Ladder Logic Program for any application.

Industrial Program Applications

15 Hours

Unit IV

Timers and Counters

Programming of Timers – Introduction - ON delay, OFF delay, Retentive Timers – PLC Timer functions – Examples of timer function in Industrial application. Programming Counters – up/down counter – Combining counter - Examples of counter function in Industrial application- PLC Program Control Instructions: Master Control Reset - Skip – Jump and Move Instruction – Case study of Tank level control system, bottle filling system and Sequential switching of motors

Data Manipulation Instructions

15 Hours

Total: 60 Hours

Textbook

1. F. D. Petruzella, "*Programmable Logic Controllers*", Tata Mc-Graw Hill, 3rd Edition, 2010.

Reference (s)

1. Hughes, T, "*Programmable Logic Controllers*", ISA Press, 2000.
2. John W. Webb, Ronald A. Reis, "*Programmable Logic Controllers Principles and Applications"*, PHI, 5th Edition, 2002.
3. Madhuchannd Mitra and Samerjit Sengupta, "*Programmable Logic Controllers Industrial Automation an Introduction*", Penram International Publishing (India) Pvt. Ltd.; 2nd Edition, 2017.

4. J. R. Hackworth and F. D. Hackworth, "*Programmable Logic Controllers Principles and Applications*", Pearson publication, 2003.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	25	20	---
Understand	50	40	---
Apply	25	40	100
Analyze	---	---	
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. List any four tasks performed by a discrete input module
2. What is the most important characteristic of the Gray code?

Understand

1. Explain the difference between a unipolar and bipolar analog input module.
2. Draw the schematic for a conventional hardwired circuit that will perform the following circuit functions using two break-make pushbuttons:
   - Turn on light L1 when pushbutton PB1 is pressed.
   - Turn on light L2 when pushbutton PB2 is pressed.

Apply

1. Develop a PLC program and prepare a typical I/O connection diagram and ladder logic program that will correctly execute the hardwired control circuit in Figure 1

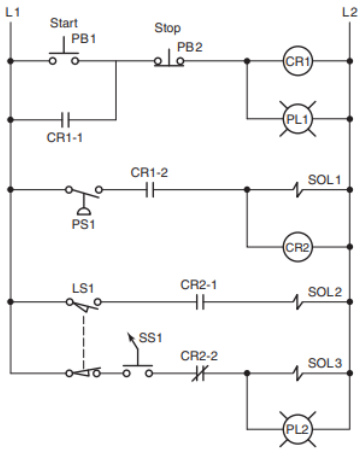


Figure 1

2. Design a PLC program and prepare a typical I/O connection diagram and ladder logic program that will correctly execute the hardwired control circuit in Figure 2 . Assume: Stop pushbutton used is an NO type. Run pushbutton used is an NO type. Jog pushbutton used has one set of NO contacts. OL contact is hardwired.

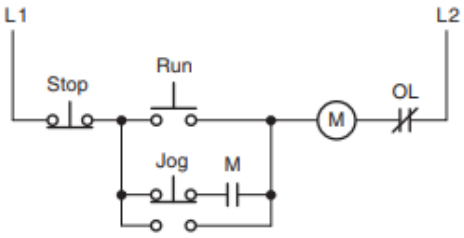


Figure 2

19EEM34 Control Design for Industrial Applications

4 0 0 4

Course Outcomes

1. Understand the preliminaries for controller design
2. Design the PLC based PID controller for DC motor
3. Design the PLC based PID controller for BLDC motor
4. Design the PID controller for mechanical systems
5. Design the PID controller for batch reactor
6. Design the PID controller for nuclear reactor

COs – POs Mapping

COs	PO_2	PO_3
1	2	2
2	3	3
3	3	3
4	3	3
5	3	3
6	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Unit I

Control systems - Preliminaries

Closed loop block diagram, stability, introduction to the time response and frequency response specifications, PID controller

Root locus method, Nyquist stability criterion

15 Hours

Unit II

Controller design for electrical systems

PLC based PID controller design for DC motor, PLC based PID controller design for BLDC motor.

Modeling of electrical systems, Preliminaries of Programmable logic controllers

15 Hours

Unit III

Controller design for mechanical systems

PID controller design for mass-spring-damper system, launch vehicle, bicycle model of a steering system

Modeling of mechanical systems

15 Hours

Unit IV

Controller design for reactor systems

PID controller for batch reactor and PID controller for nuclear reactor

Modeling of reactor systems

15 Hours

Total: 60 Hours

Textbook (s)

1. I. J. Nagrath, M. Gopal, "*Control Systems Engineering*", 5th edition, New Age International Publishers, 2010
2. Katsuhiko *Ogata*, "*Modern Control Engineering*", 5th Edition, University of Minnesota. Prentice Hall, Upper Saddle River, New Jersey, 2010.

Reference (s)

1. George Ellis, "*Control System Design Guide*", Academic Press, 3rd Edition, 2004
2. Marialena Vagia, "*PID Controller Design Approaches Theory, Tuning and Application to Frontier Areas*", University of Patras, Greece, 2012.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examination (%)
Remember	20	20	---
Understand	40	40	---
Apply	40	40	100
Analyze	---	---	
Evaluate	---	---	---
Create	---	---	---
Total (%)	100	100	100

Sample Question (s)

Remember

1. Draw the block diagram of a closed loop system
2. Enumerate the controller gains of a PID Controller

Understand

1. Explain the concept of stability in terms of time-response specifications
2. Explain the concept of stability in terms of frequency-response specifications

Apply

1. Design the PLC based PID controller for DC motor
2. Design the PLC based PID controller for BLDC motor
3. Design the PID controller for mechanical systems
4. Design the PID controller for batch reactor
5. Design the PID controller for nuclear reactor

DEPARTMENT OF INFORMATION TECHNOLOGY
B. Tech (Minors)
Cloud Application Development
(Department of Information Technology offering Minors Courses for other Departments)

Preamble

This program will equip you with all the key skills and technical know-how to kick start your career as a full-stack Cloud Native Developer. You will learn to build your own cloud-based applications and practice working with the technologies behind them. The Cloud Application Development Foundations Specialization program will teach you the tools and technologies that successful software developers use to build, deploy, test, run, and manage Cloud Native applications – putting you in an advantageous position to begin a new career in a highly in-demand areas. You do not require any prior programming experience or Cloud background to start this program. The courses in this program will help you develop skill sets in a variety of technologies including, Cloud foundations, HTML, CSS, JavaScript, GitHub, Node.js, React, Cloud Native practices, DevOps and more. After completing all the courses in the program, you will have developed and deployed several applications on a cloud platform and delivered Software as a Service (SaaS) solutions using Cloud Native methodologies.

Prospectus

The students will learn the essential characteristics, models, benefits, infrastructure, & emerging trends. Create a cloud account. Develop with front-end development languages and tools such as HTML, CSS, JavaScript and React also the student will learn program applications with back-end development languages and tools such as Node.js and NoSQL databases. *Finally the student will* Build and deploy applications using Cloud Native methodologies and tools, CI/CD tool chains, and build your portfolio using GitHub.

1. **Introduction to Cloud Computing:**

   This course introduces you to the core concepts of cloud computing. You gain the foundational knowledge required for understanding cloud computing from a business perspective as also for becoming a cloud practitioner. You understand the definition and essential characteristics of cloud computing, its history, the business case for cloud computing, and emerging technology use cases enabled by cloud. We introduce you to some of the prominent service providers of our times (e.g. AWS, Google, IBM, Microsoft, etc.) the services they offer, and look at some case studies of cloud computing across industry verticals.

