VASAVI COLLEGE OF ENGINEERING
(AUTONOMOUS)
ACCREDITED BY NAAC WITH 'A++' GRADE
Ibrahimbagh, Hyderabad-31
Approved by A.I.C.T.E., New Delhi and
Affiliated to Osmania University, Hyderabad-07

Sponsored
by
VASAVI ACADEMY OF EDUCATION
Hyderabad

SCHEME OF INSTRUCTION AND SYLLABI UNDER CBCS FOR B.E. (ECE) V and VI Semesters

With effect from 2021-22
(For the batch admitted in 2019-20)
(R-19)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
Phones: +91-40-23146040, 23146041
Fax: +91-40-23146090

Institute Vision

Striving for a symbiosis of technological excellence and human values

Institute Mission

To arm young brains with competitive technology and nurture holistic development of the individuals for a better tomorrow

Department Vision

Striving for excellence in teaching, training and research in the areas of Electronics and Communication Engineering and fostering ethical values

Department Mission

To inculcate a spirit of scientific temper and analytical thinking and train the students in contemporary technologies in Electronics and Communication Engineering to meet the needs of the industry and society with ethical values

B.E (ECE) Program Educational Objectives (PEO's)	
PEO I	Graduates will be able to identify, analyze and solve engineering problems.
PEO II	Graduates will be able to succeed in their careers, higher education, and research.
PEO III	Graduates will be able to excel individually and in multidisciplinary teams to solve industry and societal problems.
PEO IV	Graduates will be able to exhibit leadership qualities and lifelong learning skills with ethical values.

B.E. (ECE) PROGRAM OUTCOMES (PO's) Engineering Graduates will be able to:	
PO1	Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
PO2	Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
PO3	Design / development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety and the cultural, societal and environmental considerations.
PO4	Conduct investigations of complex problems: Use research based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.
PO5	Modern tool usage: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and team work: Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.
PO10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, give and receive clear instructions.
PO11	Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	Lifelong learning: Recognize the need, and for have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

B.E (ECE) PROGRAM SPECIFIC OUTCOMES (PSO's)	
PSO I	ECE students will be able to analyze and offer circuit and system level solutions for complex electronics engineering problems, keeping in mind the latest technological trends.
PSO II	ECE students will be able to apply the acquired knowledge and skills in modeling and simulation of wireless communication systems.
PSO III	ECE students will be able to implement signal and image processing techniques for real time applications.

VASAVI COLLEGE OF ENGINEERING (AUTONOMOUS) :: IBRAHIMBAGH, HYDERABAD – 500 031
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
SCHEME OF INSTRUCTION AND EXAMINATION **(R-19)** :: B.E. - ECE : FIFTH SEMESTER (2021 - 22)

B.E (ECE) V - SEMESTER								
Course Code	Name of the Course	Scheme of Instruction			Scheme of Examination			
		Hours per Week			Duration in Hrs	Maximum Marks		Credits
		L	T	P/D		SEE	CIE	
THEORY								
U19PC510EC	Control Systems Engineering	3	-	-	3	60	40	3
U19PC520EC	Integrated Circuits and Applications	3	-	-	3	60	40	3
U19PC530EC	Analog and Digital Communication	3	-	-	3	60	40	3
U19PC540EC	Computer Organization and Architecture	3	-	-	3	60	40	3
U19OE5XXXX	Open Elective – III	3	-	-	3	60	40	3
U19HS510EH	Skill Development - III : Soft skills	1	-	-	2	40	30	1
U19PE550EC	Skill Development - III : Technical Skills	1	-	-	2	40	30	1
PRACTICALS								
U19PC511EC	Control Systems Engineering Lab	-	-	2	3	50	30	1
U19PC521EC	Integrated Circuits and Applications Lab	-	-	2	3	50	30	1
U19PC531EC	Analog and Digital Communication Lab	-	-	2	3	50	30	1
U19PW519EC	Mini Project – II	-	-	2	-	-	30	1
TOTAL		**17**	**-**	**8**		**530**	**380**	**21**
GRAND TOTAL		**25**				**910**		
Left over hours will be allocated for : Sports / Library / Mentor - Mentee Interaction / CC / RC / TC / ECA / CCA								
Note: Every student should acquire one online certification course during III – VII Semester								

