VII SEMESTER

Semester: VII		
VLSI SYSTEM DESIGN (Theory and Practice)		
Course Code:	MVJ21EC71	CIE Marks:50+50
Credits:	L:T:P: 3:0:2	SEE Marks: 50 +50
Hours:	40 L+ 26 P	SEE Duration: 03+03 Hours
Course Learning Objectives: The students will be able to		
1	Understand the characteristics of CMOS circuit construction.	
2	Introduce the concepts and techniques of modern integrated circuit design and testing (CMOS VLSI).	
3	Design CMOS combinational and sequential logic at the transistor level, with mask layout.	
4	Describe the general steps required for processing of CMOS integrated circuits.	
5	Study functional units including adders, multipliers, ROMs, SRAMs.	

UNIT 1	
Prerequisites: *Basics of transistor* **Introduction to MOS Technology** : Semiconductor materials, enhancement mode MOS transistor, depletion mode MOS transistor, NMOS fabrication, CMOS fabrication, comparison of NMOS, CMOS, BICMOS, GaAs technologies. **Introduction to ASICs :** Field Programmable gate array, Full custom, Semi-custom , ASIC Design flow. **Laboratory Sessions/ Experimental learning:** 1. Design and demonstrate the MOS transistor connected as a diode using any CAD tool. **Applications:** Design of Diode **Video link / Additional online information :** 1. https://www.youtube.com/watch?v=faiEVOOCe-s&t=2519s 2. https://www.youtube.com/watch?v=FRihw0Gpi0Y 3. https://www.youtube.com/watch?v=oSrUsM0hoPs	8Hrs.

UNIT 2	
Basic Electrical Properties of MOS Circuits : Drain-to-Source current vs. voltage relationships, aspects of MOS transistor threshold voltage, MOS transistor transconductance and output conductance, the pass transistor, the NMOS inverter, determination of pull up to pull down ratio of NMOS transistor driven by another NMOS transistor, alternate forms of pull up, the CMOS inverter, MOS transistor circuit model, latch up in CMOS circuits. **Laboratory Sessions / Experimental learning:** 1. Simulation of CMOS Inverter characteristics with different values of Inverter Ratio (Kr) using LTspice / pspice software. **Applications:** Design of nMOS and CMOS inverter circuit. **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=eqnMAaYU4OY 2. https://www.youtube.com/watch?v=zNqmohJHDwc	**10Hrs.**
UNIT 3	
MOS Circuit Design Process : MOS layers, stick diagrams, design rules and layout, 2ìm, 1.2ìm CMOS rules. Layout diagrams, symbolic diagrams. Basic circuit concepts: Sheet resistance, area capacitance of layers, delay model, wiring capacitances, choice of layers. Scaling of MOS circuits: Scaling models, scaling function for device parameters and limitation of scaling. **Laboratory Sessions/ Experimental learning:** **1.** Draw layout of inverter using Cadence Tool **Applications:** Design of CMOS inverter circuit with different scaling functions. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117106093/ 2. https://nptel.ac.in/courses/117106092/ 3. https://nptel.ac.in/courses/117101058/	**10Hrs.**
UNIT 4	
Sub System Design and Layout : Architectural issues, switch logic, gate logic, examples of structural design (Combinational logic) and some clocked sequential	**10Hrs.**

circuits. Memory register and aspects of system timing, Some commonly used storage/memory elements, Subsystem design process, General arrangement of 4-bit arithmetic processor, regularity, Design of an ALU subsystem. **Laboratory Sessions/ Experimental learning:** 2. Design Manchester Carry-chain using CMOS transistors using any CAD tool **Applications:** Designing of PLA and PLD **Video link / Additional online information :** 2. https://nptel.ac.in/courses/117106093/ 3. https://nptel.ac.in/courses/117106092/ https://nptel.ac.in/courses/117101058/	
UNIT 5	
Test and Testability : System partitioning, layout and testability, reset/ initialization, design for testability, testing combinational logic, testing sequential logic, practical design for test (DFT) guidelines, scan design techniques, built-in-self-test (BIST). CMOS design projects: Incrementer/ Decrementer, comparator for two n-bit numbers. **Laboratory Sessions/ Experimental learning:** 1. Perform a survey on Prime Time CAD tool from any open source software for timing Analysis. **Applications:** Testing of Imperfections in chip fabrication. **Video link / Additional online information:** 1. https://youtu.be/V-GL-oQSa14 (Fault design & Testability) 2. https://youtu.be/P7AQJn7K8Os(Combinational Circuit Test Pattern Generation-ATPG) https://youtu.be/NGoRLtDkPwU (Sequential Circuit Testing and Scan Chains &BIST)	**10Hrs.**
Laboratory Sessions	
Sl No | Experiment Name	
ASIC Digital Design	

1	Write Verilog Code for **inverter** and Test Bench for verification, observe the waveform and synthesize the code with technological library with given constraints. Do the initial timing verification with gate level simulation.
2	Write Verilog Code for **buffer** and Test Bench for verification, observe the waveform and synthesize the code with technological library with given constraints. Do the initial timing verification with gate level simulation.
3	Write Verilog Code for **Transmission Gate** and Test Bench for verification, observe the waveform and synthesize the code with technological library with given constraints. Do the initial timing verification with gate level simulation.
4	Write Verilog Code for **Basic/universal gates** and Test Bench for verification, observe the waveform and synthesize the code with technological library with given constraints. Do the initial timing verification with gate level simulation.
5	Write Verilog Code for **Flip flops -RS, D, JK, MS, T** and Test Bench for verification, observe the waveform and synthesize the code with technological library with given constraints. Do the initial timing verification with gate level simulation.
6	Write Verilog Code for **Serial & Parallel adder** and Test Bench for verification, observe the waveform and synthesize the code with technological library with given constraints. Do the initial timing verification with gate level simulation.
7	Write Verilog Code for 4-bit counter [Synchronous and Asynchronous counter] and Test Bench for verification, observe the waveform and synthesize the code with technological library with given constraints. Do the initial timing verification with gate level simulation.
Analog Design	
8	Design an Inverter with given specifications, completing the design flow mentioned below: • Draw the schematic and verify the following i) DC Analysis ii) Transient Analysis • Draw the Layout and verify the DRC, ERC • Check for LVS Verify & Optimize for Time, Power and Area to the given constraint
9	Design the Common source amplifier with given specifications, completing the design flow mentioned below: • Draw the schematic and verify the following i) Transient Analysis ii) DC Analysis iii) AC Analysis • Draw the Layout and verify the DRC, ERC • Check for LVS RC extraction

10	Design the Common Drain amplifier with given specifications, completing the design flow mentioned below: • Draw the schematic and verify the following i) Transient Analysis ii) DC Analysis iii) AC Analysis • Draw the Layout and verify the DRC, ERC • Check for LVS RC extraction
11	Design a Single Stage differential amplifier, with given specifications, completing the design flow mentioned below: • Draw the schematic and verify the following i) Transient Analysis ii) DC Analysis iii) AC Analysis • Draw the Layout and verify the DRC, ERC • Check for LVS RC extraction
12	Design an Operational-amp with given specification using given differential amplifier Common source and Common Drain amplifier in library and completing the design flow mentioned below: • Draw the schematic and verify the following i) Transient Analysis ii) DC Analysis iii). AC Analysis • Draw the Layout and verify the DRC, ERC • Check for LVS RC extraction

Course outcomes:	
CO1	Demonstrate understanding of MOS transistor theory, CMOS fabrication flow and technology scaling.

CO2	Utilize the knowledge of physical design aspects to draw the basic gates using stick and layout diagrams.
CO3	Demonstrate ability to design Combinational, sequential and dynamic logic circuits as per the requirements.
CO4	Interpret Memory elements along with timing considerations.
CO5	Summarize testing and testability issues in VLSI Design.
Reference Books:	
1.	Sung Mo Kang & Yosuf Leblebici, "CMOS Digital Integrated Circuits: Analysis and Design" - Third Edition, Tata McGraw-Hill.
2.	Neil H. E. Weste, and David Money Harris, "CMOS VLSI Design- A Circuits and Systems Perspective"- 4th Edition, Pearson Education.
3.	Adel Sedra and K. C. Smith, "Microelectronics Circuits Theory and Applications", 6th or 7th Edition, Oxford University Press, International Version, 2009.
4	Douglas A Pucknell & Kamran Eshragian, "Basic VLSI Design", PHI 3rd Edition, (original Edition – 1994).