   You learn about the various cloud service models (IaaS, PaaS, SaaS) and deployment models (Public, Private, Hybrid) and the key components of a cloud infrastructure (VMs, Networking, Storage - File, Block, Object, CDN). We also cover emergent cloud trends and practices including - Hybrid Multicloud, Microservices, Serverless, DevOps, Cloud Native and Application Modernization. And we go over the basics of cloud security, monitoring, and different job roles in the cloud industry.

2. **Introduction to Web Development with HTML, CSS, JavaScript**

   This course will lead you through the languages and tools you will need to develop your own Cloud Apps. Beginning with an explanation of how internet servers and clients work together to deliver applications to users, this course then takes you through the context for application development in the Cloud, introducing front-end, back-end, and full-stack development. You'll then focus on the languages you need for front-end development, working with HTML, CSS, and JavaScript. Finally, you will discover tools that help you to store your projects and keep track of changes made to project files, such as Git and GitHub.

3. **Developing Cloud Native Applications**

   In this course, you'll begin with some crucial cloud concepts. Then, you will dive into specific tools and techniques for developing cloud native apps. Learning about the Cloud Native Computing Foundation, the significance of hybrid cloud infrastructures, and how they affect cloud app developers will be covered You will then look at two key areas of cloud thinking: modernization and continuous integration/continuous delivery.

4. **Developing Cloud Apps with Node.js and React**

   In this course, you will focus on server-side JavaScript and frameworks. You will discover ways to make development faster and easier in web browsers and embedded systems.

No	Course Code	Course	POs	Contact Hours			
				L	T*	P	C
1	19ITM11	Introduction to Cloud Computing	6, 7, 12	4	-	-	4
2	19ITM12	Introduction to Web Development with HTML, CSS, JavaScript	1, 2, 3, 9, 12	4	-	-	4
3	19ITM13	Developing Cloud Native Applications	5, 8, 10	4	-	-	4
4	19ITM14	Developing Cloud Apps with Node.js and React	5, 8, 10	4	-	-	4

Placements Opportunities

In 2020, the Stack Overflow survey of developers reported that 51.4% of respondents are using Node.js, making it number one in the category of Other Frameworks, Libraries, and Tools. In the Most Loved, Dreaded, and Wanted category for Other Frameworks, Libraries, and Tools, Node.js is in the top ten at 66.8%. In the Web Frameworks category, React is number two at 35.9% in usage and 66.9% in the Most Loved, Dreaded, and Wanted category for Web Frameworks. This course is designed to help you achieve success in this fast-growing cloud computing area. You may be an IT person looking to step up in your career, a new graduate seeking to establish a solid skill set to score a job in the cloud or web development, and IT decision-maker who needs to manage more cloud-centric projects, or someone in another field who wants to be able to talk about cloud computing knowledgeably.

19ITM11 Introduction to Cloud Computing

4 0 0 4

Course Outcomes

1. Interpret the architecture and infrastructure models of cloud computing, strengths, and limitations of cloud computing.
2. Analyze the performance, scalability, and availability of the underlying cloud technologies and software
3. Explain the core concepts of the cloud computing paradigm: how and why this paradigm shift came about, the characteristics, advantages and challenges brought about by the various models and services in cloud computing.
4. Apply the fundamental concepts in data centers to understand the tradeoffs in power, efficiency and cost.
5. Identify resource management fundamentals, i.e. resource abstraction, sharing and sandboxing and outline their role in managing infrastructure in cloud computing.
6. Analyze various cloud programming models and apply them to solve problems on the cloud.

CO – PO Mapping

COs	PO_6	PO_7	PO_{12}
1	3	3	2
2	3	3	3
3	3	2	3
4	3	2	2
5	2	3	3
6	3	3	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Syllabus

Unit-I **16 Hours**

Overview of Cloud Computing

Welcome to Introduction to Cloud Computing, Definition and Essential Characteristics of Cloud Computing, History and Evolution of Cloud Computing, History and Evolution of Cloud Computing, Key Considerations for Cloud Computing, Key Cloud Service Providers and Their Services, Cloud Adoption - No longer a choice, Cloud Adoption - Some case studies, Internet of Things in the Cloud, Artificial Intelligence on the Cloud, Blockchain and Analytics in the Cloud.

Beyond the Syllabus: Companies in the Cloud Today, Amazon Web Servies, Google services, IBM Cloud, Windows Azure, Tata Cloud, Salesforce.com

Unit-II **17 Hours**

Cloud Computing Models

Overview of Cloud Service Models, IaaS - Infrastructure as a Service, PaaS - Platform as a Service, SaaS - Software as a Service, Public Cloud, Private Cloud, Hybrid Cloud

Beyond the Syllabus: various cloud services provided by Amazon,

Unit-III **14 Hours**

Components of Cloud Computing

Overview of Cloud Infrastructure, Virtualization and Virtual Machines Explained,

Types of Virtual Machines, Bare Metal Servers, Secure Networking in Cloud, Containers, Basics of Storage on Cloud, File Storage, Block Storage, Object Storage Overview, Object Storage - Tiers and APIs, CDN - Content Delivery Networks

Beyond the Syllabus: various hypervisors like VMware, KVM, oracle VM,

Unit-IV **13 Hours**

Emergent Trends and Practices

Hybrid Multi-cloud, Microservices, Serverless Computing, Cloud Native Applications, DevOps on the Cloud, Application Modernization

Beyond the Syllabus: various Hybrid Multi Cloud Applications

Total: 60 Hours

Textbook (s)

1. George Coulouris, Jean Dollimore, Tim Kindberg, “Distributed Systems- Concepts and Design”, Fourth Edition, Pearson Publication.
2. Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010.

3. Cloud Computing: Principles and Paradigms, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wile, 2011.
4. Cloud Computing: Principles, Systems and Applications, Editors: Nikos Antonopoulos, Lee Gillam, Springer, 2012.
5. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley-India, 2010.

Reference (s)

1. Michael Miller, Cloud Computing-Web Based Applications that change the way you work and collaborate online, 1st Edition, Pearson Education, Publishing, 2011
2. Kai Hwang, Geoffrey C Fox and Jack J.Dongarra, Distributed & Cloud Computing from Parallel Processing to the Internet of Things , 1st Edition, MK Publishing, 2010
3. David S Linthicum, Cloud Computing and SOA Convergence in Your Enterprise: A Step-by-Step Guide, 1st Edition, Addison-Wesley, 2009
4. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed Latif, O'Reilly, SPD, rp2011.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	40	45	20
Understand	40	45	60
Apply	20	10	--
Analyze	--	--	20
Evaluate	--	--	--
Create	--	--	--
Total (%)	100	100	100

Sample Question (S)

Remember

1. Define Cloud Computing.
2. List characteristics of cloud computing.
3. Define private cloud.
4. What is virtualization?

Understand

1. Explain different cloud Infrastructure models.
2. Explain different levels of virtualization.
3. Explain about cloud Native applications.
4. Explain about Block Storage.
5. With neat diagram explain the public cloud.
6. Explain Internet of Things of cloud.

Analyze

1. Compare cloud center and service infrastructure.
2. Analyze different cloud services provided.

OBE Sample Question

1. A company has peak customer demand for its IT services in the month of April. It has enough IT resources to handle off peak demand but not peak load. What is the best approach to handle this situation?
2. Elaborate on "the advantages of Simple data backup as well as more comprehensive disaster recovery and business continuity planning as an essential part of business and personal life on cloud computing."

