SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE (AUTONOMOUS)

(Affiliated to JNTUK, Kakinada), (Recognized by AICTE, New Delhi)
UG ProgrammesCE,CSE,ECE,EEE,IT & ME are Accredited by NBA
CHINNA AMIRAM (P.O):: BHIMAVARAM :: W.G.Dt., A.P., INDIA :: PIN: 534 204

Estd:1980

LIST OF OPEN ELECTIVES
OFFERED BY VARIOUS DEPARTMENTS TO OTHER DEPARTMENTS
IN
IV YEAR II SEMESTER

Offered by	Course Code	Course Name	Offered to
CIVIL ENGINEERING	B19CEOE05	Alternative energy sources	**CSE, ECE, IT & ME**
	B19CEOE06	Intelligence Transport System	**CSE, ECE, EEE, IT & ME**
COMPUTER SCIENCE & ENGINEERING	B19CSOE07	Machine Learning	**CE, ECE, EEE & ME**
	B19CSOE08	Internet of Things	**CE & ME**
	B19CSOE09	Operating Systems	**CE, ECE, EEE & ME**
ELECTRONICS & COMMUNICATION ENGINEERING	B19ECOE05	Internet of Things	**CE & ME**
	B19ECOE06	VLSI design	**EEE**
ELECTRICAL & ELECTRONICS ENGINEERING	B19EEOE01	Introduction to Electrical Systems	**CE, CSE & IT**
	B19EEOE04	Basic Power Electronics	**ECE & ME**
	B19EEOE06	MATLAB Programming for Engineering Applications	**CE, CSE, IT & ME**
INFORMATION TECHNOLOGY	B19ITOE05	Cloud Computing	**CE, ECE, EEE & ME**
	B19ITOE06	Internet of Things	**CE & ME**
MECHANICAL ENGINEERING	B19MEOE05	Mechatronics	**CE, CSE, ECE, EEE & IT**
	B19MEOE06	Green Energy Systems	**CE, CSE, ECE & IT**
	B19MEOE07	Micro-Electro Mechanical Systems	**CE, CSE, ECE, EEE & IT**

Code	Category	L	T	P	C	I.M	E.M	Exam
B19CEOE05	**OE**	**3**	**--**	**--**	**3**	**25**	**75**	**3 Hrs.**

ALTERNATIVE ENERGY SOURCES

(Offered by CE)

(Offered to CSE, ECE, IT & ME)

Course Objectives:

1	Explain the concepts of Non-renewable and renewable energy systems
2	Outline utilization of renewable energy sources for both domestic and industrial applications
3	Analyze the environmental and cost economics of renewable energy sources in comparison with fossil fuels.

Course Outcomes: At the end of the course Students will be able to

S.No	Outcome	Knowledge Level
1	summarize the need of renewable sources in Global scenario	K2
2	explain the solar thermal conversion processes	K2
3	explain the wind energy conversion techniques	K2
4	explain the biomass energy conversion methodologies	K2
5	explain the principle of ocean thermal energy conversion system	K2

SYLLABUS

UNIT-I (10 Hrs)	Global and National Energy Scenario: Overview of conventional & renewable energy sources - need & development of renewable energy sources - Future of Energy Use, Energy for sustainable development - Potential of renewable energy sources - renewable electricity and key elements - Global climate change - CO2 reduction potential of renewable energy - concept of Hybrid systems.
UNIT-II (10 Hrs)	Solar Energy: Solar energy system - Solar Radiation – Availability - Measurement and Estimation - Solar Thermal Conversion Devices and Storage - Applications Solar Photovoltaic Conversion, applications of solar energy systems.
UNIT-III (10 Hrs)	Wind Energy: Wind Energy Conversion - Site selection, Types of wind turbines, wind Generation and Control. Nature of the wind, , factors influencing wind, wind data and energy estimation, wind speed monitoring, classification of wind, characteristics, applications of wind turbines, offshore wind energy – Hybrid systems, wind resource assessment, Betz limit, site selection, wind energy conversion devices. Windmill component design, economics and demand side management, energy wheeling, and energy banking concepts. Safety and environmental aspects, wind energy potential and installation in India.

SRKR ENGINEERING COLLEGE AUTONOMOUS Estd. 1980

UNIT-IV (10 Hrs)	Biogas: Calorific value and composition of biogas – Bio energy systems – Biomass conversion processes – Thermo chemical conversion processes – biomass gasification – pyrolysis – liquefaction – anaerobic digestion – Urban waste to energy conversion – bio diesel production – Biomass energy programme in India.
UNIT-V (10 Hrs)	Ocean Energy – Principle of Ocean Thermal Energy Conversion (OTEC) – tidal energy conversion – Scheme of development of tidal energy Hydro power plants- types of turbines – estimation of primary and secondary power Geothermal Energy – Geothermal power plants
Text Books:	
1	Non-Conventional Energy Sources by G.D.Rai
2	Twidell, J.W. and Weir, A., Renewable Energy Sources, EFN Spon Ltd., 1986.
Reference Books:	
1	Kishore VVN, Renewable Energy Engineering and Technology, Teri Press, New Delhi, 2012
2	Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K., 1996.

Estd. 1980
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Code	Category	L	T	P	C	I.M	E.M	Exam
B19CEOE06	**OE**	**3**	**--**	**--**	**3**	**25**	**75**	**3 Hrs.**

INTELLIGENCE TRANSPORT SYSTEM

(Offered by CE)

(Offered to CSE, ECE, EEE, IT & ME)

Course Objectives:

1	To know the fundamentals of ITS
2	To study sensor technologies and Data requirements of ITS
3	To know ITS functional areas and user services
4	To study various kinds of ITS architecture
5	To study ITS applications in various fields of transportation engineering

Course Outcomes: At the end of the course Students will be able to

S.No	Outcome	Knowledge Level
1	Identify the benefits of ITS from various types	K2
2	Determine various sensor applications and ITS data collection techniques	K3
3	Identify ITS user services and functional areas	K3
4	Determine various ITS models, evaluation methods and ITS planning.	K4
5	Determine the suitable ITS technology and assess its effectiveness to solve transportation Problems.	K4

SYLLABUS

UNIT-I (8 Hrs)	**Fundamentals of ITS:** Definition of ITS s, The historical context of ITS from both public policy and market economic perspectives, Types of ITS; Historical Background, Benefits of ITS.
UNIT-II (8 Hrs)	**Sensor technologies and Data requirements of ITS:** Importance of telecommunications in the ITS system, Information Management, Traffic Management Centres (TMC). Application of sensors to Traffic management; Traffic flow sensor technologies; Transponders and Communication systems; Data fusion at traffic management centres; Sensor plan and specification requirements; Elements of Vehicle Location and Route Navigation and Guidance concepts; ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), GIS, video data collection.
UNIT-III (8 Hrs)	**ITS functional areas** – Advanced Traffic Management systems (ATMS), Advanced Traveler. Information systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control systems (AVCS), Advanced Public Transportation systems