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Control Systems Engineering

SYLLABUS FOR B.E. V – SEMESTER

L:T:P (Hrs./week): 3:0:0	SEE Marks : 60	Course Code: **U19PC510EC**
Credits : 3	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES
1. Apply principles of control theory to model physical system. 2. Analyze the performance of a given system in time and frequency domains and choose appropriate compensator if needed.	On completion of the course, students will be able to 1. Derive dynamic equations for electro mechanical systems and obtain transfer function using block diagram reduction technique, Mason's gain formula from given system model. 2. Analyze the stability of the system in time domain and determine its performance characteristics. 3. Apply Bode plot, Nyquist criteria techniques to determine the performance of the system in frequency domain. 4. Determine the transfer function and stability for digital control system. 5. Analyze the system in the presence of initial conditions and apply Kalman's test for controllability and observability.

UNIT - I : Control System fundamentals and Components:
Classification of control systems, Open and Closed loop systems. Mathematical modeling of mechanical systems and their conversion into electrical systems. Block diagram reduction and Signal flow graphs.

UNIT - II : Time response Analysis
Transfer function and Impulse response, types of input. Transient response of second order system for step input. Time domain specifications. Types of systems, static error coefficients, error series, Routh - Hurwitz criterion for stability.
Root locus techniques: Analysis of typical systems using root locus techniques. Effect of location of roots on system response.

UNIT - III : Frequency response Analysis

Bode plots, frequency domain specifications. Gain margin and Phase Margin. Principle of argument, Polar plot, Nyquist plot and Nyquist criterion for stability.

Compensation: Cascade and feedback compensation using Bode plots. Phase lag, lead, lag-lead compensators. PID controller

UNIT - IV : Digital Control Systems

Digital control, advantages and disadvantages, and digital control system architecture. The discrete transfer function. Sampled data system. Transfer function of sample data systems. Stability of Discrete data systems

UNIT - V : State space representation

Concept of state and state variables. State models of linear time invariant systems, State transition matrix, Solution of state equations. Design of digital control systems using state-space concepts. Controllability and observability.

Learning Resources:

1. Nagrath, I.J., and Gopal, M., "Control System Engineering," New Age Publishers, 5/e, 2009.
2. Ogata, K., "Modern Control Engineering," 5/e, PHI, 2010.
3. Benjamin C. Kuo, "Automatic Control Systems," 7/e, PHI, 2010.
4. Nise, Norman S. Control Systems Engineering. 5th ed. New York, NY: John Wiley & Sons, 2007
5. Richard C. Dorf & Robart H. Bishop, "Modern Control Systems," 11/e, Pearson, 2008.
6. Gopal, Madan, "Digital Control Engineering," 1/e, New Age Publishers, 2008.
7. http://www.nptelvideos.in/2012/11/control-engineeringprof-gopal.html
8. https://nptel.ac.in/courses/108101037/
9. https://nptel.ac.in/courses/108106098/

The break-up of CIE: Internal Tests + Assignments + Quizzes

1.	No. of Internal Tests	: 2	Max. Marks for each Internal Test	:	30
2.	No. of Assignments	: 3	Max. Marks for each Assignment	:	5
3.	No. of Quizzes	: 3	Max. Marks for each Quiz Test	:	5

Duration of Internal Tests: 90 Minutes

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Integrated Circuits and Applications