19ITM12 Introduction to Web Development with HTML, CSS, JavaScript

4 0 0 4

Course Outcomes

1. Understand client-side scripting tools to create and modify web pages.
2. Infer the knowledge of web programming to develop and maintain web pages.
3. Develop portable and dynamic web pages.
4. Apply the knowledge of java script for validating the web pages.
5. Identify the usage of repository to deploy the web projects.
6. Explore the knowledge of deploying projects in a repository.

CO – PO Mapping

COs	PO_1	PO_2	PO_3	PO_9	PO_{12}
1	3	2	1	3	2
2	3	2	1	3	1
3	3	2	1	3	2
4	3	2	1	3	2
5	3	2	1	3	1
6	3	2	1	3	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Syllabus

Unit I **16 Hours**

Introduction to Programming for the Cloud

Welcome to Introduction to Cloud Development HTML, CSS, and JavaScript, Overview of Web and Cloud Development, Learning Front-End Development, Introducing, Application Development Tools, More Application Development Tools,

The Importance of Back-End Development

Unit II **15 Hours**

HTML5 and CSS Overview

Introduction to HTML, HTML Features, HTML Management and Support, HTML Scripting, HTML5 Browser Support,

CSS: Styling HTML

HTML5 Elements

HTML5 Tags and Structural Elements, HTML5 Input Element: Attributes for the Input Tag

Web CORS, Web RTC

.

Unit III **15 Hours**

JavaScript Programming for Web Applications

JavaScript Language: Overview and Syntax, JavaScript: Variables and Control Statements, JavaScript: Functions and Prototypes, Client-Side JavaScript: with HTML

Client-Side JavaScript: with DOM, JavaScript DOM Objects

JavaScript APIs

Unit IV **14 Hours**

GitHub

Overview of Git/GitHub, Introduction to GitHub, GitHub Repositories, GitHub Branches

Cloning and Forking GitHub Projects,

Managing GitHub Projects

Total: 60 Hours

Textbook (s)

1. Programming the World Wide Web, 8th edition Robert W. Sebesta, pearson**.**
2. HTML & CSS: The Complete Reference, Fifth Edition, Thomas Powell, Mc Graw Hill

Reference (s)

1. Web programming with HTML, XHTML and CSS, 2e, Jon Duckett, Wiley India.
2. Web programming Bai, Michael Ekedahl, CENAGE Learning, India edition.
3. An Introduction to Web Design + Programming, Paul S.Wang, India Edition.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	20	20	--
Understand	30	10	--

Apply	30	30	40
Analyze	10	20	30
Evaluate	10	20	30
Create	--	--	--
Total (%)	100	100	100

Sample Question (S)
Remember

1. Define HTML
2. Mention types of lists available in HTML
3. List the ways to add CSS to an HTML document

Understand

1. Explain about Document Object Model
2. Explain about Browser Object Model
3. Explain about the functions in Javascript

Apply

1. Design a static web page that contains following navigation links.
   Home Page
   About Us
   Contact Us
2. Apply different font styles, font families, font colors, animations and other formatting styles to the above static web pages.

Analyze

1. Compare between HTML4 and HTML5
2. Compare between CSS and CSS3.

Evaluate

1. Validate the registration form using Javascript.
2. Validate the login form using Javascript.

Open Book Exam
Question 1:
Here are a couple of useful things you can do with JavaScript just to get you started:

1. Check if all input's in signup form are valid before submitting and display error's if not
2. Have a search box bring up suggestions as you type
3. Makes changes or reload parts of the page's DOM without having to reload the page using AJAX
4. Add smooth scrolling to part of the page on single page website designs when a link on the navbar is clicked
5. Create a page loading animation
6. Make a parallax
7. Make a slider
8. Create cool animations

Question 2:
I use them for parts of my apps that need extra high performance. Otherwise, I avoid them. Other than extreme circumstances where you are willing to sacrifice lots of dev time to squeeze every bit of performance out of JavaScript, the complexity that prototypes add will make your app worse off.
Generally, I think that prototypes are often used out of habit rather than need, because people come from strongly typed languages where you have to use a class for everything. In most cases, you are well off using simple object literals and functions that create them (sometimes referred to a factory functions). It is simpler and flexible.
I use prototypes when I need very, very high performance. An example of this might be if you're doing a virtual scroll component, where you need to create hundreds or thousands of objects in 1/60th of a second to achieve 60FPS. It won't help a lot, object literals are created extremely fast too (my iPhone can create hundreds of millions per second), so you won't gain a lot.
Sidenote 1: If you make use of bind, like most people do when using prototypes, you lose much of performance benefits of the prototype. This is not commonly known.
Sidenote 2: Keep in mind that the new keyword and the ES6 class keyword are just leaky abstractions on top of the prototype, that in my opinion complicates prototypes even further - they are tricky enough without convoluted abstractions on top of them. Not a fan.

19ITM13 Developing Cloud Native Applications

4 0 0 4

Course Outcomes

At the end of the course, students will be able to

1. Understand cloud native applications.
2. Analyze various cloud modernization concepts.
3. Examine cloud resources and services .
4. Analyze the Cloud Continuous Delivery Tool chains.
5. Identify RESTful Web Services.
6. Identify the REST APIs with Watson AI Services.

CO – PO Mapping

COs	PO_5	PO_8	PO_{10}
1	3	3	2
2	3	3	2
3	3	2	2
4	2	3	3
5	3	3	1
6	3	2	2

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Syllabus

Unit I **16 Hours**

Introduction to Cloud Native

Introduction to Developing Cloud Native Applications, Cloud Computing Overview ,Cloud Native Applications, CNCF, Hybrid Cloud, Preparation for Modernization, Continuous Integration/Continuous Delivery – SRE
TDD

Unit II **15 Hours**

Getting Started with IBM Cloud

IBM Cloud Overview: IaaS, PaaS, and Runtimes, IBM Cloud Overview: Services, Regions and Cloud Foundry, Building in the IBM Cloud, Getting Started with IBM Cloud Catalog Resources, Creating and Managing an IBM Cloud Application, Creating an IBM Cloud Service and Web App, Managing Access to IBM Cloud Resources

Unit III **15 Hours**

IBM Cloud CLI

Introduction to Node.js, Preparing to use CLIs, Using CLIs

DevOps on IBM Cloud

Introduction to a DevOps Approach, IBM Cloud Continuous Delivery Overview, Creating IBM Cloud Continuous Delivery Toolchains, Web IDE Features, Source Code Management (Git Repo) and Issue Tracker,
Build and Deploy Automated Delivery Pipeline

Unit IV **14 Hours**

REST Architecture and Watson API

Introduction to Representational State Transfer (REST) , REST Characteristics and RESTful Web Services, JavaScript Object Notation (JSON), Using REST APIs with Watson AI Services.

Introduction to Data Services in IBM Cloud

Overview of Database Services in IBM Cloud, Overview of IBM Cloudant , Getting Started with IBM Cloudant
Introduction to Postman

Total: 60 Hours

Textbook (s)

1. Developing Cloud Native Applications, Ahmed AzraqHala A. AzizUzma Siddiqui, 3rd Edition, 2017.
2. Developing Open Cloud Native Microservices, Graham Charters, Sebastian Daschner, O'Reilly, a, 1st Edition, 2019.