	(APTS), Advanced RuralTransportation systems (ARTS). ITS User Needs and Services – Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management.
UNIT-IV (8 Hrs)	**ITS Architecture** – Regional and Project ITS architecture; Concept of operations; ITS Models and Evaluation Methods; Planning and human factor issues for ITS, Case studies on deployment planning and system design and operation; ITS and safety, ITS and security, ITS as a technology deployment program, research, development and business models, ITS planning.
UNIT-V (8 Hrs)	**ITS Applications:** Traffic and incident management systems; ITS and sustainable mobility, travel demand management, electronic toll collection, ITS and road-pricing.; Transportation network operations; commercial vehicle operations and intermodal freight; public transportation applications; ITS and regional strategic transportation planning, including regional architectures: ITS and changing transportation institutions Automated Highway Systems- Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries.
Text Books:	
1	Fundamentals of intelligent transportation systems planning ByMashrur A. Chowdhury, Adel WadidSadek.
2	ITS Hand Book 2000: Recommendations for World Road Association (PIARC) by Kan Paul Chen, John Miles.
Reference Books:	
1	Sussman, J. M., Perspective on ITS, Artech House Publishers, 2005.
2	National ITS Architecture Documentation, US Department of Transportation, 2007.

SRKR ENGINEERING COLLEGE AUTONOMOUS Estd. 1980

Code	Category	L	T	P	C	I.M	E.M	Exam
B19CSOE07	**OE**	**3**	**0**	**0**	**3**	**25**	**75**	**3 Hrs.**

MACHINE LEARNING

(Offered by CSE)

(Offered to CE, ECE, EEE & ME)

Course Objectives:

1.	To introduce the basic concepts and techniques of Machine Learning
2.	To demonstrate regression, classification and clustering methods.
3.	To introduce the concepts of dimensionality reduction, artificial neural networks and reinforcement learning
4.	To show the application of machine learning model evaluation and optimization techniques

Course Outcomes: At the end of the course Students will be able to

S.No	Outcome	Knowledge Level
1.	Formulate the concepts of ingredients and preliminaries of machine learning	K3
2.	Apply tree models, linear models and distance-based models	K3
3.	Identify and construct features and ensemble models	K3
4.	Demonstrate the concepts of dimensionality reduction techniques, model evaluation and selection techniques	K3
5.	Apply the concepts of artificial neural networks, reinforcement learning	K3

SYLLABUS

UNIT-I (12 Hrs)	**The ingredients of machine learning**: Basic concepts, designing a learning system, Issues in machine learning, Types of machine learning, **Tasks**: the problems that can be solved with machine learning, **Models**: the output of machine learning, Features, the workhorses of machine learning. **Preliminaries:** The curse of dimensionality, Overfitting, Training, Test and Validation sets, The confusion matrix, **The accuracy metrics**: Accuracy, sensitivity, specificity, precision, recall, F1 measure, ROC curve, Unbalanced datasets, Naïve Bayes Classifier, **Some basic statistics:** variance, covariance, bias-variance tradeoff.
UNIT-II (10 Hrs)	**Tree Models**: Decision Trees. **Linear Models**: The least-squares method: Univariate linear regression, Logistic Regression, Support vector machines (Except Logistic regression others Peter Flach) **Distance Based Models**: Introduction, Nearest Neighbours classification, Distance Based Clustering, Hierarchical Clustering.

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UNIT-III (10 Hrs)	**Features**: Kinds of feature, Feature transformations: Thresholding and discretisation, Normalisation, Incomplete Features, Feature construction and selection. **Model ensembles**: Bagging, random forests, **Boosting**: AdaBoost, Gradient Boosting. XGBoost
UNIT-IV (08 Hrs)	**Dimensionality Reduc**tion: PCA, LDA **Model Evaluation and Optimization**: Cross Validation, Grid Search, Regularization
UNIT-V (10 Hrs)	**Neurons, NNs, Linear Discriminants**: The Neuron, Neural Networks, The perceptron, **Multilayer perceptrons**: Going forwards, Going backwards: Backpropagation of error, Multilayer perceptron in practice, Examples of using MLP. **Reinforcement Learning:** Overview, Example, Markov Decision Process, Values, Back on Holiday: Using reinforcement learning, Uses of Reinforcement Learning

Text Books:	
1.	Introduction to Machine Learning, Alpaydin E, MIT Press (2014) 3rdEdition
2.	Machine Learning: The art and science of algorithms that make sense of data, Peter Flach, Cambridge, 2012
3.	Machine Learning: An algorithmic perspective, Stephen Marsland, 2nd edition, CRC press, 2014.
4.	Python Machine Learning Cookbook-Practical Solutions from Preprocessing to Deep Learning, Chris Albon, Oreilly, 2018.
Reference Books:	
1.	The elements of statistical learning, Data Mining, Inference and Prediction, Trevor Hastie, Robert Tibshirani, Jerome Friedman, Second edition , Springer, 2009.
2.	Machine Learning in Action, Peter Harington, 2012, Cengage.
3.	Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, Tensorflow, Sebastian Raschka, Vahid Mirjalili, Second edition, 2020
Online MOOC Courses:	
1.	"Machine Learning" course by Andrew Ng on Coursera
2.	"Introduction to Machine Learning (IITKGP)" by Prof. Sudeshna Sarkar, on Swayam
3.	"Machine Learning A-Z (Python & R in Data Science Course)" on Udemy
Useful Reference Links:	
1.	"Linear Discriminant Analysis", https://sebastianraschka.com/Articles/2014_python_lda.html
2.	"Principal Component Analysis versus Linear Discriminant Analysis", https://medium.com/analytics-vidhya/illustrative-example-of-principalcomponent-analysis-pcavs-linear-discriminant-analysis-lda-is-105c431e8907
3.	"A gentle introduction to K-fold cross validation", https://machinelearningmastery.com/k-foldcross-validation/
4.	Grid search for model tuning", https://medium.com/analyticsvidhya/illustrative-example-ofprincipal-component-analysis-pca-vs-lineardiscriminant-analysis-lda-is-105c431e8907
5.	"Regularization in Machine Learning", https://towardsdatascience.com/regularization-inmachine-learning76441ddcf99a

Code	Category	L	T	P	C	I.M	E.M	Exam
B19CSOE08	**OE**	**3**	**0**	**0**	**3**	**25**	**75**	**3 Hrs.**

INTERNET OF THINGS

(Offered by CSE)

(Offered to CE & ME)

Course Objectives:

1.	To understand building blocks of IoT
2.	To Know various architectures and protocols in IoT
3.	To use cloud services for data analytics in IoT applications
4.	To develop IoT applications using Arduino

Course Outcomes: At the end of the course Students will be able to

S.No	Outcome	Knowledge Level
1.	Compare and contrast various IoT architectures	K3
2	Identify the **open systems interconnection layers**	K2
3	Implement IoT applications using Arduino	K3
4	Apply various communication protocols in IoT	K3
5.	Analyse data in IoT applications using cloud services	K4

SYLLABUS

UNIT-I (9 Hrs)	Fundamentals of IoT: An Overview of Internet of Things, IoT definition, characteristics of IoT, Physical design of IoT, Logical Design of IoT, IoT protocols, IoT levels and deployment templates, Internet of Things Technology, behind IoTs Sources of the IoTs, M2M Communication, Examples of IoTs, Design Principles For Connected Devices. Introduction to IoT Architectures: IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures The oneM2M IoT Standardized Architecture.
UNIT-II (9 Hrs)	Modified OSI Stack for the IoT/M2M Systems, ETSI M2M domains and High-level capabilities, Communication Technologies, Data Enrichment and Consolidation and Device Management Gateway Ease of designing and affordability.
UNIT-III (10 Hrs)	Design Principles**:** Design Principles for the Web Connectivity for connected-Devices, Web Communication protocols for Connected Devices, Message Communication protocols for Connected Devices, Web Connectivity for connected-Devices. Programming with Arduino: Features of Arduino, Components of Arduino board, Arduino IDE, C programming concepts for Arduino, Traffic control system, DHT Sensor with Arduino, Servo Motor Interface with Arduino.