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the self - study are 20 (2 presentations are be held for 10 marks each). The marks obtained in test, quiz and self -studies are added to get marks out of 100 and report CIE for 50 marks.

Laboratory- 50 Marks

The laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of the marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are awarded 10 marks. Total marks for the laboratory is 50.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks are executed by means of an examination.

The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Laboratory- 50 Marks

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	1	-	-	-	-	-	1
CO2	3	3	3	2	2	1	-	-	-	-	-	1
CO3	3	3	3	2	2	1	-	-	-	-	-	1
CO4	3	3	3	2	2	1	-	-	-	-	-	1
CO5	3	3	3	2	2	1	-	-	-	-	-	1

High-3, Medium-2, Low-1

Professional Elective II

Semester: VII		
MEDICAL ELECTRONICS (Theory)		
Course Code:	MVJ21EC721	CIE Marks:100
Credits:	L:T:P: 3:0:0	SEE Marks: 100
Hours:	40L	SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	Explain physiological parameters such as electrical, non-electrical and the recording methods.	
2	Learn the methods used for recording and measuring the biological signals.	
3	Illustrate the various Medical Imaging devices used in the hospitals.	
4	Explain the telemetry systems and know the safety aspects required in medical equipment.	
5	Understand the various Therapeutic Devices and know about recent trends in medical system.	

UNIT 1	
Prerequisites: *Basics of Transducer* **Fundamentals of Physiology and Transducer:** **Types of Bioelectric Potentials:** Introduction to different types of bioelectric potentials, Action and resting potentials, Propagation of action potentials. **Biological Systems:** Nervous system and its fundamentals, Basic components of a biomedical system, Cardiovascular systems, Respiratory systems **Electrodes and Transducers in Medical systems:** Different type of electrodes, sensors used in biomedicine. Physiological signals and transducers, Piezoelectric Transducers, ultrasonic transducers, Temperature measurement, Fibre optic temperature sensors. Selection criteria for transducer and electrodes. **Laboratory Sessions/ Experimental learning:** 1. Practical applications of electrodes in medical field. **Applications:** Ultrasonic scanning devices, Measures skin and body temperature, Measures Respiratory rate**Video link / Additional online information :** 1. https://nptel.ac.in/courses/102/104/102104043/ 2. https://www.youtube.com/watch?v=QiwxdcckPGc	8Hrs.

3. https://www.youtube.com/watch?v=LOjK2wB_qcg&feature=youtu.be 4. https://youtu.be/7TabKYSbdH4	
UNIT 2	
Electrical and Non-Electrical Parameter Measurement: **Electro Physiological Measurement:** Biological amplifiers, ECG,EEG, EMG, PCG, typical waveforms and signal characteristics **Non Electrical Parameter Measurement:** Measurement of blood pressure, Ultra sound blood flow meter, Blood flow cardiac output, Heart rate, heart sound, measurement of gas volume, flow rate of CO2 and O2 in exhaust air, pH of blood **Laboratory Sessions/ Experimental learning:** 1. Measure the "PQRST ECG" signal in both normal and abnormal conditions. **Applications:** Psychology and Neuroscience, Brain Computer Interfaces (BCI) **Video link / Additional online information:** 1. https://nptel.ac.in/courses/108/108/108108167/ 2. https://www.youtube.com/watch?v=7cvgDIdtw8M 3. https://www.youtube.com/watch?v=mK6sPBbChqc	8Hrs.
UNIT 3	
Amplifiers used in Medical Electronics: Amplifiers, preamplifiers, differential amplifiers, chopper amplifiers, Isolation amplifier **Medical Imaging:** X-ray machine, Computer tomography, Magnetic resonance imaging system, Positron emission tomography and endoscopy. **Laboratory Sessions/ Experimental learning:** 1. Graphical results of all Medical Images. **Applications:** Diagnose disease, blood clots, tumours, bone fractures ,inflammation or infection in an organ ,degenerative diseases ,strokes **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=N0Dwh3avx9A 2. https://www.youtube.com/watch?v=5_k6GVMwQ8w 3. https://www.youtube.com/watch?v=1ftsuzhJ-vk	8Hrs.
UNIT 4	
Telemetry: Introduction to telemetry systems, Different types of biotelemetry systems, Retinal Imaging, Imaging application in Biometric systems.	8Hrs.

Safety in Medical Environment: Electrical safety in medical environment, shock hazards, leakage current, Instruments for checking safety parameters of biomedical equipment **Laboratory Sessions/ Experimental learning:** Practical applications of telemetry in medical systems. **Applications:** In the branch of Ophthalmology **Video link / Additional online information :** 1. https://www.youtube.com/watch?v=0UPoSdBFD48 2. https://www.youtube.com/watch?v=8SPHA_1tTw4	
UNIT 5	
Assisting and Therapeutic Devices: Cardiac pacemakers, Defibrillators, Ventilators, Surgical diathermy, Heart lung machine, Laser in surgery and medicine. **Recent Trends in medical System:** Insulin Pumps, Radio pill, Endo microscopy, Brain machine interface, Lab on a chip, ICCU patient monitoring system, Wearable Antennas. **Robotic Devices:** Nano Robots, Robotic surgery, Orthopedic prostheses fixation. **Laboratory Sessions/ Experimental learning:** 1. Functions of ICCU patient Monitoring Systems. **Applications:** Diagnosis of the gastrointestinal tract. Applications of BCI are neuroergonomics, medical, smart environment, education and self-regulation, games and entertainment, neuro marketing and advertisement **Video link / Additional online information:** 1.https://www.youtube.com/watch?v=SMXBR_YFocs 2. https://www.youtube.com/watch?v=qUD865w2Drw 3. https://www.youtube.com/watch?v=KAvQsRL-jeo	8Hrs.

Course outcomes:	
CO1	Analyse the operation and characteristics of Electronic devices and use of them in applications.

CO2	Evaluate the performance of electronic circuits.
CO3	Demonstrate the electronic systems and analyse their applicability
CO4	Analyse requirement of electronic devices and systems.
CO5	Design a simple prototype for a certain application.

Reference Books:	
1.	R.S. Khandpur, "Hand book of Bio Medical Instrumentation" (2nd edition)- ISBN-13: 9789339205430.
2.	Mandeep Singh, "Introduction to Biomedical Instrumentation", ISBN-13: 9788120350236
3.	S.K. Guha, "Principles of Medical Electronics and biomedical Instrumentation" - ISBN-13: 978-8173712579.
4.	J.G.Webster (Wiley India), "Medical instrumentation Application and Design", ISBN-13: 978-0471676003.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	1	-	-	1	-	-	1
CO2	3	3	2	2	2	1	-	-	1	-	-	1
CO3	3	3	2	2	3	1	-	-	1	-	-	1
CO4	3	3	2	2	3	1	-	-	1	-	-	2
CO5	3	3	2	2	2	1	-	-	1	-	-	3

High-3, Medium-2, Low-1

Semester: VII		
SATELLITE & RADAR COMMUNICATION (Theory)		
Course Code:	MVJ21EC722	CIE Marks:100
Credits:	L:T:P: 3:0:0	SEE Marks: 100
Hours:	40L	SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	Provide a conceptual knowledge of communication through satellites.	
2	Study the concept of navigation - both inertial and by navigation satellites.	
3	Understand typical challenges of satellite-based systems.	
4	Learn the basic principle of radar equation.	
5	Motivate to learn modern radar and navigational techniques.	