SYLLABUS FOR B.E. V – SEMESTER

L:T:P (Hrs./week): 3:0:0	SEE Marks : 60	Course Code: **U19PC520EC**
Credits : 3	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES
1. Students will acquire the knowledge of linear IC applications and design various circuits using IC's for any given specifications. 2. Student shall describe specifications of a digital IC for various logic families and design combinational and sequential circuits with digital ICs.	On completion of the course, students will be able to 1. Illustrate the internal circuit, parameters and features of op-amp. 2. Design of linear and non-linear circuits using op- amp. 3. Design and analyze various applications using ICs, such as 741, 555, 723 etc,. 4. Define specifications of digital IC and select appropriate IC based on specifications. 5. Design and analyze applications using different combinational and Sequential circuits (IC's)

UNIT - I : Integrated Circuits and Op-Amp Applications

Chip Size and Circuit Complexity, Ideal and Practical Op-Amp, Op-Amp Characteristics - DC, AC-Slew Rate and Frequency Response, 741 Op-Amp, Modes of Operation: Inverting, Non- Inverting, Differential.

Op-Amp Applications: Basic Applications of Op-Amp, Instrumentation Amplifier, V to I and I to V Converters, Sample & Hold Circuits, Differentiators and Integrators, Comparators, Schmitt Trigger

UNIT - II : Active filters, Timers & Phase Locked Loops

Active Filters: First Order and Second Order Low Pass, High Pass filters, Band Pass, Band Reject and All Pass Filters. Analysis and Design of Function Generators using IC 8038.

555 Timers: Functional Diagram, Monostable, Astable Operations and Applications.

Phase Locked Loop (PLL): Block Schematic, Principles and Description of Individual Blocks of 565, Applications.

UNIT - III : IC regulators & Data convertors

IC Regulators: Analysis and design of fixed voltage regulators & IC 723 voltage regulator

Data convertors : Basic DAC Techniques – Weighted Resistor Type, R-2R Ladder Type, Inverted R- 2R Type DAC's Different types of ADCs – Parallel Comparator Type, Counter Type, Successive Approximation Register Type and Dual Slope Type.

UNIT - IV : Logic Families

Digital Integrated Circuits: Classification of Digital Integrated Circuits, Standard TTL NAND Gate-Analysis & Characteristics, TTL Open Collector Outputs, Tristate TTL, MOS & CMOS Open Drain and Tristate Outputs,. Comparison of various Logic Families, IC Interfacing - TTL Driving CMOS & CMOS Driving TTL.

UNIT - V : Digital IC Applications

TTL-74XX Series & CMOS 40XX Series ICs, Arithmetic Circuit ICs-Parallel Binary Adder/Subtractor using 2's Complement System, Magnitude Comparator Circuits.

Sequential Circuits 74XX and CMOS 40XX Series ICs, Design of Synchronous and Asynchronous Counters , Shift Registers & Applications.

Learning Resources:

1. Op-amps and Linear Integrated Circuits, Ramakant A. Gayakwad, Prentice Hall, 2003.
2. Linear Integrated Circuits, D. Roy Chowdhury, 3rd Edition, New Age International(P) Ltd., 2008
3. Ronald J. Tocci, Neal S.Widmer & Gregory L.Moss, "Digital Systems: Principles and Applications,"PHI,10/e, 2009.
4. Sonde, B. S., "Introduction to system Design using IC's," Wiley, 2/e, 1994.
5. Digital Fundamentals, Floyd and Jain, 8th Edition, Pearson Education, 2005.
6. Modern Digital Electronics, RP. Jain, 4th Edition, Tata McGraw-Hill, 2010.
7. https://nptel.ac.in/courses/108106069/
8. https://nptel.ac.in/courses/108108111/
9. https://nptel.ac.in/courses/108108114/

The break-up of CIE: Internal Tests + Assignments + Quizzes

1. No. of Internal Tests	: 2	Max. Marks for each Internal Test	:	30
2. No. of Assignments	: 3	Max. Marks for each Assignment	:	5
3. No. of Quizzes	: 3	Max. Marks for each Quiz Test	:	5