UNIT-IV (9 Hrs)	Data link layer of IoT, Wireless Communication Technologies, Wired Communication Technologies, Manet Networks: Network Layer of IoT, 6LowPAN adaptation layer for devices with limited resources, Dynamic routing protocols for wireless adhoc networks Communication protocols for IoT, Service oriented protocol (COAP), Communication protocols based on the exchange of messages (MQTT), Service discovery protocols.
UNIT-V (9 Hrs)	Data Acquiring, Organizing and Analytics in IoT/M2M, Applications/ Services/ Business Processes, IOT/M2M Data Acquiring and Storage, Business Models for Business Processes in the Internet Of Things, Organizing Data, Transactions, Business Processes, Integration and Enterprise Systems.
Text Books:	
1.	Internet of Things: Architecture, Design Principles and Applications, Rajkamal, McGraw Hill Higher Education. 2017
2.	Internet of Things - A Hands-on Approach, ArshdeepBahga and Vijay Madisetti, Universities Press, 1st edition, 2014.
Reference Books:	
1.	Designing the Internet of Things, Adrian McEwen and Hakim Cassimally, Wiley, 1st edition, 2014.
2.	Getting Started with the Internet of Things CunoPfister, Oreilly. 2011
3.	Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD),2014.
e-Resources:	
1.	Introduction to Internet of Things, https://swayam.gov.in/nd1_noc20_cs66/preview
2.	An Introduction to Programming the Internet of Things(IoT) specialization, https://www.coursera.org/specializations/iot

SRKR ENGINEERING COLLEGE AUTONOMOUS Estd. 1980

Code	Category	L	T	P	C	I.M	E.M	Exam
B19CSOE09	**OE**	**3**	**0**	**0**	**3**	**25**	**75**	**3 Hrs.**

OPERATING SYSTEMS

(Offered by CSE)

(Offered to CE, ECE, EEE & ME)

Course Objectives:

1.	Introduce to the internal operation of modern operating systems
2.	Define, explain, processes and threads, mutual exclusion, CPU scheduling, deadlock, memory management, and file systems
3.	Understand File Systems in Operating System like UNIX/Linux and Windows
4.	Understand Input Output Management and use of Device Driver and Secondary Storage (Disk) Mechanism
5.	Analyze Security and Protection Mechanism in Operating System

Course Outcomes: At the end of the course Students will be able to

S.No	Outcome	Knowledge Level
1.	Describe various generations of Operating System and functions of Operating System	K2
2.	Describe the concept of program, process and thread and analyze various CPU Scheduling Algorithms and compare their performance	K2
3.	Solve Inter Process Communication problems using Mathematical Equations by various methods	K3
4.	Compare various Memory Management Schemes especially paging and Segmentation in Operating System and apply various Page Replacement Techniques	K3
5.	Outline File Systems in Operating System like UNIX/Linux and Windows	K2

SYLLABUS

UNIT-I (10 Hrs)	**Operating Systems Overview**: Operating system functions, Operating system structure, Operating systems operations, Computing environments, Open-Source Operating Systems. **System Structures**: Operating System Services, User and Operating-System Interface, systems calls, Types of System Calls, system programs, operating system structure, operating system debugging, System Boot.
UNIT-II (10 Hrs)	**Process Concept**: Process scheduling, Operations on processes, Inter-process communication, Communication in client server systems. **Multithreaded Programming**: Multithreading models, Thread libraries, Threading issues. **Process Scheduling**: Basic concepts, Scheduling criteria, Scheduling algorithms, Multiple processor scheduling, Thread scheduling. **Inter-process Communication**: Race conditions, Critical Regions, Mutual exclusion with

	busy waiting, Sleep and wakeup, Semaphores, Mutexes, Monitors, Message passing, Barriers, Classical IPC Problems - Dining philosophers problem, Readers and writers problem.
UNIT-III (10 Hrs)	**Memory-Management Strategies**: Introduction, Swapping, Contiguous memory allocation, Paging, Segmentation. **Virtual Memory Management**: Introduction, Demand paging, copy on-write, Page replacement, Page replacement Algorithms, Frame allocation, Thrashing, Memory-mapped files, Kernel memory allocation.
UNIT-IV (10 Hrs)	**Deadlocks**: Resources, Conditions for resource deadlocks, Deadlock detection and recovery, Deadlock avoidance, Deadlock prevention. **File Systems**: Files, Directories, File system implementation, management and optimization. **Secondary-Storage Structure**: Overview of disk structure, and attachment, Disk scheduling, RAID structure, Stable storage implementation.
UNIT-V (10 Hrs)	**System Protection**: Goals of protection, Principles and domain of protection, Access matrix, Access control, Revocation of access rights. **System Security**: Introduction, Program threats, System and network threats. **Case Studies**: Linux, Microsoft Windows.
Text Books:	
1.	Silberschatz A, Galvin P B, and Gagne G, Operating System Concepts, 9th edition, Wiley, 2013.
2.	Tanenbaum A S, Modern Operating Systems, 3rd edition, Pearson Education, 2008. (forInterprocess Communication and File systems.)
Reference Books:	
1.	Dhamdhere D M, Operating Systems A Concept Based Approach, 3rd edition, Tata McGraw-Hill, 2012.
2.	Stallings W, Operating Systems -Internals and Design Principles, 6th edition, Pearson Education, 2009
3.	Nutt G, Operating Systems, 3rd edition, Pearson Education, 2004
e-Resources:	
1.	https://nptel.ac.in/courses/106/105/106105214/

SRKR ENGINEERING COLLEGE AUTONOMOUS Estd. 1980

Code	Category	L	T	P	C	I.M	E.M	Exam
B19ECOE05	**OE**	**3**	**--**	**--**	**3**	**25**	**75**	**3 Hrs**

INTERNET OF THINGS

(Offered by ECE)

(Offered to CE, & ME)

Course Objectives:

1.	To make students familiar with the basic concepts of M2M &IoT architecture and Communication protocols.
2.	To introduce the Python Scripting Language with Raspberry PI platform, that is widely used in IoT applications.
3.	To introduce the implementation of web-based services on IoT devices.