UNIT 1	
Prerequisites: *Digital Communication Systems* **Introduction to Satellite Communication:** Orbital aspects of Satellite Communication: Introduction to geo-synchronous and geo-stationary satellites, Kepler's laws, Locating the satellite with respect to the earth, Sub-satellite point, Look angles, Mechanics of launching a synchronous satellite. **Laboratory Sessions/ Experimental learning:** 1. To study the details regarding satellite communication toolbox in Matlab. **Applications:** DTH, or satellite television, services (such as the DirecTV and DISH Network services **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105131/# 2. https://youtu.be/n70zjMvm8L0 3. https://youtu.be/oYRMYSIVj1o	8Hrs.
UNIT 2	
Satellite sub-systems: Attitude and Orbit control systems, Telemetry, Tracking and command control system, Power supply system, Space craft antennas, Multiple access techniques, comparison of FDMA, TDMA, and CDMA. Earth station equipment, tracking systems. **Satellite Link Design** : Basic transmission theory, System noise temperature and G/T Ratio, Noise figure and noise temperature, Calculation of system noise temperature, G/T ratio for earth stations, Link budgets - Uplink and downlink	8Hrs.

budget calculations, Error control for digital satellite links, Prediction of rain attenuation and propagation impairment counter measures. **Laboratory Sessions/ Experimental learning:** 1. Study and analyze the parameters of RF-link satellite simulation using Matlab **Applications:** Mobile Communication, Error detection and correction **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105131/# https://www.youtube.com/watch?v=FTHt-c8hWKw	
UNIT 3	
Communication Satellites: Introduction, C band and Ku band Home satellite TV, Digital DBS TV, DBS TV System Design, Installation of DBS TV Antenna, Satellite Radio Broadcasting. **Navigation Satellite** s: Introduction, Radio and Satellite Navigation, GPS Position Location Principle, Satellite Signal Acquisition, GOS Navigation Message, GPS Signal Levels, GOS Receiver Operation. **VSAT Systems:** Introduction, Overview, Network Architectures. **Laboratory Sessions/ Experimental learning:** 1. A Case Study of Using Remote Sensing Data and GIS for Land Management **Applications:** Communication, Weather forecasting, Remote sensing, Navigation **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105131/# 2. https://nptel.ac.in/courses/121/107/121107009/ https://onlinecourses.nptel.ac.in/noc19_ce45/preview	**8Hrs.**
UNIT 4	
Introduction to Radar: Radar block diagram and operation, Radar frequencies, Applications of radar, Prediction of range performance, Minimum detectable signal, Receiver noise, Probability density function, SNR, Integration of radar pulses, Radar cross-section of targets, PRF and range ambiguities, Transmitter power, System losses.	**8Hrs.**

Electronically steered Phased Array Antenna in Radar: Phase shifters, Frequency scan arrays, Array elements, Feeds for arrays, Computer Control of Phased-Array Radar. **Laboratory Sessions/ Experimental learning:** 1. Implement the radar range equations for remote sensing. **Applications:** Ground surveillance, missile control, fire control, air traffic control (ATC), moving target indication (MTI). **Video link / Additional online information:** 1. https://onlinecourses.nptel.ac.in/noc19_ee58/preview https://nptel.ac.in/courses/108/105/108105154/	
UNIT 5	
Radar Technology and Applications: Doppler Effect, CW radar, FM CW radar, Multiple frequency CW radar, MTI radar, Delay line canceller, Range gated MTI radar, Blind speeds, Staggered PRF, Limitations to the performance of MTI radar, Non-coherent MTI radar. Tracking radar: sequential lobing, conical scan, Monopulse: amplitude comparison and phase comparison methods, Radar antennas. Radar displays. **Laboratory Sessions/ Experimental learning:** 1. Study the implementation and importance of MTI radar with Power amplifier. **Applications:** Ground surveillance, weapons location, and vehicle search **Video link / Additional online information:** 1. https://nptel.ac.in/courses/108/105/108105154/ 2. https://youtu.be/XFapyIIzX_8 https://freevideolectures.com/course/5299/introduction-radar-systems/42	8Hrs.

Course outcomes:	
CO1	Apply the basics of digital transmission related to satellite communication
CO2	Comprehend the design of satellite subsystems
CO3	Evaluate spacecraft subsystem performance and trades

CO4	Model the characteristics of radar echoes from different types oftargets and clutter.
CO5	Calculate and simulate receiver noise and losses.

Reference Books:	
1.	T. Pratt, C.W. Boastian and Jeremy Allnutt, "Satellite Communication", 2013, 2nd edition, John Wiley and Sons, Bangalore, India.
2.	Merril. I. Skolnik, "Introduction to Radar Systems", 2/e, MGH, 1981.
3.	Dennis Roddy, Satellite Communications, 4th Edition, McGraw- Hill International edition, 2006
4.	Timothy Pratt, Charles Bostian, Jeremy Allnutt, Satellite Communications, 2nd Edition, Wiley India Pvt. Ltd , 2017, ISBN: 978-81-265-0833-4

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	3	-	-	-	2	-	-	-	-	-	-	-
CO2	3	3	2	-	2	-	-	-	-	-	-	-
CO3	3	3	3	2	-	-	-	-	-	-	-	-
CO4	3	3	3	2	1	-	-	-	-	-	-	-
CO5	3	3	3	-	2	-	-	-	-	-	-	-

High-3, Medium-2, Low-1

Semester: VII		
REAL TIME OPERATING SYSTEMS (Theory)		
Course Code:	MVJ21EC723	CIE Marks:100
Credits:	L:T:P: 3:0:0	SEE Marks: 100
Hours:	40L	SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	Acquire knowledge about concepts related to OS for Embedded Systems.	
2	Gain knowledge about different types of scheduling algorithms suitable for embedded real time systems.	
3	Introduce the principles of Inter process communication and multitasking applications.	
4	Explain the architecture of Linux Kernel and RTOS applications to Linux.	
5	Discuss Real-Time Programming in Linux and µC Linux.	

UNIT 1	
Prerequisites: *Basic Concepts of Operating systems and basics of task management and task scheduling.* **Real Time Systems:** Introduction, issues in real time computing, Structure of a real time system, task classes, performance measures for real time systems, task assignment and scheduling algorithms, mode changes, Fault tolerant scheduling, Real Time Models. **Laboratory Sessions/ Experimental learning:** 1. Create an application that creates two tasks that wait on a timer whilst the main task loops. 2. Create an application that creates tasks and scheduling tasks. **Applications:** Kiel RTOS for ARM (Keil RTX - ARM) **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/105/106105036/ https://nptel.ac.in/courses/106/105/106105172/	8Hrs.
UNIT 2	

µC/OS- II RTOS Concepts: Foreground/Background process, Resources, Tasks, Multitasking, Priorities, Schedulers, Kernel, Exclusion, Inter task communication, Interrupts, Clock ticks, µC/OS- II Kernel structure , µC/OS- II Initialisation, Starting µC/OS- II. **Laboratory Sessions/ Experimental learning:** 1. Write an Keil RTOS code that demonstrates the multitasking priority. 2. Write an Keil RTOS code that assigns priority and sets the time slice period to illustrate time slicing. **Applications:** 1. Email Spam and Malware Filtering 2. File Managers and Resource management systems **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/106/106106198/ http://www.nptelvideos.in/2012/11/real-time-systems.html	**8Hrs.**
UNIT 3	
µC/OS- II RTOS Functions: Task Management, Time management, Semaphore management, Mutual exclusion semaphore, Event Management, Message management, Memory management, porting µC/OS- II – comparison and study of various RTOS like QNX, VX Works, Psos. **Laboratory Sessions/ Experimental learning:** 1. Write a Keil RTOS code to manage tasks to handle semaphore to overcome mutual exclusion. 2. Demonstrate Porting of µC/OS- II in Embedded processor. **Applications:** Traffic light controller system **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/105/106105215/ https://nptel.ac.in/courses/106/105/106105172/	**8Hrs.**
UNIT 4	
Embedded Linux: Embedded Linux, Features, Embedded Linux Distributions, Architecture of Embedded Linux, Linux Kernel Architecture, User Space, Root File System, Linux Start, Up Sequence, GNU Cross Platform Tool chain, Porting Traditional RTOS Applications to Linux.	**8Hrs.**

Laboratory Sessions/ Experimental learning: 1. Write an application that display two different messages in LCD display in two lines. **Applications:** Smart Mobile Phone operating system development process demonstration. **Video link / Additional online information:** 1. http://1.https//nptel.ac.in/courses/11706087/ https://nptel.ac.in/courses/106/106/106106198/	
UNIT 5	
Real time Linux: Linux and Real-Time, Real-Time Programming in Linux, Hard Real-Time Linux, Building and Debugging, Building the Kernel, Integrated Development Environment, Kernel Debuggers, Embedded Drivers, Board support packages, Introduction to µC Linux. **Laboratory Sessions/ Experimental learning:** 1. Creating and UART driver for USB bus. **Applications:** Demonstration of ABS system in automobiles **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117102059/ 2. http://www.nptelvideos.in/2012/11/real-time-systems.html https://www.youtube.com/watch?v=HlU5cYqGLZE	**8Hrs.**

Course outcomes:	
CO1	Summarize fundamental principles for programming of real time systems with time and resource limitations.
CO2	Develop RTOS based embedded real time applications.
CO3	Analyze the functions of real time operating systems.
CO4	Utilize RTOS software tool chain for Embedded Applications.
CO5	Develop real time kernels and Embedded Drivers.