Reference (s)

1. Developing Cloud Native Applications In Azure Using.Net Core, Rekha Kodali Gopala Behara Sankara Govindarajulu, BPB Publications, 1st Edition, 2020.
2. Cloud Native: Using Containers, Functions, and Data to Build Next-Generation Applications, Boris Scholl , Trent Swanson , Peter jausovec, O'Reilly 1st Edition, 2019.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	20	20	--
Understand	30	10	--
Apply	30	30	40
Analyze	10	20	30
Evaluate	10	20	30
Create	--	--	--
Total (%)	100	100	100

Sample Question (S)

Remember

1. List any four cloud applications.
2. Define Integration
3. List four cloud services

Understand

1. Explain cloud foundry
2. Explain RESTful Web Services
3. Illustrate Representational State Transfer

Apply

1. Give an example of Creating and Managing an IBM Cloud Application
2. How to build IBM cloud.

Analyze

1. Compare SRE and TDD
2. Analyze Source Code Management (Git Repo) and Issue Tracker

Evaluate

1. Describe CNCF.
2. Summarise the REST APIs with Watson AI Services

Open Book Exam Questions

1. How to move from monolithic app development to cloud-native app development?
2. Protecting your company data is mission critical. Confidential Computing provides encrypted enclaves that break down data siloes, not only within your organization, but with external entities—all without ever exposing the data to any of the parties give solutions for encrypting the data.

19ITM14 Developing Cloud Apps with Node.js and React

4 0 0 4

Course Outcomes

1. Understand Server side programming with java script.
2. Create server-side applications with Node.js Java script framework.
3. Build applications using REACT & ES6.
4. Practice DevOps and utilize continuous delivery pipelines with Git.
5. Deploy web applications to different Cloud platforms.
6. Extend Node.js application with third-party packages.

CO – PO Mapping

Cos	PO_5	PO_8	PO_{10}
1	3	2	3
2	3	2	2
3	3	3	3
4	3	3	2
5	3	3	2
6	3	2	3

3–Strongly linked | 2–Moderately linked | 1–Weakly linked

Syllabus

Unit I **15 Hours**

Introduction to Server-Side JavaScript

Welcome to Developing Cloud Applications with Node.js and React, Introduction to Node.js (optional), Introduction to Server-Side JavaScript, Creating a Web Server with Node.js.

Working with Node.js Modules

Unit II **15 Hours**

Asynchronous I/O with Callback Programming

Asynchronous I/O with Callback Programming, Creating Callback Functions.

Working with JSON

Unit III **13 Hours**

Express Web Application Framework

Extending Node.js, Express Web Application Framework, Your First Express Web Application, Routing, Middleware.

Templating

Unit IV **17 Hours**

Building a Rich Front-End Application using REACT & ES6

Introduction to ES6, Introduction to Front End Frameworks and React.JS, Working with React Components, Passing Data and States between Components, Connecting React to External Services, Testing Cloud Applications, Introduction to Logging,

IBM Cloud Monitoring with LogDNA and Sysdig

Total: 60 Hours

Textbook (s)

1. Fullstack React, The complete guide to ReactJS and Friends, Anthony Accomazzo, Nate Murray, Ari Lerner, Clay Allsopp, David Guttman, Tyler McGinnis, 1st Edition, Newline publications, 2021.
2. The Road to React, Robin Wieruch, 2021 Edition.
3. React Explained, Zac Gordon, 2020 Edition, OS Training.

Reference (s)

1. Learning React: Modern Patterns for Developing React Apps, Alex Banks, Eve Porcello, 2nd Edition, O'Reilly Publications.
2. Beginning React, Greg Lim, 2nd Edition, 2020
3. React.js Essentials, Artemij Fedosejev, 1st Edition, 2015, Peckt Publishing Ltd.

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Exam (%)
Remember	20	20	--
Understand	30	30	--
Apply	20	20	30
Analyze	20	10	20
Evaluate	10	30	50
Create	--	--	--
Total (%)	100	100	100

Sample Question (S)

Remember

1. Name a few techniques to optimize React app performance.
2. List the lifecycle methods of React?

Understand

1. Explain Strict Mode in React.
2. Explain React state and props

Apply

1. What are the differences between functional and class components?
2. What is the difference between Shadow DOM and Virtual DOM?

Analyze

1. Is it good to use setState() in componentWillMount() method?
2. Why should we not update the state directly?
3. Do Hooks replace render props and higher order components?

Evaluate

1. Can you force a component to re-render without calling setState?Describe how to implement a lock using semaphores.
2. Describe how to combine multiple inline style objects?
3. Describe how to re-render the view when the browser is resized?

Open Book Exam Questions

1. Real-time chat is any online communication tool that enables the live transmission of text, video, or audio messages from a sender to a receiver. Real-time chats can take the form of one-to-one or one-to-many group chats built on instant messaging (IM) or Internet Relay Chat (IRC) technologies. Using Node.js implement basic functionalities for building real-time chats of any complexity with a skeleton structure.

DEPARTMENT OF MECHANICAL ENGINEERING

AR19 MINOR COURSES

Minors for other Departments offered by Mechanical Engineering

Title I-Robotics and Automation							
S.No.	**Course Code**	**Course Name**	**POs**	**L**	**T**	**P**	**C**
1	19MEM11	Introduction to Robotics	1,2,3	4	-	-	4
2	19MEM12	Drives and Sensors	1,2,3,4	4	-	-	4
3	19MEM13	Control Systems for Robotics	1,2,3,4	4	-	-	4
4	19MEM14	Machine Learning for Robotics	2,5	4	-	-	4
Title II- Industrial Systems Engineering							
1	19MEM21	Industrial Engineering	1,10,11,12	4	-	-	4
2	19MEM22	Fundamentals of Operations Research	1,2,3,5	4	-	-	4
3	19MEM23	Enterprise Resource Planning	1,2,3,5,11,12	4	-	-	4
4	19MEM24	Production Planning and Control	1,2,3,5,11,12	4	-	-	4

Robotics and Automation:

Robotics is a field of engineering that deal with design and application of robots. Robots are used in industries for speeding up the manufacturing process. They are also used in the field of nuclear science, sea-exploration, servicing of transmission electric signals, designing of bio-medical equipment's etc.

Robotics engineering is one of the recognized professional careers in India. There are ample opportunities in this field for robotics engineers both in India as well as in abroad countries. A specialization in robotics engineering may lead to potential career opportunities in manufacturing, research and engineering, agriculture, mining, nuclear, power plant maintenances and a variety of other areas. Besides, there is great scope for qualified experts and researchers to associate themselves with different segments of R & D in robotics.

Industrial Systems Engineering:

The industrial & systems engineering specialization curriculum prepares the engineers to create the excellence in operations management, industrial engineering, and decision sciences such as information systems & analytics by adopting world class real practices and further helps them to become an expert in management consulting to solve the industrial as well as business management problems. It is a branch of engineering that uses mathematical, statistical, and scientific techniques to design, analyze, implement, and improve systems of people, information, and materials. Such systems often involve complex interactions between humans and machines. ISEs strive to ensure that these systems work safely and efficiently.

A specialization in Industrial systems engineering may lead to potential career opportunities as Ergonomist Engineer, Operations Analyst, Quality Control Engineer, Sales Engineer, Project Manager etc.,

19MEM11 Introduction to Robotics

4 0 0 4

Course Outcomes:

1. Explain fundamentals of the robotics, history, evolution, applications, and anatomy
2. Infer basic configurations and components of robotic systems
3. Apply the basic transformations to robotic systems
4. Model the robot motion through forward kinematics and inverse kinematics
5. Develop mathematical models for dynamic motions and trajectory planning
6. Explain Robotic programming with application

COs – POs Mapping

COs	PO_1	PO_2	PO_3
1	3	1	1
2	2	1	1
3	3	2	1
4	1	3	2
5	1	3	2
6	1	3	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I - Introduction to Robotics

Overview of Robotics: Present and future applications. Classification based on coordinate system and control system. Definition of mechanisms and manipulators

Anatomy of Robots: Components of robots, common types of arms, Function line diagram representation of robot arms, and Degrees of Freedom

15 Hours

Unit II - Robot Manipulator Kinematics

Kinematic Modeling: Position and orientation of a rigid body, Coordinate Transformation and Homogeneous transformations

Kinematics: DH parameters, Forward kinematics, Jacobian, Singularity and Statics. Inverse kinematics

15 Hours

Unit III - Robot Dynamics and Trajectory Planning

Dynamics: Introduction to Dynamics of Robotics and Jacobian for velocity analysis. Robot Dynamics equation: Lagrange - Euler and Newton - Euler formations formulations.