Course Outcomes: At the end of the course Students will be able to

S.No	Outcome	Knowledge Level
1.	Explain the architecture and communication protocols of IoT.	K2
2.	Understand IoT sensors and technological challenges faced by IoT devices, with a focus on wireless, energy, power, and sensing modules.	K2
3.	Explore about Python with the help of Raspberry Pi for preparing projects designed for IoT.	K3
4.	Analyze data from physical devices through the cloud using data analytics.	K4

SYLLABUS

UNIT-I (09 Hrs)	Embedded hardware units and Devices in a system, Embedded software in a system, Examples of embedded systems, embedded. Real world interfacing, Introduction to advanced architectures, I/O types and examples, Serial Bus communication protocols, Parallel bus device protocols,
UNIT-II (09 Hrs)	IoT definition, Characteristics of IoT, Physical Design of IoT, Logical Design of IoT, IoT Protocols, M2M, Differences and Similarities between M2M and IOT, SDN and NFV for IoT.
UNIT-III (08 Hrs)	Basic building blocks of an IoT Device, Sensors like ultrasonic, IR sensor, temperature & humidity etc., communication modules like Bluetooth, zigbee, Wi-Fi & WSN, Lora WAN 6LoWPAN
UNIT-IV (10 Hrs)	Introduction to Arduino and Raspberry Pi- Installation, Interfaces (serial, SPI, I2C), Programming – Python program with Raspberry PI with focus on interfacing external gadgets like ultrasonic, IR sensor, temperature & humidity.

UNIT-V (10 Hrs)	IOT Physical Servers, Cloud Offerings & Data Analytics for IOT Web Application Messaging Protocol (WAMP), Cloud based communication, Data Analytics, IoT Design Methodology with a use.
Text Books:	
1.	Embedded System Architecture Programming and Design, Raj Kamal, 2nd Edition, McGraw Hill.
2.	Internet of Things: A Hands-On Approach, ArshdeepBahga, Vijay Madisett
Reference Books:	
1.	Embedded Software Primer, David Simon, Pearson
2.	Internet of Things: Principles and Paradigms by RajkumarBuyya, Amir VahidDastjerdi.
e-Resources:	
1.	https://www.youtube.com/watch?v=kOjdExBUqAI
2.	https://www.codemag.com/article/1607071/Introduction-to-IoT-Using-the-Raspberry-Pi

Estd. 1980
SRKR
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AUTONOMOUS

Code	Category	L	T	P	C	I.M	E.M	Exam
B19ECOE06	**OE**	**3**	**--**	**--**	**3**	**25**	**75**	**3 Hrs**

VLSI DESIGN

(Offered by ECE)

(Offered to EEE)

Course Objectives:

1.	To introduce various fabrication steps of MOS transistors and their electrical properties.
2.	To implement the stick diagrams and layouts using CMOS/Bi-CMOS design rules.
3.	To explain MOS technology interconnection as circuits, scaling models, static and dynamic designs.

Course Outcomes: The students will be able to

S.No	Outcome	Knowledge Level
1.	Analyze the Electrical properties and Fabrication processes of MOS circuits.	K4
2.	Design the layouts of various MOS circuits by applying the concept of design rules.	K4
3.	Interpret various scaling models and their impact on scaling of MOS circuits	K2
4.	Interpret the basic MOS circuit concepts, static and dynamic CMOS logic designs and the impact of scaling on MOS circuits.	K2

SYLLABUS

UNIT-I (10 Hrs)	**Introduction**: Introduction to IC Technology, Fabrication process: NMOS, PMOS and CMOS. Ids versus Vds Relationships, Aspects of MOS transistor Threshold Voltage, MOS transistor Transconductance, Output Conductance and Figure of Merit. NMOS Inverter, Pull-up to Pull down Ratio for NMOS inverter driven by another NMOS Inverter, and through one or more pass transistors, Alternative forms of pull-up, The CMOS Inverter, Latch-up in CMOS circuits, Comparison between CMOS and Bi-CMOS technology.
UNIT-II (5 Hrs)	**MOS and Bi-CMOS Circuit Design Processes**: MOS Layers, Stick Diagrams, Design Rules and Layout, General observations on the Design rules, 2µm Double Metal, Double Poly, CMOS/BiCMOS rules, 1.2µm Double Metal, Double Poly CMOS rules, Layout Diagrams of NAND and NOR gates and CMOS inverter.
UNIT-III (8 Hrs)	**Basic Circuit Concepts**: Sheet Resistance, Sheet Resistance concept applied to MOS transistors and Inverters, Area Capacitance of Layers, Standard unit of capacitance, The Delay Unit, Inverter Delays, Propagation Delays.

SRKR ENGINEERING COLLEGE AUTONOMOUS Estd. 1980

UNIT-IV (10 Hrs)	**Scaling of MOS Circuits**: Scaling models, Scaling factors for device parameters, Limitations of Scaling on substrate doping, Miniaturization, Interconnect and contact Resistance, Subthreshold currents and current density.
UNIT-V (8 Hrs)	**CMOS Combinational and Sequential logic circuit design:** **Static CMOS Design:** Complementary CMOS and its static properties, Ratioed logic, Pass Transistor logic- Design of logic gates. **Dynamic CMOS Design:** Basic principles,Issues in dynamic logic- charge leakage, charge sharing, Static latches and registers- Latches versus registers, The bistability principle, SR- Flip flops, Multiplexer based latch, Master-slave-edge triggered register.
Text Books:	
1.	Essentials of VLSI Circuits and Systems By Kamran Eshraghian, Douglas and A. Pucknell and SholehEshraghian, Prentice-Hall of India Private Limited,2005 Edition.
2.	Digital Integrated Circuits, Jan M. Rabaey, AnanthaChandrakasan and Borivoje Nikolic,2nd edition, 2016
Reference Books:	
1.	FPGA Based System Design‖- Wayne Wolf, Pearson Education, 2004, Technology and Engineering
2.	CMOS Digital Integrated Circuits Analysis and Design, Sung-Mo Kang, Yusuf Leblebici, Tata McGraw Hill Education,2003.
Web Links:	
1.	https://www.engineersgarage.com/vlsi-technology-an-overview/
2.	https://www.tutorialspoint.com/vlsi_design/vlsi_design_digital_system.htm
3.	https://www.powershow.com/viewfl/e5a26-ZDc1Z/Lecture_4_Design_Rules_Layout_and_Stick_Diagram_powerpoint_ppt_presentation

Code	Category	L	T	P	C	I.M	E.M	Exam
B19EEOE01	**OE**	**3**	**--**	**--**	**3**	**25**	**75**	**3 Hrs.**

INTRODUCTION TO ELECTRICAL SYSTEMS

(Offered by EEE)

(Offered to CE, CSE & IT)

Course Objectives:

1.	To study the various aspects of electricity generation and power generation scenario in India
2.	To study the various aspects of transmission and distribution of electrical energy and Indian Power grid scenario
3.	To study the utilization of electricity in various applications.
4.	To study the power conversion and energy storage of electricity
5.	To study the electrical hazards, electrical safety measures and equipment protection devices