Reference Books:	
1.	Krishna C.M., Kang G. Shin, "Real Time Systems", Tata McGraw-Hill international Edition, 2010.

2.	Philip A.Laplante, "Real Time Systems Design and Analysis-An Engineers Handbook", II Edition-IEEE Press, IEEE Computer Society Press, 2001.
3	Jean J Labrosse, "MicroC/OS-II The Real Time Kernel" II Edition, CMP Books, 2002.
4.	P.Raghavan, Amol Lad, Sriram Neelakandan, "Embedded Linux System Design and Development",Auerbach Publications, Taylor& Francis Group, 2006.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	1	-	-	1	-	2	1
CO2	3	3	3	2	1	1	_	_	1	_	2	1
CO3	3	3	3	2	1	1	_	_	1	_	2	1
CO4	3	3	3	2	1	1	_	_	1	_	2	1
CO5	3	3	3	2	1	1	_	_	1	_	2	1

High-3, Medium-2, Low-1

Semester: VII		
CRYPTOGRAPHY & CYBER SECURITY (Theory)		
Course Code:	MVJ21EC724	CIE Marks:100
Credits:	L:T:P: 3:0:0	SEE Marks: 100
Hours:	40L	SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	Outline the basic principles of Cyber security and its applications	
2	Familiarize with Cryptography and very essential algorithms	
3	Use the theorems needed for cryptographic operations and compare & contrast different types of cryptography	
4	State the concepts & uses of Digital signature and web security	
5	Demonstrate the need and summarize the concept of Secure Electronic Transactions & Intrusion detection system.	

UNIT 1	
Introduction: Services, Mechanisms, Mechanism Attacks, The OSI Security Architecture, A Model for Network Security, Cyber Attacks, Defence Strategies and Techniques, Guiding Principles **Mathematical Background of Cryptography:** Integer Arithmetic, Modular Arithmetic, Matrices, The Greatest Comma Divisor, Useful Algebraic Structures, Chinese Remainder Theorem **Applications:** Time Stamping, Electronic Money, Secure Network Communication **Laboratory Sessions/ Experimental learning:** 1. Breaking the Shift Cipher **Video link / Additional online information :** 1. https://nptel.ac.in/courses/117103063/ 2. https://nptel.ac.in/courses/117107095/ 3. http://nptelvideos.com/video.php?id=2441 http://www.nptelvideos.com/video.php?id=429	8Hrs.
UNIT 2	
Basics of Cryptography: Preliminaries, Elementary Substitution Ciphers, Elementary Transport Ciphers, Other Cipher Properties.	8Hrs.

Symmetric Ciphers: Symmetric Ciphers model, Substitution Techniques, Transposition Techniques, Simplified DES, Data encryption Standard (DES), The strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles and modes of operation, Evaluation Criteria for Advanced Encryption standard, The AES Cipher. **Laboratory Sessions/ Experimental learning:** 1. Breaking the Mono-alphabetic Substitution Cipher **Applications:** wireless security, processor security, file encryption. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117106087/ 2. https://www.youtube.com/watch?v=ANHTfY9feZg https://nptel.ac.in/courses/108102095/	
UNIT 3	
Public Key Cryptography: Principles of public key Cryptosystem, The RSA algorithms, Key management, Diffie – Hellman key exchange, PRNG. **Key Management and Distribution:** Symmetric key distribution using symmetric encryption, Symmetric key distribution using asymmetric encryption, Distribution of Public keys, X.509 Certificates, Public key infrastructure. **Laboratory Sessions/ Experimental learning:** 1. Diffie-Hellman Key Establishment **Applications:** Random number generator, permutation generator **Video link / Additional online information:** 1. https://www.youtube.com/watch?v=m4sjTt7rhow 2. https://nptel.ac.in/courses/117101106/ 3. https://nptel.ac.in/courses/108108114/	**8Hrs.**
UNIT 4	
Intruders, Intrusion Detection, Password Management, Malicious software programs – Viruses and related Threats, Virus Countermeasures **Firewall:** Need of firewalls, Firewall Characteristics, Types of Firewalls, Design Principles, Trusted Systems	**8Hrs.**

Laboratory Sessions/ Experimental learning: 1. Digital Signatures Scheme 2. Cryptographic Hash Functions and Applications (HMAC) **Applications:** Cyber-attacks, Cybercrime, Cyber security. **Video link / Additional online information :** 1. https://nptel.ac.in/courses/108105113/ https://nptel.ac.in/courses/117106086/	
UNIT 5	
Transport Level Security: Web Security Considerations, Secure Sockets Layer, Transport Layer Security, HTTPS, Secure Shell (SSH) **IP Security:** IP Security Overview, IP Security Policy, ESP, Combining Security Associations. **Laboratory Sessions/ Experimental learning:** 1. Program for SSL operation. **Applications:** Encryption , message authentication and integrity, and replay attack protection **Video link / Additional online information:** https://nptel.ac.in/courses/117102052/	**8Hrs.**

Course outcomes:	
CO1	Analyse the importance of security attacks, service mechanism, basic network security model and its applications.
CO2	Design and develop simple cryptography algorithms and Explain basic structure of DES and AES
CO3	Apply the concepts of Primes, Testing, Factorization, Chinese remainder theorem and RSA Cryptosystem.
CO4	Illustrate the concept public key cryptography & apply digital signatures in email. Processing and Explain usages of email-security, IP security and web security.
CO5	Describe different techniques used in key exchange protocols.
Text Books:	

1.	Cryptography and Network Security- Behrouz A Forouzan, Debdeep Mukhopadhyay,Mc-GrawHill, 3rd Edition, 2015
2.	Cryptography and Network Security- William Stallings, Pearson Education, 7th Edition.

Reference Books:

1.	Cryptography, Network Security and Cyber Laws – Bernard Menezes, Cengage Learning, 2010 edition.

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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CO4	3	3	3	2	1	1	-	-	1	-	-	1
CO5	3	3	3	2	1	1	-	-	1	-	-	1

High-3, Medium-2, Low-1

Semester: III		
ROBOTICS & AUTOMATION (Theory)		
Course Code:	MVJ21EC725	CIE Marks:100
Credits:	L:T:P: 3:0:0	SEE Marks: 100
Hours:	40L	SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	Understand basic concepts of RPA	
2	Describe RPA, where it can be applied and how it implemented	
3	Describe the different types of variables and data manipulation techniques	
4	Understand Image, Text and Data Tables Automation	
5	Describe various types of Exceptions and strategies to handle	

UNIT 1	
RPA Foundations -What is RPA – Flavors of RPA- History of RPA- The Benefits of RPA- The downsides of RPA- RPA Compared to BPO, BPM and BPA – Consumer Willingness for Automation- The Workforce of the Future- RPA Skills-On-Premise Vs. the Cloud- Web Technology- Programming Languages and Low Code- OCR-APIs- AI-Cognitive Automation-Agile, Scrum, Kanban and Waterfall- Flowcharts. **Laboratory Sessions/ Experimental learning:** 1. Interface various sensors with Microcontroller. **Applications:** Machine Tending,Picking, Packing and Palletizing, painting, all Industrial applications **Video link / Additional online information:** 1. https://nptel.ac.in/courses/112/105/112105249/ 2. https://nptel.ac.in/courses/112/101/112101098/ 3. https://nptel.ac.in/courses/112/101/112101098/	8Hrs.
UNIT 2	