Duration of Internal Tests: 90 Minutes

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Analog and Digital Communication

SYLLABUS FOR B.E. V – SEMESTER

L:T:P (Hrs./week): 3:0:0	SEE Marks : 60	Course Code: **U19PC530EC**
Credits : 3	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES
To acquire knowledge on analog and digital modulation schemes and analyze the communication system in the presence of noise.	On completion of the course, students will be able to 1. Analyze analog modulation technique employed at the transmitter and design an analog receiver accordingly. 2. Perform pulse modulation and hence apply source coding techniques for digital processing of information. 3. Estimate the performance of various modulation schemes in the presence of noise to choose an appropriate receiver 4. Analyze various digital modulation schemes and compare their error performances. 5. Interpret spread spectrum modulation and its need in limited available band for transmission of signals.

UNIT - I : Analog Communication

Principle of modulation, generation and detection of AM, DSBSC, SSBSC, FM signals. Quantitative analysis of continuous wave modulation, frequency division multiplexing, Introduction to transmitters and receivers, Super heterodyne receiver.

UNIT - II : Pulse Communication

Principles of Pulse modulation- generation and detection of PAM, PWM and PPM signals, quantization, Pulse code modulation (PCM), Differential pulse code modulation, Delta modulation, Time Division multiplexing.

UNIT - III : Noise in communication systems

Gaussian and white noise characteristics, Noise in AM, FM systems, Pre emphasis and De-emphasis, Threshold effect in angle modulation. Noise considerations in PCM and DM, Optimum detection of signals in noise, Coherent receiver, matched filter -Probability of Error evaluations.

UNIT - IV : Digital communication

Baseband Pulse Transmission- Inter symbol Interference and Nyquist criterion. Pass band Digital Modulation schemes- PSK, FSK, QAM, CPM and MSK, Digital Modulation tradeoffs.

UNIT - V : Spread spectrum communications

Need for spreading a code, generation and characteristics of PN sequences. Direct Sequence Spread Spectrum and Frequency hopping spread spectrum systems and their applications. Acquisition schemes for spread spectrum receivers, Tracking of FH and DS signals.

Learning Resources:

1. Simon Haykin, "Communication Systems," 4/e, Wiley India, 2011.
2. Sam Shanmugham.K., "Digital and Analog Communication Systems," Wiley, 2005.
3. Communication Systems (Analog and Digital) by Dr. Sanjay Sharma, 2013
4. Singh, R.P. and Sapre, S.D., "Communication Systems," TMH, 2012.
5. https://nptel.ac.in/courses/117105143/
6. https://nptel.ac.in/courses/108104091/
7. https://nptel.ac.in/courses/117105144/
8. https://nptel.ac.in/courses/108104098/

The break-up of CIE: Internal Tests + Assignments + Quizzes

1.	No. of Internal Tests	: 2	Max. Marks for each Internal Test	:	30
2.	No. of Assignments	: 3	Max. Marks for each Assignment	:	5
3.	No. of Quizzes	: 3	Max. Marks for each Quiz Test	:	5

Duration of Internal Tests: 90 Minutes

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Computer Organization and Architecture

SYLLABUS FOR B.E. V – SEMESTER

L:T:P (Hrs./week): 3:0:0	SEE Marks : 60	Course Code: **U19PC540EC**
Credits : 3	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES
To familiarize the students with the concept of organization of a computer system, issues related to performance analysis of CPU in the aspect of memory and I/O interface.	On completion of the course, students will be able to 1. Apply digital engineering fundamentals to acquire knowledge of arithmetic algorithms for different processors 2. Interpret the concept of Basic processor system with reference to 8085 processor and Analyze the performance of Micro programmed Control unit organization. 3. Implementing the techniques of pipelining and parallelism to analyze the performance of a Processor. 4. Apply the conceptual knowledge of system development with appropriate I/O Interface. 5. Interpret various techniques for efficient memory utilization to develop a system application.