Course Outcomes: At the end of the course Students will be able to

Sl.No	Outcome	Knowledge Level
1.	**Apply** basic knowledge to understand principles of power generation and its scenario in India.	K3
2.	**Illustrate** different components of transmission and distribution substations and **understand** the Indian Power grid scenario.	K3
3.	**Apply** energy conversion principles to understand operation of electrical utility components	K3
4.	**Apply** basic knowledge to understand operation of rectifier, Inverter, batteries and uninterrupted power supply	K3
5.	**Understand and apply** the Electrical safety measures while handling electrical equipment.	K3

SYLLABUS

UNIT-I (10 Hrs)	**ELECTRICITY GENERATION** History of Electricity generation, Basic electrical quantities-Voltage, Current, Power and energy, DC and AC power supplies, frequency and rms value of sinusoidal voltage, Electric generator - principle of operation, Major sources of electricity generation: schematics of conventional power plants (Thermal and Hydro), Non-conventional sources (solar and wind)- principles and advantages, Power generation scenario in India.
UNIT-II (10 Hrs)	**TRANSMISSION AND DISTRIBUTION OF ELECTRICITY** Transmission of Electrical Energy: Layout of power system**,** Overhead lines and cables, Power transmission at high voltage, Transformer - Working principle, Construction, Distribution of electrical energy - schematics diagrams of radial and ring main

	distribution, Substations - substation layout, substation equipment and their purpose. Overview of Indian power grid.
UNIT-III (10 Hrs)	**ELECTRICAL ENERGY CONSUMPTION** Conversion to mechanical energy - Classification of Electrical motors and their applications, DC motor - Working principle, Torque equation, AC motor - Working principle of 3-phase Induction motor, slip, Illumination- laws of illumination, fluorescent lamp, LED lamp, Electrical energy consumption in India
UNIT-IV (10 Hrs)	**POWER CONVERTERS AND STORAGE** Need of power conversion, Rectifier- Single phase full wave diode rectifier with C-filter, rectifier applications, Inverter- Single phase full bridge inverter operation, Inverter Applications, Electricity storage- Batteries, types of batteries, Lead acid battery, Li ion batteries, Ratings and basic parameters of batteries, battery pack, Domestic Uninterrupted power supply (UPS) system.
UNIT-V (10 Hrs)	**ELECTRICAL SAFETY AND EQUIPMENT PROTECTION**. Hazards in electrical systems, Different types of hazards, Electric Shock, Electrical safety measures, Earthing, Different methods of earthing. Domestic Protective Devices - Fuses and their ratings, Miniature Circuit Breaker (MCB), Earth Leakage Circuit Breaker (ELCB), Power ratings of different domestic loads - Fans, Lights, Air conditioners, Refrigerators, etc.

Text Books:	
1.	Basic Electrical Engineering- S. K. Sahdev, Pearson Publications, ISBN 978-93-325-4216-7
2.	Dr P.S. Bimbhra, Power Electronics - 4th Edition, Kanna Publisher
Reference Books:	
1.	Iqbal Husain, “Electric and Hybrid Vehicles Design Fundamentals”, CRC Press, Taylor & Francis Group, 2011
2.	Generation Distribution and Utilization of Electrical Energy by C.L Wadhwa.3rd Edition

SRKR ENGINEERING COLLEGE

Code	Category	L	T	P	C	I.M	E.M	Exam
B19EEOE04	**OE**	**3**	**--**	**--**	**3**	**25**	**75**	**3 Hrs.**

BASIC POWER ELECTRONICS

(Offered by EEE)

(Offered to ECE & ME)

Course Objectives: Students will learn

1.	The power electronic switching devices.
2.	The characteristics of power electronic switching devices
3.	The performances of uncontrolled AC-DC converters
4.	The performance and control of DC-DC converters
5.	The operation of DC-AC converters

Course Outcomes: At the end of the course Students will be able to

Sl.No	Outcome	Knowledge Level
1.	**Explain** the principle of operation of thyristor, modern power semiconductor devices.	K3
2.	**Illustrate** the phase-controlled rectifiers with different loads.	K3
3.	**Acquire** the knowledge on DC-DC choppers.	K3
4.	**Analyse** Cyclo-converter and AC voltage Controller configurations.	K3
5.	**Evaluate** the operation of inverters.	K3

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SYLLABUS

UNIT-I (10 Hrs)	**Thyristors** Silicon Controlled Rectifiers (SCRs)-Construction Operating principle with two transistor analogy – Static V-I characteristics of SCR – Turn on methods -dv/dt triggering, gate triggering, Temperature triggering, light triggering, forward voltage triggering, turn-off methods-load commutation, line commutation, Thyristor family devices IGBT and MOSFET- V-I characteristics.
UNIT-II (10 Hrs)	**AC-DC Converters (Phase Controlled Rectifiers)** Principles of phase-controlled rectification -Study of Single-phase half wave controlled and full wave-controlled bridge rectifiers with R and RL load-Freewheeling Diode-Average output voltage expression- Numerical Problems.
UNIT-III (10 Hrs)	**DC-DC Converters (Choppers)** Step up and Step-down chopper- input and output voltage relationship-critical value of inductance and capacitance- Duty Cycle control strategies- Numerical Problems.

UNIT-IV (10 Hrs)	**AC-AC Converters (Cycloconverters and AC Voltage Controllers)** Single phase to single-phase step up cycloconverter and step down cycloconverter with R and RL load-Bridge type. Operation of AC Voltage controllers with R and RL load, RMS value of output voltage. Numerical Problem
UNIT-V (10 Hrs)	**DC-AC Converters (Inverters)** Principle of operation of Single-phase half bridge and full bridge Inverters with R-load-Voltage control in single phase inverter- PWM Techniques-Single pulse modulation-multiple pulse modulation-sinusoidal pulse modulation.

Text Books:	
1.	Power electronics - P.S. Bimbhra- Khanna Publishers, 4th Edition
2.	Power Electronics: Circuits Devices and Applications – M.H. Rashid, Prentice Hall of India, 3rd edition.
Reference Books:	
1.	Power electronics – M.D. Singh & K.B. Kanchandhani, Tata McGraw – Hill Publishing Company, 2nd edition
2.	Power Electronics – Vedam Subramanyam, New Age International (p) Limited, Publishers.
3.	Power Electronics – P.C. Sen, Tata McGraw-Hill Publishing.
4.	Thyristorised power Controllers – G.K. Dubey, S.R Doradra, A. Joshi and R.M.K. Sinha, New Age international Pvt Ltd. Publishers latest edition
e-Resources:	
1.	https://www.youtube.com/watch?v=1Auay7ja2oY
2.	https://nptel.ac.in/courses/108/105/108105066/

SRKR ENGINEERING COLLEGE AUTONOMOUS Estd. 1980

Code	Category	L	T	P	C	I.M	E.M	Exam
B19EEOE06	**OE**	**3**	**--**	**--**	**3**	**25**	**75**	**3 Hrs**

MATLAB PROGRAMMING FOR ENGINEERING APPLICATIONS

(Offered by EEE)

(Offered to CE, CSE, IT & ME)

Course Objectives: Students will learn

1.	About the MATLAB basics, built-in functions, matrix operations, plotting commands.
2.	Conditional and looping statements to write MATLAB programs.
3.	About the different statistical approaches for better interpretation of data using MATLAB.
4.	About the MATLAB programming to solve engineering systems described by the mathematical equations.
5.	About the MATLAB programming for numerical methods.