RPA Platforms -Components of RPA- RPA Platforms-About Ui Path- About UiPath - The future of automation - Record and Play - Downloading and installing UiPath Studio -Learning Ui Path Studio- - Task recorder - Step-by step examples using the recorder. **Laboratory Sessions/ Experimental learning:** 1. Interface motors using various Motor drivers. **Applications:** Industrial application, agriculture robots, surgical robots **Video link / Additional online information:** 1. https://nptel.ac.in/courses/112/105/112105249/ 2. https://nptel.ac.in/courses/112/101/112101098/	8Hrs.
UNIT 3	
Sequence, Flowchart, and Control Flow -Sequencing the workflow Activities-Control flow, various types of loops, and decision making Step-by-step example using Sequence and Flowchart-Step-by-step example using Sequence and Control flow-Data Manipulation-Variables and Scope Collections-Arguments – Purpose and use-Data table usage with examples Clipboard management-File operation with step-by-step example-CSV/Excel to data table and vice versa **Laboratory Sessions/ Experimental learning:** 1. Interface servo motors to form gripper. **Applications:** Pick and Place, Excavators, Robotic ARM. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/112/105/112105249/ 2. https://nptel.ac.in/courses/112/101/112101098/	8Hrs.
UNIT 4	
Taking Control of the Controls- Finding and attaching windows- Finding the control- Techniques for waiting for a control- Act on controls – mouse and keyboard activities- Working with UiExplorer- Handling events- Revisit recorder-Screen Scraping- When to use OCR- Types of OCR available- How to use OCR-Avoiding typical failure points.	8Hrs.

Laboratory Sessions/ Experimental learning: 1. Design algorithm for Maze solving robot. **Applications:** Defence, Surveillance, Autonomous Vehicle. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/112/105/112105249/ 2. https://nptel.ac.in/courses/112/101/112101098/	
UNIT 5	
Exception Handling- Exception Handling, Debugging, and Logging- Exception handling- Common exceptions and ways to handle them- Logging and taking screenshots Debugging techniques- Collecting crash dumps- Error reporting- Future of RPA **Laboratory Sessions/ Experimental learning:** 1. Case Study on Robots in material handling and assembly. Human Robot Interaction **Applications:** Humanoid, Robotic Arms. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/112/105/112105249/ 2. https://nptel.ac.in/courses/112/101/112101098/	**8Hrs.**

Course outcomes:	
CO1	Understand the basic concepts of RPA
CO2	Describe various components and platforms of RPA
CO3	Describe the different types of variables, control flow and data manipulation techniques
CO4	Understand various control techniques and OCR in RPA
CO5	Describe various types and strategies to handle exceptions.

Text Books:	
1.	"Tom Taulli, The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems,2020,ISBN-13 (electronic):978-7-4842-5729-6
2.	"Alok Mani Tripathi, Learning Robotic Process Automation, Publishing Release Date: March 2018 ISBN: 9787788470940
3	Frank Casale, Rebecca Dilla, Heidi Jaynes, Lauren Livingston, "Introduction to Robotic Process Automation: a Primer", Institute of Robotic Process Automation.
4.	Richard Murdoch, Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	1	-	-	1	-	-	1
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CO3	3	3	3	2	1	1	-	-	1	-	-	1
CO4	3	3	3	2	1	1	-	-	1	-	-	1
CO5	3	3	3	2	1	1	-	-	1	-	-	1

High-3, Medium-2, Low-1

Professional Elective-III

Semester: VII		
DIGITAL IMAGE PROCESSING (Theory)		
Course Code:	MVJ21EC731	CIE Marks:100
Credits:	L: T:P: 3:0:0	SEE Marks: 100
Hours:	40L	SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	Learn the fundamentals of digital image processing	
2	Understand the image transforms and other image enhancement techniques used in digital image processing.	
3	Study the image restoration techniques and methods used in digital image processing.	
4	Understand region-based segmentation and segmentation using morphological watersheds.	
5	Know the color fundamentals and various morphological image processing techniques.	

UNIT 1	
Prerequisites: *Discrete Fourier Transform, MATLAB Basics* **Introduction to Digital Image Processing:** What is Digital Image Processing? Origin of Digital Image Processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Some Basic Relationships Between Pixels, Linear and Nonlinear Operations. **Applications of Image Processing:** Medical imaging, Robot vision, Character recognition, Remote Sensing. **Laboratory Sessions/ Experimental learning:** 1. Implementation and analysis of image sampling methods including uniform, grid, jittered and best candidate algorithms using MATLAB	8Hrs.

Applications: Medical imaging, Robot vision, Character recognition, Remote Sensing. **Video link / Additional online information :** 1. https://nptel.ac.in/courses/117/105/117105079/ 2. https://www.tutorialspoint.com/dip/index.htm	
UNIT 2	
Spatial Domain: Some Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters **Frequency Domain:** Preliminary Concepts, The Discrete Fourier Transform (DFT) of Two Variables, Properties of the 2-D DFT, Filtering in the Frequency Domain, Image, Smoothing and Image Sharpening Using Frequency Domain Filters, Selective Filtering. **Laboratory Sessions/ Experimental learning:** 1. Implementation and analysis of image smoothing and sharpening algorithms using MATLAB. **Applications:** Image Enhancement, Image Analysis **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105079/ 2. https://www.tutorialspoint.com/dip/index.htm	**8Hrs.**
UNIT 3	
Restoration: Noise models, Restoration in the Presence of Noise Only using Spatial Filtering and Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering. **Laboratory Sessions/ Experimental learning:**	**8Hrs.**

1. Test the restoration with the Inverse Filter for deblurring and denoising. Identify the problem with the Inverse Filter and discuss the solution for the same. **Applications:** Image Enhancement, Image Analysis, Error detection and correction **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105079/ 2. https://www.tutorialspoint.com/dip/index.htm	
UNIT 4	
Segmentation: Point, Line, and Edge Detection, Thresholding, Region-Based Segmentation, Segmentation Using Morphological Watersheds. **Representation and Description:** Representation, Boundary descriptors. **Laboratory Sessions/ Experimental learning:** 1. Develop and implement a matlab code for Image segmentation using thresholding technique. **Applications:** Object tracking, Pattern recognition **Video link / Additional online information :** 1. https://nptel.ac.in/courses/117/105/117105079/ 2 .https://www.tutorialspoint.com/dip/index.htm	**8Hrs.**
UNIT 5	
Color Image Processing: Color Fundamentals, Color Models, Pseudo color Image Processing.	**8Hrs.**

Morphological Image Processing: Preliminaries, Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transforms, Some Basic Morphological Algorithms. Four morphological principles, Skeletons and object marking. **Laboratory Sessions/ Experimental learning:** 1. Implementation and analysis of multimodal image fusion using MATLAB. **Applications:** Color conversion, Object marking **Video link / Additional online information:** 1. https://nptel.ac.in/courses/117/105/117105079/ 2. https://www.tutorialspoint.com/dip/index.htm	

Course outcomes:	
CO1	Analyze image processing algorithms used for sampling and quantization.
CO2	Apply and analyze image processing techniques in both the spatial and frequency (Fourier) domains.
CO3	Implement and analyse various image restoration algorithms
CO4	Design image analysis techniques for image segmentation and evaluate the methodologies for segmentation.
CO5	Conduct independent study and analyze various Morphological Image Processing techniques.

Reference Books:	
1.	Rafel C Gonzalez and Richard E. Woods, "Digital Image Processing"-, PHI 3rd Edition, 2010.