Trajectory and Path planning: Point to point and continuous path trajectories. General considerations in path planning. Trajectory planning by straight line motion, Skew motion, joint integrated motion and avoidance of obstacles

15 Hours

Unit IV - Robotics Programming and Application

Introduction to Robotic Programming, On-line and off-line programming, programming examples.

Robot applications - Material handling, Machine loading and unloading, assembly, Inspection, Welding and Spray painting

15 Hours

Total: 60 Hours

Textbook(s):

1. Industrial Robotics : M. P. Groover, Ashish Dutta , McGraw Hill
2. Robotics and Control: R K Mittal and Nagrath, McGraw Hill

Reference(s):

1. Philippe Coiffet, Michael Chirouze, An Introduction to Robot Technology, Springer Science & Business Media, Illustrated Edition, 2011
2. K S Fu, Ralph Gonzalez, C S G Lee, Robotics: Control Sensing. Vision, and Intelligence, Tata McGraw-Hill Education, 2nd Edition, 2008
3. Richard David Klafter, Thomas A. Chmielewski, Michael Negin, Robotic Engineering: An Integrated approach, Prentice Hall, 1st Edition, 1989
4. John J. Craig, Introduction to Robotics: Mechanics and Control, Pearson/Prentice Hall, 3rd Edition, 2005
5. S K Saha, Introduction to Robotics, Tata McGraw-Hill Education, 2nd Edition, 2014

Sample Questions:

1. Determine the equations of motion for 2DOF RR- planar manipulator arm using Lagrange-Euler Formulation.
2. Explain the different ways of accomplishing lead through method of robot programming.
3. Explain in detail the DH algorithm for frame assignment with supporting sketches.

19MEM12 Drives and Sensors

4 0 0 4

Course Outcomes:

1. Apply theoretical knowledge: understanding selection of suitable sensors and actuators; designing electro-mechanical systems
2. Use concepts in common methods for converting a physical parameter into an electrical quantity
3. Understand different types of drive systems
4. Work with mechanical systems that include digital and analogue electronics as a data acquisition model
5. Choose an appropriate sensor comparing different standards and guidelines to make sensitive measurements of physical parameters
6. Evaluate performance characteristics of different types of sensors

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_4
1	3	3	2	2
2	2	3	3	2
3	3	2	2	1
4	3	2	2	1
5	2	3	1	1
6	2	3	1	1

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I - Introduction to Robot Drives and Actuators

Introduction, drives and actuators, classification of actuator systems, open loop control, closed loop control with feedback, functions and classification of drive systems, chain and linkages, lead screw, ball screws, belt drives, gear drives, precision gear boxes, harmonic drives, speed reducers, classification of grippers

15 Hours

Unit II – Electric Drives and Servo systems

Introduction, classification, Electric Drives - AC motors, DC motors, stepper motors, types of stepper motors, half step mode operation, micro step mode, linear actuators, direct drive actuators.
Pneumatic and Hydraulic actuators – Advantages and Disadvantages

15 Hours

Unit III - Fundamentals of Sensors and Transducers Performance

Terminology, static and dynamic characteristics of transducers, classification of sensors and transducers, signal processing and signal conditioning. Operational amplifiers, filters, protection devices, analog to digital converter, digital to analog converter

15 Hours

Unit IV - Sensors and their applications

Inductive, capacitive, magnetic, various types of photo sensors, detection methods, through beam detection, reflex detection & proximity detection, ultrasonic and microwave sensors. Applications and understanding of the above sensors

15 Hours

Total: 60 Hours

Textbook(s):

1. Knapczyk, J. (2014). Basics of Robotics: Theory and Components of Manipulators and Robots. Austria: Springer Vienna.
2. De Silva, C. W. (2015). Sensors and Actuators: Engineering System Instrumentation, 2nd Edition. United States: CRC Press.
3. D.V.S. Murthy, "Transducers and Instrumentation", PHI 20032. B.C. Nakra and K.K. Chaudhary, “Instrumentation, Measurement and Analysis”: Tata McGraw Hill.

Reference(s):

1. Pawlak, A. M. (2017). Sensors and Actuators in Mechatronics: Design and Applications. CRC Press.
2. Prof. R. C., and Bishop, R. H., Modern Control Systems, Addison Wesley, 7th Edition, 1995.

Sample Questions:

1. What are the different types of actuators used for robots? Explain the working of a hydraulic actuator system.
2. What are the basic characteristics that a sensor should possess?
3. Discuss the advantages and disadvantages of different types of actuators. Explain the working of pneumatic actuator system.

19MEM13 Control Systems for Robotics

4 0 0 4

Course Outcomes:

1. Elucidate the need and implementation of related Instrumentation & control in robotics
2. Illustrate the movement of robotic joints with computers/microcontrollers
3. Categorize different types of system and identify a set of algebraic equations to represent and model a complicated system into a more simplified form
4. Interpret different physical and mechanical systems in terms of electrical system to construct equivalent electrical models for analysis
5. Employ time domain analysis to predict and diagnose transient performance parameters of the system for standard input functions
6. Formulate different types of analysis in frequency domain to explain the nature of stability of the system

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_4
1	3	2	-	-
2	2	3	-	-
3	-	2	3	-
4	-	-	2	3
5	-	3	3	-
6	-	-	3	3

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I - Introduction to Control Systems

Introduction to Control Systems: Types of Control Systems, Effect of Feedback Systems, Differential equation of Physical Systems – Mechanical Systems, Electrical Systems, Analogous Systems. Block diagrams and signal flow graphs: Transfer functions, Block diagram algebra and Signal Flow graphs

15 Hours

Unit II - Time Response of feedback control systems

Time Response of feedback control systems: Standard test signals, Unit step response of First and Second order Systems. Time response specifications, Time response specifications of second order systems, steady state errors and error constants. Introduction to PI, PD and PID Controllers

15 Hours

Unit III - Stability analysis

Stability analysis: Concepts of stability, Necessary conditions for Stability, Routh stability criterion, Relative stability analysis: more on the Routh stability criterion, Introduction to Root-Locus Techniques, The root locus concepts, Construction of root loci

15 Hours

Unit IV - Frequency domain analysis and stability

Frequency domain analysis and stability: Correlation between time and frequency response, Bode Plots, Experimental determination of transfer function. Introduction to Polar Plots, (Inverse Polar Plots excluded) Mathematical preliminaries, Nyquist Stability criterion

15 Hours

Total: 60 Hours

Textbook(s):

1. Nagrath I. J. and M. Gopal, Control Systems Engineering, New Age International (P) Ltd, 5th Ed, 2007.

Reference(s):

1. Kuo, B. C., and Golnaraghi, F., Automatic Control Systems, John Wiley & Sons, 8th Ed, 2003.
2. Prof, R. C., and Bishop, R. H., Modern Control Systems, Addison Wesley, 7th Ed, 1995.

Sample Questions:

1. Distinguish between open loop system and close loop system.
2. Explain the effect of time constant on the speed of time response of a control system.
3. Obtain the transfer function of an armature-controlled DC motor.