Course Outcomes: At the end of the course Students will be able to

S.No	Outcome	Knowledge Level
1.	**Use** the built-in functions, matrix operations, plotting commands, arithmetic operations in MATLAB programs.	K3
2.	**Apply** the conditional and looping statements to write MATLAB programs.	K3
3.	**Apply** different statistical approaches for better interpretation of data using MATLAB.	K3
4.	**Apply** MATLAB programming to solve engineering systems described by the mathematical equations.	K3
5.	**Apply** MATLAB programming for numerical methods.	K3

SYLLABUS

UNIT-I (10 Hrs)	**INTRODUCTION TO MATLAB** History, purpose and importance, data types, conversion of data types, operators, built-in functions, creating vectors, matrices, manipulation of vectors and matrices, Matrix Operations, addition, subtraction, multiplication, transpose, Inverse, Determinant, Identity matrix, using simple xy Plotting Functions, line plots, subplots, bar plots, surface plots, pie plots, Saving and loading data.
UNIT-II (10 Hrs)	**MATLAB PROGRAMMING** Program Design and Development, Relational Operators and Logical Variables, Logical Operators, If statement, Else-if statement, Else statement, Switch Statement, For Loops, While Loops, Debugging MATLAB Programs, Simple programming examples.
UNIT-III (10 Hrs)	**STATISTICS, PROBABILITY AND INTERPOLATION** Statistics and Histograms, The Normal Distribution, Mean, Mode, Median and Standard

	Deviation, Uniformly Distributed Numbers, Normally Distributed Random Numbers, Generating Random Integers, Interpolation, Two-Dimensional Interpolation, curve fitting using least square method.
UNIT-IV (10 Hrs)	**SOLVING EQUATIONS** Linear algebra, Rank, Eigen values, Eigen vectors, Linear algebraic equations solving using matrices (up to three variables), Gauss elimination method, Matrix inverse method, quadratic equation, ordinary differential equation (upto second order), solution of partial differential equation (two variable).
UNIT-V (10 Hrs)	**NUMERICAL METHODS** Gauss Seidel method, Newton Raphson method for solving nonlinear equations, Rungekutta-4 method for solving ordinary differential equations, Trapezoidal method for solving numerical integration.
Text Books:	
1.	MATLAB and Simulink Crash Course for Engineers by Eklas Hossain, Oregon Institute of Technology Klamath Falls, OR, USA, Springer publication, 2022.
2.	Applied Numerical Methods Using MATLAB, by Won Young Yang Chung, Wenwu Cao, Tae-Sang Chung, John Morris, A John Wiley & Sons, Inc., Publication, 2005
Reference Books:	
1.	MATLAB ® for Engineering Applications by William J. Palm III, Fourth edition, New York, NY: McGraw-Hill Education, 2018.
2.	MATLAB Programming for Engineers, Stephen J.Chapman, third edition, Thomson Learning publication, 2005.

SRKR ENGINEERING COLLEGE AUTONOMOUS

Subject Code	Category	L	T	P	C	I.M	E.M	Exam
B19ITOE05	**OE**	**3**	**-**	**--**	**3**	**25**	**75**	**3 Hrs.**

CLOUD COMPUTING

(Offered by IT)

(Offered to CE, ECE, EEE & ME)

Course Objectives:

1.	The student will learn about the basic of cloud environment, building software systems and components that scale to millions of users in modern internet cloud concepts capabilities
2..	The student will learn about the various cloud service models including IaaS, PaaS, SaaS
3.	The student will learn about developing cloud based software applications on top of cloud platforms.
4.	The student will learn about the cloud governance and Security issues in Cloud Environment

Course Outcomes: At the end of this course, the students will be able to

S.No	Outcome	Knowledge Level
1	Understand the cloud environment	K2
2	Explain SaaS and PaaS services	K2
3	Understand and learn various Cloud based Services.	K2
4	Understand cloud-based applications and web applications.	K2
5	Understand the concepts of security, governance, and Economics in Cloud computing.	K2

SYLLABUS

UNIT-I (12Hrs)	**Introduction to cloud computing:** Cloud computing components, Infrastructure services, storage applications, database services – introduction to SaaS, PaaS, IaaS, IdaaS, data storage in cloud, Virtualization: enabling technologies, types of virtualization, server virtualization, desktop virtualization, memory virtualization, application and storage virtualization, tools and products available for virtualization.
UNIT-II (8 Hrs)	**SAAS and PAAS:** Getting started with SaaS, Software plus Services - Overview SaaS solutions, SOA, PaaS and benefits.
UNIT-III (10Hrs)	**IaaS and Cloud Data Storage:** understanding IaaS, improving performance for load balancing, server types within IaaS, utilizing cloud based NAS devices, cloud based data storage, and backup services, cloud based block storage and database services.
UNIT-IV (10Hrs)	**Cloud Application development:** Client server distributed architecture for cloud designing cloud based solutions, coding cloud based applications, traditional Apps vs cloud Apps, fundamental treatment of web application frameworks. Web Applications, Web APIs, Web Browsers.

UNIT-V (10Hrs)	**Cloud Governance and economics:** Securing the cloud, disaster recovery and business Continuity in the cloud, Managing the cloud, migrating to the cloud, governing and evaluating the clouds business impact and economics, Inside Cloud: Introduction to MapReduce and Hadoop over view of big data and its impact on cloud.

Text Books:	
1.	Cloud Computing: SaaS, PaaS, IaaS, Virtualization, Business Models, Mobile, Security and More, Kris Jamsa, Jones & Bartlett Publishers, Paper back edition,2013.
2.	Cloud Computing: A Practical Approach, Anthony T .Velte, Toby J.Velte, Robert Elsenpeter, Tata McGraw Hill Edition.
Reference Books:	
1.	Hadoop MapReduce cookbook, SrinathPerera and ThilinaGunarathne, Packet publishing

Estd. 1980
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Subject Code	Category	L	T	P	C	I.M	E.M	Exam
B19ITOE06	OE	3	--	--	3	25	75	3 Hrs.