2.	Milan Sonka, Vaclav Hlavac, Roger Boyle, –"Image Processing, Analysis, and Machine Vision‖", Cengage Learning, Fourth Edition, 2013, ISBN: 978-81-315-1883-0
3	S.Jayaraman, S.Esakkirajan, T.Veerakumar, "Digital Image Processing"- Tata McGraw Hill 2014.
4	A. K. Jain, "Fundamentals of Digital Image Processing"- Pearson 2004.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

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CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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CO3	3	3	3	2	2	1	-	-	1	-	-	1
CO4	3	3	3	2	2	1	-	-	1	-	-	1
CO5	3	3	3	2	2	1	-	-	1	-	-	1

High-3, Medium-2, Low-1

Semester: VII		
IOT & WIRELESS SENSOR NETWORK (Theory)		
Course Code:	MVJ21EC732	CIE Marks:100
Credits:	L:T:P: 3:0:0	SEE Marks: 100
Hours:	40L	SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	Provide knowledge about IoT and M2M architecture.	
2	Understand various layers of IoT and their functionality.	
3	Describe Cloud computing and design principles of IoT	
4	Understand the architecture and design principles of WSNs.	
5	Provide knowledge about MAC and routing protocols in WSN	

UNIT 1	
Prerequisites: *Knowledge on Computer Networks* **Introduction to IoT:** Genesis, Digitization, Impact- Connected Roadways, Buildings, IoT Challenges, Network Architecture and Design, Drivers Behind New Network Architectures, Security, Constrained Devices and Networks Comparing IoT Architectures, M2M architecture, IoT world forum standard, IoT Reference Model, Simplified IoT Architecture. **Laboratory Sessions/ Experimental learning:** 1. Comparative study of Oracle, IBM and Cisco Architectures of IoT **Applications:** Smart Cities, Home Automation System **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/105/106105166/ https://www.analyticsvidhya.com/blog/2016/08/10-youtube-videos-explaining-the-real-world-applications-of-internet-of-things-iot/	8Hrs.
UNIT 2	
IoT Layers and functionality: IoT Network Architecture and Design Core IoT Functional Stack, Layer1(Sensors and Actuators), Layer 2(Communications Sublayer), Access network sublayer, Gateways and backhaul sublayer, Network transport sublayer, IoT Network management. Layer 3(Applications and	**8Hrs.**

Analytics), Analytics vs Control, Data vs Network Analytics IoT Data Management and Compute Stack. **Laboratory Sessions/ Experimental learning:** 1. Implement an IoT architecture to design an application of your own. **Video link / Additional online information:** 2. https://nptel.ac.in/courses/108/108/108108147/ https://onlinecourses.nptel.ac.in/noc20_cs69/unit?unit=17&lesson=18	
UNIT 3	
Data Collection, Storage and Computing using a Cloud Platform : Introduction, Cloud computing paradigm for data collection, storage and computing, Cloud service models, IoT Cloud - based data collection, storage and computing services using Nimbits, The Hierarchy of Edge, Fog, and Cloud. **Prototyping and Designing Software for IoT Applications:** Introduction, Prototyping Embedded device software, Programming Embedded Device, Arduino Platform using IDE, Reading data from sensors and devices, Devices, Gateways, Internet and Web/Cloud services software development. **Laboratory Sessions/ Experimental learning:** 1. Weather monitoring using Blynk/ThingSpeak through cloud 2. Design a people counter using Node MCU 3. Christmas light show with Arduino **Applications:** Google Cloud, SAAS, PAAS, Sensor applications **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/105/106105167/ https://onlinecourses.swayam2.ac.in/aic20_sp04/preview	8Hrs.
UNIT 4	
Overview of Wireless Sensor Networks: Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks. **Architectures:** Single-Node Architecture, Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems and Execution Environments, Network Architecture, Sensor Network Scenarios, Optimization Goals and Figures	8Hrs.

of Merit, Design principles for WSNs, Service interfaces of WSNs Gateway Concepts. **Laboratory Sessions/ Experimental learning:** 1. Do a case study on total energy conservation opportunities in Solar Power **Applications:** Health care monitoring, Area monitoring, Industrial monitoring, Threat detection. **Video link / Additional online information :** 1.https://nptel.ac.in/courses/106/105/106105166/ 2.https://nptel.ac.in/courses/106/105/106105160/	
UNIT 5	
Communication Protocols: Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols and Wakeup Concepts - S-MAC , The Mediation Device Protocol, Wakeup Radio Concepts, Contention based protocols(CSMA,PAMAS), Schedule based protocols (LEACH) Address and Name Management in WSNs, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing, Hierarchical networks by clustering. **Laboratory Sessions/ Experimental learning:** 1. Design an energy efficient system for a WSN using the routing protocols using NetSim or NS2. **Applications:** Environmental/Earth sensing, Air pollution monitoring, Forest fire detection, Landslide detection, Water quality monitoring **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/105/106105160/ 2. https://nptel.ac.in/courses/106/105/106105195/	8Hrs.

Course outcomes: After studying this course, students will be able to:

CO1	Analyze different IOT Architecture and select them for a particular application.
CO2	Evaluate the sensor data generated and map it to IOT protocol stack.
CO3	Implement and execute programs using development tools.
CO4	Develop an energy efficient system for WSN.

CO5	Create a real-life application involving Wireless Sensor Networks using IoT concepts.
Textbooks:	
1.	Cisco, IOT Fundamentals – Networking Technologies, Protocols, Use Cases for IOT, Pearson Education; First edition (16 August 2017). ISBN-10: 9386873745, ISBN-13: 978-9386873743
2.	Raj Kamal, "Internet of Things-Architecture and design principles", McGraw Hill Education.
3.	Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley, 2005.
Reference Books:	
1.	Kazem Sohraby, Daniel Minoli, & Taieb Znati, "Wireless Sensor NetworksTechnology, Protocols, And Applications", John Wiley, 2007.
2.	Anna Hac, "Wireless Sensor Network Designs", John Wiley, 2003.
3.	Arshdeep Bahga and Vijay Madisetti, 'Internet of Things – A Hands on Approach', Orient Blackswan Private Limited - New Delhi; First edition (2015), ISBN-10: 8173719543, ISBN-13: 978-8173719547

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to

answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

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CO4	3	3	3	3	2	2	-	-	2	-	-	1
CO5	3	3	3	3	2	2	-	-	2	-	-	1

High-3, Medium-2, Low-1

Semester: VII		
OPTICAL COMMUNICATION (Theory)		
Course Code:	MVJ21EC733	CIE Marks:100
Credits:	L:T:P: 3:0:0	SEE Marks: 100
Hours:	40L	SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	Learn the basic principles of optical fiber communication with different modes of light propagation	
2	Study of optical sources, detectors, and receivers	
3	Understand the transmission characteristics and losses in optical fiber and study optical components.	
4	Know the concept of WDM and system design.	
5	Learn the network standards in optical fiber and understand the network architectures along with its functionalities.	

UNIT 1	
Optical fiber Communications: Historical development, General system, Advantages of optical fiber communication, Optical fiber wave guides: Ray theory transmission, Modes in planar guide, Phase and group velocity, cylindrical fiber: Modes, Step index fibers, Graded index fibers, Single mode fibers, Cutoff wavelength, Mode field diameter, effective refractive index, Fiber Materials, Photonic crystal fibers. **Laboratory Sessions/ Experimental learning:** 1. Measurement of numerical aperture of an optical fiber. **Applications:** Networking, Telecommunication **Video link / Additional online information:** 1. https://youtu.be/9seDKvbaoHU 2. https://youtu.be/BGUhTDWkwx8	8Hrs.
UNIT 2	
Pre-requisite: *Knowledge of Semiconductor Devices* **Optical sources: Light Emitting diodes:** LED Structures, Light Source Materials, Quantum Efficiency and LED Power, Modulation. Laser Diodes: Modes and	8Hrs.