19MEM14 Machine Learning for Robotics

4 0 0 4

Course Outcomes:

1. Discuss about the concepts of machine learning
2. Describe the types of trees and bias
3. Outline the supervised learning methods with various case studies
4. Compare the learning methodologies and dimensionality concepts
5. Summarize the applications of neural networks in robotic applications
6. Illustrate the applications of machine learning using case studies

COs – POs Mapping

COs	PO_2	PO_5
1	1	2
2	3	2
3	3	1
4	3	2
5	3	2
6	2	3

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I Introduction

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

Solving problems by searching -Informed search and exploration–Constraint satisfaction problems- Adversarial search, knowledge, and reasoning–knowledge representation – first order logic.

15 Hours

Unit II Problem Solving and Planning

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

15 Hours

Unit III Reasoning and Learning

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

Forms of learning – Knowledge in learning – Statistical learning methods –reinforcement learning, communication, perceiving and acting, Probabilistic language processing and perception.

15 Hours

Unit IV AI in Robotics

Robotic perception, localization, mapping- configuring space, planning uncertain movements, dynamics and control of movement, Ethics and risks of artificial intelligence in robotics.

15 Hours

Total: 60 Hours

Textbook(s):

1. Stuart Russell, Peter Norvig, “Artificial Intelligence: A modern approach”, Pearson Education, India, 2016
2. Negnevitsky, M, “Artificial Intelligence: A guide to Intelligent Systems”, Harlow: Addison Wesley, 2002

Reference(s):

1. David Jefferis, “Artificial Intelligence: Robotics and Machine Evolution”, Crabtree Publishing Company, 1992
2. Robin Murphy, Robin R. Murphy, Ronald C. Arkin, “Introduction to AI Robotics”, MIT Press, 2000
3. Francis.X.Govers, “Artificial Intelligence for Robotics”, Packt Publishing, 2018
4. Huimin Lu, Xing Lu, “Artificial Intelligence and Robotics”, Springer, 2017

Sample Questions:

1. What do you understand by AI bias? Discuss in detail with some examples.
2. What is data mining? Explain with example.
3. What is Computer Vision? Give an example of it.

19MEM21 Industrial Management

4 0 0 4

Course Outcomes

1. Design organization structure and implement management principles in real time business environment
2. Establish layouts for different types of industries, manufacturing, process and service sectors
3. Elaborate productivity and profitability by implementing work study and SQC
4. Select and maintain skilled and sufficient manpower for various business proposals
5. Find total production time and cost by using networking techniques
6. Enunciate a best method of making a product in the production process

COs – POs Mapping

COs	PO_1	PO_{10}	PO_{11}	PO_{12}
1	3	1	2	2
2	3	2	2	1
3	3	1	1	2
4	3	1	2	2
5	2	2	1	1
6	3	1	1	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I

Evolution of Management Thought-Organizational Structures

Douglas McGregor's Theory X and Theory Y, Maslow's Hierarchy of Human Needs, Systems Approach to Management. Designing. Basic concepts related to Organization, Depart mentation and Decentralization, Types of mechanistic and organic structures of organization (Line organization, Line and staff organization, functional organization, Committee organization, matrix organization, Virtual Organization) and their merits, demerits, and suitability.

Cellular Organization and team structure

15 Hours

Unit II

Facilities location- Work study

Plant location, definition, factors affecting the plant location, comparison of rural and urban sites methods for selection of plant, Matrix approach, Plant Layout; definition, objectives, types of production, types of plant layout, various data analyzing forms, travel chart. Definition, objectives, method study; definition, objectives, steps involved, various types of associated charts. Work measurement- definition, time study, steps involved, equipment, different methods of performance rating, allowances, standard time calculation. Work Sampling, definition, steps involved.

Standard time calculations and differences with time study

15 Hours

Unit III

Materials Management-Quality Control

Objectives, Inventory, functions, types, associated costs, inventory classification techniques, EOQ, ABC and VED analysis. Inspection and quality control, types of inspections, Statistical Quality Control; techniques, variables and attributes, assignable and non-assignable causes, variable control charts, and R charts, attributes control charts, p charts and c charts. sampling plans.

Introduction to TQM, Quality Circles, ISO 9000 series procedures

15 Hours

Unit IV

Introduction to PERT / CPM-Introduction to Human Resource Management

Project management, network modeling: PERT/CPM Time and cost estimations. Functions of HRM, Job Evaluation, different types of evaluation methods, Job description, Merit Rating, difference with job evaluation.

Different methods of merit ratings, wage incentives.

15 Hours

Total: 60 Hours

Textbook (s)

1. O.P. Khanna, Industrial Engineering and Management, S Chand & Co Publications, 3rd Edition, 2013
2. Teslang Martand, Industrial Engineering and Production Management, S Chand & Co Publications, 1stEdition, 2002
3. Phillip E Hicks, Industrial Engineering and Management; a new perspective, TMH publications, 2nd Edition, 1994
4. H.T. Amrine, J. A. Ritchey and O.S. Hulley, Manufacturing Organization and Management, , Prentice-Hall, 2nd Edition, 1966
5. P.C. Tripathi and P.N. Reddy, Principles of Management, TMH Publications, 4th Edition, 2012

Reference (s)

1. H. Koontz & H. Weihrich, Essentials of Management, Tata McGraw Hill, 8th Edition, 2010
2. Paneer Selvam, Production and Operations Management, PHI, 3rd Edition, 2012

Sample Question (s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examinations (%)
Remember	35	35	-
Understand	45	35	-
Apply	20	30	-
Analyze	-	-	50
Evaluate	-	-	30
Create	-	-	20
Total (%)	100	100	100

Remember

1. List the five objectives of work study
2. List any four merits and demerits of committee organization
3. Define Mc-Gregor's theory X and theory Y
4. List the three types of plant layout
5. List any four functions of HRM
6. List the three functions of material management?

Understand

1. Explain the factors effecting plant locations
2. Explain about purchase management
3. Write about Statistical Quality Control-techniques
4. Compare the Mc-Gregor's Theory X and Theory Y

Apply

1. Explain the attribute charts
2. Compare the PERT and CPM
3. Explain about stores management and stores records
4. What are the different types of evaluation methods and explain them?
5. Identify duties of purchase manager

Analyse

1. Compare the rural and urban sites methods for selection of plant
2. Classify of various types of associated charts
3. Explain about the suitability of line and staff organization

Evaluate

1. Explain the jobs of a network along with their time estimates. Draw the project network, evaluate the completion time of the project, and identify the critical paths for any case study

Create

1. Create a plant layout and establish optimum resources for an organization
2. Create a new problem-solving technique for network analysis

19MEM22 Fundamentals of Operations Research

4 0 0 4

Course Outcomes

1. Formulate a real time situation into a mathematical model.
2. Assign a right job to a right person using job sequencing.
3. Make right decisions in operations management using game theory, queuing theory and replacement analysis.
4. Solve nonlinear problems using nonlinear programming techniques.
5. Perform optimum problem solving using dynamic programming and simulation techniques.
6. Distinguish the process of waiting lines and its applications.