INTERNET OF THINGS

(Offered by IT)

(Offered to CE & ME)

Course Objectives:

1	To understand not objects and IoT architectures
2	To learn about design principles of IoT devices
3	Learn about IoT related protocols
4	To understand the data link layer of IoT
5	To understand data analytics and cloud in context of IoT

Course Outcomes: By the end of the course, the student should have the ability to:

S.No.	Outcome	Knowledge Level
1	Evaluate the concept of Internet of Things in different contexts.	K4
2	Understand about design principles IoT devices.	K2
3	Analyze various protocols of IoT.	K4
4	Identify the need of data link layer in IoT.	K2
5	Apply data analytics and cloud offerings related to IoT.	K3

SRKR ENGINEERING COLLEGE AUTONOMOUS Estd. 1980

SYLLABUS

UNIT-I (8 Hrs)	**The Internet of Things: An Overview** Internet of Things, IoT architectural view, Technology behind IoTs: major components of IoT system, Sources of the IoTs, M2M Communication, M2M architecture, software development tools, Examples of IoTs: Wearable smart watch, smart home, smart cities.
UNIT-II (10 Hrs)	**Design Principles for Connected Devices** IoT/M2M systems LAYERS AND designs standardizations, Modified OSI Stack for the IoT/M2M Systems, ETSI M2M domains and High-level capabilities, Communication Technologies: Bluetooth, Zigbee, Wi-Fi, Data Enrichment and Consolidation and Device Management Gateway, Ease of designing and affordability.
UNIT-III (9 Hrs)	**Design Principles for the Web Connectivity for connected-Devices** Web Communication protocols for Connected Devices: Constrained RESTful environment (CoRE), Service oriented protocol (COAP), Communication protocols based on the exchange of messages (MQTT), Web Connectivity for connected-Devices network using SOAP,REST and HTTP RESTFUL.
UNIT-IV	D**ata link layer of IoT**, Wireless Communication Technologies, Wired Communication

(8 Hrs)	Technologies, Manet Networks: Network Layer of IoT, 6lowPAN adaptation layer for devices with limited resources, Dynamic routing protocols for wireless adhoc networks
UNIT-V (10 Hrs)	**Data Acquiring, Organizing and Analytics** Data Acquiring and Storage, Organizing Data, Transactions, Business Processes, Integration and Enterprise Systems. Data Collection, Storage and Computing Using a Cloud Platform, Cloud computing paradigm for data collection, storage, and computing, cloud service models: IOT based cloud based services using Xively, Nimbits

Textbooks:	
1	Internet of Things: Architecture, Design Principles And Applications,Rajkamal, McGraw Hill Higher Education.
2	Internet of Things, A.Bahgya and V.Madisetti, Univesity Press, 2015.
3	Internet of Things from Hype to Reality: The road to Digitization, Ammar RayesSamersalam.
Reference Books:	
1	Designing the Internet of Things, Adrian McEwen and Hakim Cassimally,Wiley.
2	Getting Started with the Internet of Things CunoPfister ,Oreilly.
3	Internet of Things and Data Analytics Handbook, HWAIYU GENG, Wileypublications.

Estd. 1980
SRKR
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Code	Category	L	T	P	C	I.M	E.M	Exam
B19MEOE05	**OE**	**3**	**--**	**--**	**3**	**25**	**75**	**3 Hrs.**

MECHATRONICS

(Offered by ME)

(Offered to CE, CSE, ECE, EEE & IT)

Course Objectives:

1.	To equip the students with fundamental knowledge on mechatronic systems.
2.	To familiarize the student with interdisciplinary knowledge of electronics required for application in mechanical engineering.

Course Outcomes: At the end of the course, students will be able to

S.No	Outcome	Knowledge Level
1.	**Understand** about various types of sensors, transducers and amplifiers applied in a mechatronic system.	K2
2.	**Identify** the use of signal converters, logic gates and actuation systems required for the design of mechatronic systems.	K2
3.	**Illustrate** mathematical models for physical systems using the fundamental knowledge of control systems.	K3
4.	**Develop** transfer function of first and second order systems with feedback loops.	K3
5.	**Develop** the knowledge on microcontrollers, programmable logic controllers and their applications in mechatronic systems.	K3

SYLLABUS

UNIT-I (10 Hrs)	**Introduction to Mechatronics:** **Sensors &Transducers:** Introduction, performance terminology, Classification of sensors: Potentiometer sensor, strain gauged element, Capacity element, LVDT, Optical Encoders, Selection of sensors. **Signal Conditioning**: Introduction signal Conditioning-Operational amplifiers: Inverting amplifier, summing amplifier, Integrating amplifier, Difference amplifier, filtering process.
UNIT-II (10 Hrs)	**Digital signals:** Digital and analog signals - DA and AD converter – Data Acquisition **Digital logic**: Digital logic - Logic gates – Application of logic gates **Pneumatic and hydraulic Actuation Systems**: Direction control valves –process control valve-cylinders**,** Mechanical actuation systems
UNIT-III (10 Hrs)	**Electric Actuation System**: Switching devices: Mechanical switches, solid state switches – solenoids - DC motors, AC motors, stepper motors **Basic System Models**: Modeling of one and two degrees of freedom Mechanical,

	Electrical, Fluid and thermal systems. Block diagram representations for these systems. Mechanical translational systems, Mechanical rotational systems, Electromechanical coupling
UNIT-IV (10 Hrs)	**System Transfer functions**: The Transfer function, Laplace transforms, First order systems, Second order systems, systems in series, systems with feedback loops. **Closed loop controllers**: Continuous and discrete processes, control modes, Two step, Proportional, Derivative, Integral, PID controllers
UNIT-V (10 Hrs)	**Microprocessors:** Microprocessor systems, Micro controllers, Applications **PLC**: Introduction, basic structure, I/P, O/P, processing, programming, ladder diagrams, timers, internal relays and counters, data handling, analogue input and output, selection of PLC. **Case studies of Mechatronic Systems**: Pick and place robot, Digital camera, Automotive control
Text Books:	
1.	Mechatronics Electronic control systems in Mechanical and Electrical Engineering by W. Bolton, Pearson Education, 4th Edition,2011
2.	Introduction to Mechatronics – David and Alcaitore Michael B.Histand TMH, 4th Edition, 2006.
Reference Books:	
1.	Mechatronics System Design by Devdas Shetty and Richard A. Kolk, P.W.S. Publishing Company, 2001
Web links:	
1.	https://nptel.ac.in/courses/112107298
2.	https://nptel.ac.in/courses/112103174

SRKR ENGINEERING COLLEGE AUTONOMOUS Estd. 1980

Code	Category	L	T	P	C	I.M	E.M	Exam
B19MEOE06	**OE**	**3**	**--**	**--**	**3**	**25**	**75**	**3 Hrs.**

GREEN ENGERGY SYSTEMS

(Offered by ME)

(Offered to CE, CSE, ECE, & IT)

Course Objectives:

1.	Significance of alternative sources of energy
2.	Significance of green energy systems and processes and provides the theory and working principles of probable sources of renewable and green energy systems that are Environmental friendly.