Threshold conditions, Rate equation, External Quantum Efficiency, Resonant Frequencies. **Photo detectors:** Physical principles of Photodiodes, Photo detector noise, Detector response time. **Optical Receiver:** Optical Receiver Operation: Error sources, Front End Amplifiers, Receiver sensitivity, Quantum Limit. **Applications:** Optical memories, OMEMS, Basic Principle Holography, Principle Of Hologram Recording **Laboratory Sessions/ Experimental learning:** 1. To Investigate the Transmission (Intermodal dispersion) Characteristics of Multi-mode Optical Fiber. **Applications:** Networking, Telecommunication, Military and Space Applications **Video link / Additional online information :** https://youtu.be/15WulWvjWEg	
UNIT 3	
Transmission characteristics of optical fiber: Attenuation, Material absorption losses, Linear scattering losses, Nonlinear scattering losses, Fiber bend loss, Dispersion, Chromatic dispersion, Intermodal dispersion: Multimode step index fiber. **Optical Fiber Connectors:** Fiber Splicing, Splicing Techniques, Splicing Single-Mode Fibers, Optical Fiber Connectors, Connector Types, Single-Mode Fiber Connectors, and Connector Return Loss. **Optical amplifiers:** Basic application and Types, Semiconductor optical amplifiers, Erbium Doped Fiber Amplifiers, Raman Amplifiers, Wideband Optical Amplifiers. **Laboratory Sessions/ Experimental learning:** 1. Measurement of propagation loss, bending loss of an optical fiber. **Applications:** Networking, Telecommunication , Automotive Industry **Video link / Additional online information:** https://youtu.be/BGUhTDWkwx8	**8Hrs.**
UNIT 4	

WDM Concepts and Components: Overview of WDM: Operational Principles of WDM, WDM standards, Passive Optical couplers, Mach-Zehnder Interferometer Multiplexers, Isolators and Circulators, Fiber grating filters, Dielectric Thin-Film Filters, Diffraction Gratings. **Optical System Design** : Point-to- Point Links, System Considerations, Link Power Budget Rise Time Budget, Short-Wavelength Band, Attenuation-Limited Distances for Single-Mode Links. **Laboratory Sessions/ Experimental learning:** 1. Determine the wavelength of light from a monochromatic source using Interferometer and calculate the refractive index of a thin film. **Applications:** Networking, Telecommunication **Video link / Additional online information:** 1. https://youtu.be/t8a25L58-m8 https://vlab.amrita.edu/index.php?sub=1&brch=189	**8Hrs.**
UNIT 5	
Optical Networks: Optical network evolution and concepts: Optical networking terminology, Optical network node and switching elements, Wavelength division multiplexed networks, public telecommunication network overview. Optical network transmission modes, layers, and protocols: Synchronous networks, Asynchronous transfer mode, OSI reference model, Optical transport network, Internet protocol, Wavelength routing networks: Routing and wavelength assignment, Optical switching networks: Optical circuit switched networks, packet switched networks, Multiprotocol Label Switching, Optical burst switching networks. **Laboratory Sessions/ Experimental learning:** 1. Analog and Digital (with TDM) communication link using optical fiber. **Applications:** Networking, Telecommunication **Video link / Additional online information:** 1. http://ofcvlab.vesit.ves.ac.in/page2/honeycomb.html https://www.youtube.com/embed/f5EmFoXlYyQ	**8Hrs.**

Course outcomes:	
CO1	Classify and working of optical fiber with different modes of signal propagation.
CO2	Analyze the characteristics of optical sources and detectors.
CO3	Describe the transmission characteristics and losses in optical fiber communication and identify various amplifiers.
CO4	Understand the concept of WDM and analyze the various aspects of system design.
CO5	Illustrate the networking aspects of optical fiber and describe various standards associated with it.

Reference Books:	
1.	Gerd Keiser, Optical Fiber Communication, 5th Edition, McGraw Hill Education(India) Private Limited, 2015. ISBN:1-25-900687-5.
2.	John M Senior, Optical Fiber Communications, Principles and Practice, 3rd Edition, Pearson Education, 2010, ISBN:978-81-317-3266-3
3	Joseph C Palais, Fiber Optic Communication, Pearson Education, 2005, ISBN:0130085103
4	Ramaswami, Sivarajan and Sasaki "Optical Networks", Morgan Kaufmann, 2009.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	-	1	-	-	-	-	-	1
CO2	3	3	3	1	-	1	-	-	-	-	-	1
CO3	3	3	3	1	-	1	-	-	-	-	-	1
CO4	3	3	3	1	-	1	-	-	-	-	-	1
CO5	3	3	3	1	-	1	-	-	-	-	-	1

High-3, Medium-2, Low-1

Semester:VII		
ARTIFICIAL INTELLIGENCE & DATA SCIENCE (Theory)		
Course Code: MVJ21EC734		CIE Marks:100
Credits: L:T:P: 3:0:0		SEE Marks: 100
Hours: 40L		SEE Duration: 3 Hrs

Course Learning Objectives: The students will be able to	
1	Identify the problems where AI is required and the different methods available.
2	Compare and contrast different AI techniques available.
3	Understand and explain learning algorithms.
4	Obtain a Comprehensive knowledge of various tools and techniques for Data transformation and visualization.
5	Learn the probability and probabilistic models of data science

UNIT 1	
Prerequisites: *Machine Learning* **Artificial Intelligence:** What is Artificial Intelligence? AI Technique, Level of the Model, Problem Spaces, and Search: Defining the Problem as a State Space Search, Production Systems, Problem Characteristics, Production System Characteristics, and issues in the Design of Search Programs. Heuristic Search Techniques: Generate-and Test, Hill Climbing, Best-first Search, Problem Reduction, Constraint Satisfaction, Means-ends. **Laboratory Sessions/ Experimental learning:** 1. Write a program to solve 8 queens problem using PROLOG **Applications:** Astronomy, Health care, Finance, Gaming, Data security **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/102/106102220/ 2. https://www.simplilearn.com/artificial-intelligence-introduction-for-beginners-training-course	8Hrs.
UNIT2	
Analysis, Knowledge Representation: Representations and Mappings, Approaches to Knowledge Representation, Using Predicate Logic: Representing	8Hrs.

Simple Facts in Logic, Representing Instance and ISA Relationships, Computable Functions and Predicates, Resolution, Natural Deduction. Using Rules: Procedural Versus Declarative Knowledge, Logic Programming, Forward Versus Backward Reasoning. **Laboratory Sessions/ Experimental learning:** 1. Program to replace an integer from the list using PROLOG **Applications:** Computer database **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/105/106105077/ 2. https://www.youtube.com/watch?v=xUIqkAmfi8A	
UNIT 3	
Reasoning: Symbolic Reasoning Under Uncertainty, Statistical Reasoning, Weak Slot and Filler, Structure, Semantic nets, Frames, Strong Slot and Filler Structure, Conceptual Dependency, Scripts, CYC. **Natural Language Processing:** Natural Language Processing, Syntactic processing, semantic analysis, Parallel and Distributed AI, Psychological modelling- parallelism and distributed in reasoning systems, Learning, Connectionist Models, Hopfield networks, neural networks. Expert Systems. **Laboratory Sessions/ Experimental learning:** 1. Solve Robot (traversal) problem using means End Analysis using PROLOG **Applications:** Search Autocorrect and Autocomplete, Language Translator, Social Media Monitoring. **Video link / Additional online information:** 1.https://nptel.ac.in/courses/106/101/106101007/ 2.https://www.youtube.com/watch?v=WHCo4m2VOws&vl=en 3.https://www.youtube.com/watch?v=dw6kp0jfi5w	**8Hrs.**
UNIT 4	
Prerequisites: *Mathematical and Statistical concepts, Programming skills like C or C++*	**8Hrs.**

Data Visualization: Introduction, Causality and Experiments - Data Pre-processing: Knowing data, Data cleaning, Data reduction, Data transformation, Data discretization -Visualization and Graphing: Visualizing Categorical Distributions, Visualizing Numerical Distributions, Overlaid Graphs, plots, and summary statistics of Exploratory Data Analysis (EDA). Exploring Univariate Data - Histograms -Stem-and Leaf Quantile Based Plots - Continuous Distributions - Quantile Plots- QQ Plot- Box Plots **Laboratory Sessions/ Experimental learning:** R as CALCULATOR APPLICATION 1. Using with and without R objects on console 2. Using mathematical functions on console 3. Write an R script, to create R objects for calculator application and save in a specified location in disk. **Applications:** Fraud and Risk Detection, Website Recommendations, Advanced Image Recognition, Airline Route Planning **Video link / Additional online information:** 1. https://nptel.ac.in/courses/106/106/106106179/ 2.https://nptel.ac.in/courses/106/107/106107220/	
UNIT 5	
Prerequisites: *Probability theory* **Big Data Analytics:** Hadoop Distributed File System Basics, Running Example Programs and Benchmarks, Hadoop Map Reduce Framework, Map Reduce Programming **Applications:** Customer Relationship management, Health care, Education, Retail, Banking, Financial services, Insurance, Manufacturing, Telecom, Public Sector **Laboratory Sessions/ Experimental learning:** 1. Word Count Map Reduce program to understand Map Reduce Paradigm Installing and configuring Hadoop **Applications:** Communication, Healthcare **Video link / Additional online information:**	**8Hrs.**