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_5
1	3	2	2	1
2	1	2	3	2
3	1	3	3	2
4	3	2	2	3
5	2	1	3	2
6	3	2	1	3

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I

Linear Programming – Characteristics and Methods, Development, definition, characteristics and phases, types of models, operation research models, applications, Allocation

Linear programming problem formulation, graphical solution, simplex method, two phase methods, big m method, duality principle

Nonlinear Programming

One Dimensional Minimization: Unimodal function, Elimination methods, unrestricted search, Exhaustive Search, Dichotomous search

Evaluation of a nonlinear problem using advanced search methods

15 Hours

Unit II

Transportation Problem- Solution methodology with examples

Formulation, optimal solution, unbalanced transportation problem, degeneracy, assignment problem formulation, optimal solution, variants of assignment problem travelling salesman problem

Solving a given transportation problem using soft computing techniques

15 Hours

Unit III

Sequencing- Solution methodology

Introduction, flow, shop sequencing, n jobs through two machines, n jobs through three machines, job shop sequencing, and two jobs through "m" machines

Replacement

Introduction, replacement of items that deteriorate with time, when money value is not counted and counted, replacement of items that fail completely, group replacement.

Development of a replacement policy of the components for an enterprise

15 Hours

Unit IV

Theory of Games-Various types of games

Introduction, mini. Max (max. mini) criterion and optimal strategy, solution of games with saddle points, Rectangular games without saddle points, 2 x 2 games, dominance principle, m x 2 & 2 x n games, graphical method.

Waiting Lines

Introduction, single channel, poison arrivals, exponential service times, with infinite population and finite population models, multichannel, poison arrivals, exponential service times with infinite population single channel poison arrivals.

Implementing the principles of waiting lines for a given case study.

15 Hours
Total: 60 Hours

Textbook (s)

1. S.D Sharma, Operations Research: Theory method and Applications, Kedarnath, Ram Nath & Co, Meerut Publications, 16th Edition, 2012
2. FredErick S Hiller & Gerald J Liberman, Introduction to Operations Research, TMH Publications, 7th Edition, 2002

Reference (s)

1. Handy A Taha, Operations Research: An Introduction, Prentice Hall of India Publications, 6th Edition, 1997
2. R. Pannerselvam, Operation Research, PHI Publications, 1st Edition, 2002
3. J. K Sharma, Operation Research: Problems and Solutions, McMillan, 1st Edition, 2002

Sample Question (s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examinations (%)
Remember	35	30	-
Understand	35	40	-
Apply	30	30	
Analyze	-	-	60
Evaluate	-	-	20
Create	-	-	20
Total (%)	100	100	100

Remember

1. Define Operations research for engineers
2. State the factors to be consider in Simplex procedure
3. List any three assumptions in Game theory strategies

Understand

1. Explain about the procedural steps involved in two phase methods?
2. Classify different types of queuing systems?
3. Explain the role of computers in Operations research?

Apply

1. Seven jobs are to be processed on two machines A and B in the order A→B. Each machine can process only one job at a time. The processing times (in Hours) are as follows. Find the optimum sequence

Job	1	2	3	4	5	6	7
Machine A	10	12	13	7	14	5	16
Machine B	15	11	8	9	6	7	16

2. Determine the initial basic feasible solution of the following transportation problem?

To →		I	II	III	Supply
From	A	50	30	200	1
	B	90	45	170	3
	C	250	200	50	4
Demand		4	2	2	

Analyze

1. ABC Company is engaged in manufacturing 5 brands of packed snacks. It is having five manufacturing setups, each capable of manufacturing any of its brands, one at a time. The cost to make a brand on these setups varies according to the following table. Analyse the optimum assignment of products on these setups resulting in the minimum cost?

Brands↓ & Setups→	S1	S2	S3	S4	S5
B1	4	6	7	5	11
B2	7	3	6	9	5
B3	8	5	4	6	9
B4	9	12	7	11	10
B5	7	5	9	8	11

2. Analyze the game whose payoff matrix to the player A is given in the following table?

		B		
		I	II	III
A	I	1	8	4
	II	6	4	5
	III	0	1	2

Evaluate

1. Fleet cars have increased their costs as they continue in service due to increased direct operating cost and increased maintenance. The initial cost is Rs. 3,500 and the trade in value drops as time passes until it reaches a constant value of Rs.500. Given the cost of operating, maintaining and the trade in value, evaluate the proper length of service before cars should be replaced?

Year of service	1	2	3	4	5
Year-end trade in value	1900	1050	600	500	500
Annual operating cost	1500	1800	2100	2400	2700
Annual maintaining cost	300	400	600	800	1000

2. Use Simplex method to evaluate the following problem:

   Maximize $Z = 3x_1+5x_2+4X_3$

   Subjected to $2x_1+3x_2 \leq 8;\ 2x_2+5X_3 \leq 10;\ 3x_1+2x_2+4X_3 \leq 15;\ x_1, x_2, X_3 \geq 0$

3. A TV repairman finds that the time spent on his jobs has an exponential distribution with mean 30 minutes. If he repairs sets in the order in which they come in, and if the arrival of sets is approximately Poisson with an average rate of 10 per 8-hour day, what is repairman's expected idle time each day?

Create

1. Create a suitable OR model by taking a medium scale industry
2. Create an assignment model for a large-scale enterprise

19MEM23 Enterprise Resource Planning

4 0 0 4

Course Outcomes

1. Describe the concept of ERP and develop ERP model for various projects
2. Describe the advantages, strategic value, and organizational impact of utilizing an ERP system for the management of information across the functional areas of a business
3. Develop model for E-commerce architecture for any application
4. Demonstrate a working knowledge of how data and transactions are integrated in an ERP system
5. Design the ERP implementation strategies by evaluating organizational opportunities and challenges
6. Create reengineered business processes for successful ERP implementation

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_5	PO_{11}	PO_{12}
1	3	2	2	3	2	2
2	3	2	2	3	2	2
3	2	2	2	3	2	2
4	2	2	2	2	2	2
5	2	1	3	2	2	2
6	2	1	3	2	2	2

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I

Basics of ERP

Business Modelling: Business process concept and business functions
ERP: Introduction, benefits, origin, evolution, and structure. Conceptual model of ERP, the evolution of ERP and the structure of ERP
Business intelligence

15 Hours

Unit II

Business modules in ERP

Companies and business Processes, Finance, Manufacturing, Human Resource, Plant Maintenance, Materials Management, Quality Management, Sales and Distribution
Business Process Reengineering, Data ware Housing, Data Mining, Online Analytic Processing (OLAP), Product Life Cycle Management (PLM), Supply Chain Management (SCM)
Business Analytics

15 Hours

Unit III

Enterprise information architectures

Enterprise architecture, planning, ERP usage in real world, Integration of ERP, Supply chain and Customer Relationship Applications, an overview of Integrated Management Information, ERP and E–Commerce , ERP and Internet
Data Migration

15 Hours

Unit IV

ERP Implementation

ERP & E-Commerce, Future Directives in ERP, ERP and Internet, Critical success and failure factors, Integrating ERP into organizational culture. Change management techniques. Using ERP tool: SAP/ORACLE- case study
Implementation life cycle of ERP, ERP Implementation best Practices, Future of ERP applications
Selection of ERP software

15 Hours

Total: 60 Hours

Textbook (s)

1. Vinod Kumar Garg and Venkitakrishnan N K, "Enterprise Resource Planning Concepts and Practice", PHI, 2003
2. Joseph A Brady, Ellen F Monk, Bret Wagner, "Concepts in Enterprise Resource Planning", Thompson Course Technology, USA, 2006
3. Alexis Leon, Enterprise Resource Planning, Tata McGraw Hill, 2nd Edition, 2000

Reference (s)

1. Rahul V. Altekar "Enterprise Resource Planning", Tata McGraw Hill, 2011
2. Mary Summer, "Enterprise Resource Planning"- Pearson Education, 2005

3. Jyotindra Zaveri, Enterprise Resource Planning, Himalaya Publishing House, 2012

Sample Question (s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examinations (%)
Remember	30	30	-
Understand	40	40	-
Apply	30	30	60
Analyze	-	-	30
Evaluate	-	-	10
Create	-	-	-
Total (%)	**100**	**100**	**100**

Remember

1. List the implementation methodologies of ERP software
2. List any four tangible and intangible benefits of ERP system
3. What is inventory management system?
4. What is CRM?
5. List out the various ERP system packages available in market

Understand

1. Explain in detail about ERP implementation methodology
2. Describe about the following ERP functional modules:
    a. Human capital Management
    b. Financial management
    c. Supply chain planning
    d. Sales and service
3. Explain about the following terms in ERP:
    a. Product lifecycle Management
    b. Customer Relationship Management
    c. Enterprise Asset management
    d. Quality Management.
4. Explain in detail about application of ERP in service industries.
5. Explain the various criteria to be met and possessed by an ERP system, when proposed for the small and medium enterprises.
6. Explain the following with suitable examples wherever necessary:
   (i) ERP system architecture
   (ii) Future trends in web-enabled ERP.
7. Differentiate between ERP and E-Commerce.