Course Outcomes: At the end of the course, students will be able to

S.No	Outcome	Knowledge Level
1.	Explain the importance of solar energy and solar energy collection	K2
2.	Apply the principles of solar energy storage systems and wind energy.	K3
3.	Apply the principles of biomass, geo thermal and ocean energies & their potential future applications.	K3
4.	Describe the principles of energy efficient systems like electrical and mechanical systems.	K2
5.	Discuss the concepts of green manufacturing systems.	K2

SYLLABUS

UNIT-I (10 Hrs)	**Introduction:** Role and potential of new and renewable sources, the solar energy option, Environmental impact of solar power. **Solar Radiation**: the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data **Solar Energy Collection**: Flat plate and concentrating collectors, classification of concentrating collectors, Photo voltaic energy conversion – types of PV cells.
UNIT-II (10 Hrs)	**Solar Energy Storage and Applications**: Different methods, sensible, latent heat and stratified storage, solar ponds, solar applications- solar heating/cooling technique, solar distillation and drying, central power tower concept. **Wind Energy:** Sources and potentials, horizontal and vertical axis windmills.
UNIT-III (10 Hrs)	**Bio-Mass:** Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters **Geothermal Energy**: Resources, types of wells, methods of harnessing the energy **Ocean Energy**: OTEC, Principles of utilization, setting of OTEC plants.

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UNIT-IV (10 Hrs)	**Energy Efficient Systems**: ELECTRICAL SYSTEMS: Energy efficient motors, energy efficient lighting and control, controls for HVAC (heating, ventilation and air conditioning). **Mechanical Systems:** Fuel cells- principle, selection of fuels & working of various types of fuel cells, Environmental friendly and Energy efficient compressors and pumps.
UNIT-V (10 Hrs)	**Green Manufacturing Systems**: Environmental impact of the current manufacturing practices and systems, benefits of green manufacturing systems, selection of recyclable and environment friendly materials in manufacturing, vegetable based cutting fluids, alternate casting and joining techniques, zero waste manufacturing.

Text Books:	
1.	Non-Conventional Energy Sources - G. D. Rai, fifth edition, Khanna Publishers, 2015.
2.	Non-Conventional Energy Resources - Khan B.H., Tata McGraw Hill, New Delhi, 2006
3.	Solar Energy – Principles of Thermal Collection and Storage/Sukhatme S.P. and J.K.Nayak/TMH
4.	Green Manufacturing Processes and Systems - J. Paulo Davim/Springer 2013.
Reference Books:	
1.	Alternative Building Materials and Technologies - K.S Jagadeesh, B.V Venkata Rama Reddy and K.S Nanjunda Rao/New Age International
2.	Non-Conventional Energy - Ashok V Desai /New Age International (P) Ltd
3.	Renewable Energy Technologies -Ramesh & Kumar /Narosa
4.	Principles of Solar Engineering - D.Yogi Goswami, Frank Krieth& John F Kreider/Taylor & Francis.
5.	Fuel Cell Technology -Hand Book / Gregor Hoogers / BSP Books Pvt. Ltd
Web links:	
1.	https://nptel.ac.in/courses/103103206
2.	https://nptel.ac.in/courses/115103123

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Code	Category	L	T	P	C	I.M	E.M	Exam
B19MEOE07	**OE**	**3**	**--**	**--**	**3**	**25**	**75**	**3 Hrs.**

MICRO-ELECTRO MECHANICAL SYSTEMS

(Offered by ME)

(Offered to CE, CSE, ECE, EEE & IT)

Course Objectives:

1.	To learn basics of Micro Electro Mechanical Systems (MEMS) and study the various materials used for micromachining techniques and to learn about various sensors and actuators used in MEMS
2.	To give exposure to different MEMS Thermal Sensors And Actuators.
3.	To learn the principle and various devices of MOEMS and Magnetic Sensors And Actuators devices.
4.	To impart knowledge of the basic concept of fluid actuation methods, dielectrophoresis (DEP), electro thermal flow, opto electro wetting (OEW), and thermal effects Micro fluidics and to learn Radio Frequency (RF) MEMS..

Course Outcomes: At the end of the course, students will be able to

S.No	Outcome	Knowledge Level
1.	Identify the materials used for micromachining techniques and Analyze the process of sensors and actuators.	K4
2.	Acquire the knowledge of Heat transfer processes, Thermal effects, Devices such as thermal flow sensors, thermo vessels.	K3
3.	Analyze and develop models for different types of Magnetic Sensors and magnetic sensing and detection. Develop MOEMS technology	K4
4.	Analyze the process of Micro Fluidic System.	K4

SYLLABUS

UNIT-I (10 Hrs)	**Introduction:** Definition of MEMS, MEMS history and development, micro machining, lithography principles & methods, structural and sacrificial materials, thin film deposition, impurity doping, etching, surface micro machining, wafer bonding, LIGA. **Mechanical Sensors And Actuators:** Principles of sensing and actuation: beam and cantilever, capacitive, piezo electric, strain, pressure, flow, pressure measurement by micro phone, MEMS gyroscopes, shear mode piezo actuator, gripping piezo actuator, Inchworm technology.
UNIT-II (10 Hrs)	**Thermal Sensors And Actuators:** Thermal energy basics and heat transfer processes, thermisters, thermo devices, thermo couple, micro machined thermo couple probe, peltier effect heat pumps, thermal flow sensors, micro hot plate gas sensors, MEMS thermo vessels, pyro electricity, shape memory alloys (SMA), U-shaped horizontal and vertical

	electro thermal actuator, thermally activated MEMS relay, micro spring thermal actuator, data storage cantilever.
UNIT-III (10 Hrs)	**Micro-Opto-Electro Mechanical Systems:** Principle of MOEMS technology, properties of light, light modulators, beam splitter, micro lens, micro mirrors, digital micro mirror device (DMD), light detectors, grating light valve (GLV), optical switch, wave guide and tuning, shear stress measurement.
UNIT-IV (10 Hrs)	**Magnetic Sensors And Actuators:** Magnetic materials for MEMS and properties, magnetic sensing and detection, magneto resistive sensor, more on hall effect, magneto diodes, magneto transistor, MEMS magnetic sensor, pressure sensor utilizing MOKE, mag MEMS actuators, by directional micro actuator, feedback circuit integrated magnetic actuator, large force reluctance actuator, magnetic probe based storage device.
UNIT-V (10 Hrs)	**Micro Fluidic Systems:** Applications, considerations on micro scale fluid, fluid actuation methods, dielectrophoresis (DEP), electro wetting, electro thermal flow, thermo capillary effect, electro osmosis flow, opto electro wetting (OEW), tuning using micro fluidics, typical micro fluidic channel, microfluid dispenser, micro needle, molecular gate, micro pumps. **Radio Frequency (Rf) MEMS:** RF – based communication systems, RF MEMS, MEMS inductors, varactors, tuner/filter, resonator, clarification of tuner, filter, resonator, MEMS switches, phase shifter.

Text Books:	
1.	MEMS, NitaigourPremchandMahalik, TMH Publishing co.
Reference Books:	
1.	Foundation of MEMS, Chang Liu, Prentice Hall Ltd.
2.	MEMS and NEMS, Sergey EdwrdLyshevski, CRC Press, Indian Edition.
3.	MEMS and Micro Systems: Design and Manufacture, Tai-Ran Hsu, TMH Publishers.
4.	Introductory MEMS, Thomas M Adams, Richard A Layton, Springer International Publishers.
Web links:	
1.	https://nptel.ac.in/courses/117105082
2.	https://nptel.ac.in/courses/108108113

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