1. https://nptel.ac.in/courses/106/104/106104189/ 2.https://www.digimat.in/nptel/courses/video/106104189/L06.html	

Course outcomes:	
CO1	Identify the AI based problems
CO2	Apply techniques to solve the AI problems.
CO3	Demonstrate learning and various learning techniques
CO4	Apply pre-processing techniques to convert raw data so as to enable further analysis
CO5	Analyze the probability density function of transformations of random variables and use these techniques to generate data from various distributions

Reference Books	
1.	E. Rich , K. Knight & S. B. Nair - Artificial Intelligence, 3/e, McGraw Hill.
2.	"Artificial Intelligence: A Modern Approach", Stuart Rusell, Peter Norving, Pearson Education 2nd Edition.
3.	Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining Concepts and Techniques", Third edition, Elsevier Publisher, 2006
4	Dan W. Patterson, "Introduction to Artificial Intelligence and Expert Systems" – Prentice Hal of India
4.	Douglas Eadline,"Hadoop 2 Quick-Start Guide: Learn the Essentials of Big Data Computing in the Apache Hadoop 2 Ecosystem", 1stEdition, Pearson Education, 2016. ISBN-13: 978-9332570351
5.	Anil Maheshwari, "Data Analytics", 1st Edition, McGraw Hill Education, 2017. ISBN-13: 978-9352604180

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

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CO3	3	3	3	2	2	1	-	-	1	-	-	1
CO4	3	3	3	2	2	1	-	-	1	-	-	1
CO5	3	3	3	2	2	1	-	-	1	-	-	1

High-3, Medium-2, Low-1

Semester:VII		
SYSTEM ON CHIP ARCHITECTURE (Theory)		
Course Code:	MVJ21EC735	CIE Marks:100
Credits:	L:T:P: 3:1:0	SEE Marks: 100
Hours:	40L	SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	Understand the needs of SoC architecture & design.	
2	Analyze various elements in SoC design.	
3	Study the overview of SoC memory system.	
4	Outline the reconfiguration mechanism of SoC.	
5	Learn the algorithms used in SoC system design	

UNIT 1	
Prerequisites: *Moore's law, Basics of embedded system and embedded C programming, Motivation for SoC.* **Introduction to the System Approach:** Need for SoC, System Architecture, and Components of the system, Hardware & Software, Processor Architectures, Memory and Addressing, System level interconnection, an approach for SoC Design, System Architecture and Complexity. **Laboratory Sessions/Experimental learning:** 1. Case study on Comparison on System-on-Board, System-on-Chip and System-in-Package. **Applications** : Embedded System, mobile device. **Video link / Additional online information:** 1. http://www.nptelvideos.com/lecture.php?id=7838 2. https://www.youtube.com/watch?v=PRQXzjTrCJY	8Hrs.
UNIT 2	

Processors: Introduction, Processor Selection for SoC, Basic concepts in Processor Architecture, Basic concepts in Processor Micro Architecture, Basic elements in Instruction handling. **Buffers:** Minimizing Pipeline Delays, Branches, More Robust Processors, Vector Processors and Vector Instructions extensions, VLIW Processors, Superscalar Processors. **Laboratory Sessions/Experimental learning:** 1. Design a model to generate a square wave using suitable programming language with appropriate delay. 2. Design a model for generating a Interrupt using different addressing modes by selecting suitable programming language. **Applications :** Supercomputers **Video link / Additional online information:** 1. https://youtu.be/4VRtujwa_b8 2. https://nptel.ac.in/courses/124107010/	8Hrs.
UNIT 3	
Memory Design for SoC: Overview of SoC external memory, Internal Memory, Size, Scratchpads and Cache memory, Cache Organization, Cache data, Write Policies, Strategies for line replacement at miss time, Types of Cache, Split – I, and D – Caches, Multilevel Caches, Virtual to real translation, SoC Memory System, Models of Simple Processor, memory interaction. **Laboratory Sessions/Experimental learning:** 1. Case study on on-chip peripherals of MSP430 **Applications:** Cloud, Datacentres. **Video link / Additional online information:** 1. https://youtu.be/cjNORC_00_A	8Hrs.

2. https://www.youtube.com/watch?v=A_bWZLIs0Tw	
UNIT 4	
Interconnect: Interconnect Architectures, Bus: Basic Architectures, SoC Standard Buses, Analytic Bus Models, Using the Bus model, Effects of Bus transactions and contention time. SoC Customization: An overview, Customizing Instruction Processor, Reconfiguration Technologies, Mapping design onto Reconfigurable devices, Instance Specific design, Customizable Soft Processor. **Laboratory Sessions/Experimental learning:** 1 Design a model to save and store data in SD card with MSP430 microcontroller. **Applications** : Data-Centre interconnects, PC peripherals **Video link / Additional online information:** https://youtu.be/PvZ5GXR9Ri8	**8Hrs.**
UNIT 5	
Application Studies / Case Studies: SoC Design approach, AES algorithms, Design and evaluation, Image compression – JPEG compression. **Laboratory Sessions/Experimental learning:** 1. Implement an algorithm for JPEG compression using MATLAB. **Applications:** Wireless security, processor security, encryption **Video link / Additional online information:** https://nptel.ac.in/courses/105104183/	**8Hrs.**

Course outcomes:	
CO1	Interpret the need of SoC system design.

CO2	Outline the SoC Architecture design and basic concepts of processor.
CO3	Design memory organization in SoC system.
CO4	Utilize the reconfiguration mechanism of SoC in reconfigurable devices.
CO5	Apply various algorithm for SoC system design.
Reference Books:	
1.	Michael J. Flynn and Wayne Luk, "Computer System Design System-on-Chip", Wiley India Pvt.Ltd.
2.	Ricardo Reis, "Design of System on a Chip: Devices and Components", 1st Edition, 2004, Springer
3	Prakash Rashinkar, Peter Paterson and Leena Singh L, "System on Chip Verification n – Methodologies and Techniques", 2001, Kluwer Academic Publishers
4	Web Source: What is a System on Chip (SoC)? - AnySilicon

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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Semester End Examination (SEE):

Total marks: 50+50=100

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have

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CO3	3	3	3	2	1	1	-	-	-	-	-	1
CO4	3	3	3	2	1	1	-	-	-	-	-	1
CO5	3	3	3	2	1	1	-	-	-	-	-	1

High-3, Medium-2, Low-1

PROJECT PHASE – I		
Course Code:	MVJ21ECPR76	CIE Marks:100
Credits:	L:T:P: 0:0:4	SEE Marks: 100
Hours:	-	SEE Duration: 3 Hrs
Course Learning Objectives: The students will be able to		
1	To support independent learning.	
2	To develop interactive, communication, organization, time management, and presentation skills.	
3	To impart flexibility and adaptability.	
4	To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.	

Project Work Phase - I: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.	
Course outcomes: At the end of the course the student will be able to:	
CO1	Describe the project and be able to defend it.
CO2	Learn to use modern tools and techniques.
CO3	Develop skills to work in a team to achieve common goal. Develop skills of project management and finance.
CO4	Develop skills of self-learning, evaluate their learning and take appropriate actions to improve it.
CO5	Prepare them for life-long learning to face the challenges and support the technological changes to meet the societal needs.

Scheme of Evaluation:

Internal Marks: The Internal marks (50 marks) evaluation shall be based on Phase wise completion of the project work, Project report, Presentation and Demonstration of the actual/model/prototype of the project.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	3	3	2	1	1	2	1	1	2
CO2	2	2	2	3	3	2	1	1	2	1	2	2
CO3	2	2	2	3	3	2	1	1	2	1	2	2
CO4	2	2	2	3	3	2	1	1	2	1	2	2
CO5	2	2	2	3	3	2	1	1	2	1	2	2

High-3, Medium-2, Low-1