Apply

1. Write detailed reports on i) ERP and E-Business ii) Emerging trends in ERP for healthcare industry.
2. How BPR relates to ERP. Explain in the context of an IT industry.
3. Discuss key activities of ERP solution to petroleum, gas and oil Industry. ***(For Open Book Examination and not for semester end examination)***
4. Using a flow diagram, explain the various 'Phases' involved in the ERP implementation life cycle of an IT industry.
5. Explain 7 requirements from educational institutes in terms of ERP.

Analyze

1. List various steps in Procurement Cycle of an Electronics part manufacturing industry and explain what support ERP provides in each step to make the process more efficient. ***(For Open Book Examination and not for semester end examination)***
2. You have recently joined as Technology Consultant in a leading Mumbai based automobile firm that manufactures various models of passenger Cars and three wheelers right from 2007. This profit-making firm plans to streamline its main business process, i.e., its manufacturing process through ERP adoption. Now, your GM instructs you to prepare and present a 'Manufacturing Process cum Data Model' for your firm, which will be treated as a Blueprint for streamlining your firm. Your 'Process cum Data Model' should provide the following :
    i) Representative list of various core processes and their brief description in an ideal automobile manufacturing company like your firm and
    ii) Representative list of various Entities and their brief description, for forming a 'Data Model' that is suitable for a manufacturing company like your firm. Justify your report with charts providing valid information on processes and relevant Data. ***(For Open Book Examination and not for semester end examination)***

Evaluate

1. Glomove is a Singapore based premier MNC, involved in the design, manufacturing, global marketing and selling of its high demand products such as Footwear, Sports shoes, apparels, equipment etc. right from 2009. This profit-making firm decided to adopt ERP in 2015 and fully implemented the ERP system by 2018 in its many modules say CRM, Manufacturing, HR. SCM, FICO etc. by renowned ERP Vendors. Initially ERP was seen as a success, but of late especially after July 2020, the firm's customer attrition, operating cost etc are increasing whereas the sales volume has come down. Having invested huge capital in ERP implementation and maintenance the firm is now puzzled and want to identify the probable failure factors responsible for this ERP debacle. The firm has approached you and in your assumed role as a ERP Management Consultant prepare and present the firm with a 'Generic Report' incorporating the most probable factors, possible avenues (both Internal and external) along with any other solid reasons for the ERP failure, as identified by you. You may assume relevant data for this case, but the same needs mention in the report. Justify your report with valid points as well as your valuable suggestions for the Firm to overcome the debacle. ***(For Open Book Examination and not for semester end examination)***
2. Ganong Brothers LTD is the oldest candy company in Canada, but it's only through continuous innovation and keeping up with technology trends that a company like this can remain successful. That's why Ganong Brothers decided to implement a new ERP system in 2002 to obtain real-time financial data, improve order processing and support a mixed-mode manufacturing workflow. By implementing ERP software, Ganong Brothers obtained the ability to estimate demand several months in advance to help determine material requirements. The company is also able to readily access information about product and customer profitability. Evaluate the possibilities and challenges of integrating estimation tools of GBL with AI, which are a new feature that is becoming more and more common in ERP solutions***. (For Open Book Examination and not for semester end examination)***

19MEM24 Production Planning and Control

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Course Outcomes

1. Explain the features of the operations and production planning functions in an organization
2. Develop extrapolative forecasting models for demand
3. Explain productivity and quality and how it contributes to the competitiveness of firms
4. Compare different production aspects such as production control, quality control, manufacturing costs control, marketing management and waste reduction
5. Develop an aggregate and disaggregate production plan schedule into assembly quantities for end items
6. Explain the strategies of dispatching

COs – POs Mapping

COs	PO_1	PO_2	PO_3	PO_5	PO_{11}	PO_{12}
1	2	2	1	-	3	1
2	3	3	2	-	2	1
3	2	1	3	-	1	2
4	3	2	1	-	3	2
5	3	1	2	-	3	2
6	3	1	2	3	2	3

3 – Strongly linked | 2 – Moderately linked | 1 – Weakly linked

Unit I

Introduction-Forecasting

Definition - Objectives of production Planning and Control - Functions of production planning and control Elements of production control - Types of production - Organization of production planning and control department - Internal organization of department. Importance of forecasting -Types of forecasting, their uses - General principles of forecasting - Forecasting techniques.

Qualitative and Quantitative methods

15 Hours

Unit II

Inventory management

Functions of inventories - relevant inventory costs - ABC analysis –VED analysis -EOQ model – Inventory control systems - P-Systems and Q-Systems -Introduction MRPI, MRP II & ERP, LOB (Line of Balance)

JIT inventory, and Japanese concepts

15 Hours

Unit III

Routing

Definition - Routing procedure -Route sheets - Bill of material – Factors affecting routing procedure.

Schedule

Definition - Difference with loading. Scheduling Policies - Techniques, Standard scheduling methods, Line Balancing, Aggregate planning, Master production schedule, Chase planning, Information Technology in Production Planning and Scheduling

Expediting, controlling aspects

15 Hours

Unit IV

Dispatching

Activities of dispatcher - Dispatching procedure – functions of dispatcher-follow-up - Reason for existence of functions –Role of computers in dispatching

Role of Information technology tools in Dispatching

15 Hours

Total: 60 Hours

Textbook (s)

1. S Eilon, Elements of Production Planning and Control, Navaneet Prakasan Ltd, Revised Edition 2014
2. P Rama Murthy, Production and Operations management, New Age International, Revised Edition, 2005

Reference (s)

1. S.N. Chary, Operations Management, Tata McGraw-Hill Education, 4th Edition, 2009
2. M K. Starr and David W. Miller, Inventory Control Theory and Practice, Prentice-Hall, 1962
3. J E. Biegel, Production Control A Quantitative Approach, Prentice-Hall, 1971
4. Joseph Monks, Operations Management, McGraw Hill Series, 1996

Sample Question (s)

Internal Assessment Pattern

Cognitive Level	Int. Test 1 (%)	Int. Test 2 (%)	Open Book Examinations (%)
Remember	35	30	-
Understand	35	50	-
Apply	30	20	25
Analyze	-	-	50
Evaluate	-	-	25
Create	-	-	-
Total (%)	**100**	**100**	**100**

Remember

1. State the objectives of production planning and control.

Understand

1. What is production planning and control?
2. What is the need for production planning and control?
3. What are the principles of forecasting?

Apply

1. Develop production scheduling method by using heuristic approach.

Analyze

1. Compare the scheduling techniques for time, material and cost.

Evaluate

1. Compare the scheduling techniques for the optimal criteria