UNIT - I: DATA REPRESENTATION AND COMPUTER ARITHMETIC

Introduction to Computer Organization and architecture, evolution and computer generations; Fixed point representation of numbers, digital arithmetic algorithms for Addition, Subtraction, ripple carry adder, carry look-ahead adder, Multiplication using Booth's algorithm and Division using restoring and non restoring algorithms. Floating point representation with IEEE standards and its arithmetic operations.

UNIT-II: BASIC PROCESSOR ORGANIZATION AND ARCHITECTURE

8085 Architecture, CPU ,ALU UNIT, Register organization of 8085CPU, Memory organization of 8085CPU, Instruction set of Basic 8085 processor, Stored program organization, stack organization of basic processor system, Hardwired control unit, Micro programmed Control organization, address sequencing, micro instruction format and micro program sequencer.

UNIT - III: PIPELINIG & PARALLELISM

Features of CISC and RISC and their comparison,Amdhal's law ,Concept of Pipelining, Data path and control path pipelining, Design of Arithmetic pipeline, Instruction Pipeline, performance issues in pipelining, Pipeline hazards, and techniques of Reducing pipeline branch penalties. Concept of parallelism, vector processors, Array processors.

UNIT - IV: INPUT-OUTPUT ORGANIZATION

I/O Bus and interface modules, I/O versus Memory Bus, Asynchronous data transfer: Strobe control, Handshaking, Asynchronous serial transfer. Modes of Transfer: Programmed I/O, Interrupt driven I/O, Priority interrupt; Daisy chaining, Parallel Priority interrupt. Direct memory Access, DMA controller and transfer. Input output Processor , CPU-IOP communication.

UNIT - V: MEMORY ORGANIZATION

Memory hierarchy, Mapping of memory with CPU, Primary memory, Concept of memory interleaving, Associative memory, Cache memory organization and performance measures, cache mapping functions, Virtual memory organization, paging mechanism ,address mapping using pages, Memory management hardware.

Learning Resources:

1. Morris Mano, M., "Computer System Architecture," 3/e, Pearson Education, 2005.
2. Hamacher, Vranesic, Zaky, "Computer Organization," 5/e, McGraw Hill, 2007.
3. William Stallings, "Computer Organization and Architecture: Designing for performance," 7/e, Pearson Education, 2006.
4. Govindarajulu, B., "Computer Architecture and Organization," 2/e, TMH, 2010.
5. John Hennessy and David Patterson, Computer Architecture : A Quantitative Approach, 5 th Edition,Elsevier.
6. Microprocessor Architecture, Programming, and Applications with the 8085, 5th Edition, Peaerson Education
7. Computer Organization and Architecture by IIT Delhi https://nptel.ac.in/courses/106102062/
8. Computer Organization and Architecture by Prof.V. kamkoti,IIT Madras https://onlinecourses.nptel.ac.in/noc17_cs35

The break-up of CIE: Internal Tests + Assignments + Quizzes

1. No. of Internal Tests	: 2	Max. Marks for each Internal Test	:	30
2. No. of Assignments	: 3	Max. Marks for each Assignment	:	5
3. No. of Quizzes	: 3	Max. Marks for each Quiz Test	:	5

Duration of Internal Tests: 90 Minutes

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Control Systems Engineering Lab

SYLLABUS FOR B.E. V – SEMESTER

L:T:P (Hrs./week): 0:0:2	SEE Marks : 50	Course Code: **U19PC511EC**
Credits : 1	CIE Marks : 30	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES
1. To demonstrate data acquistion from sensors using NI lab view. 2. To design and analyze control systems using control system tool/box / simulink / MATLAB	On completion of the course, students will be able to 1. Model any system using MATLAB, simulink. 2. Perform data acquisition through NI myRIO, 3. Appreciate the operation of various measuring and control instruments which they encounter in their respective fields. 4. Perform stability analysis of a given system in time and frequency domain. 5. Design a compensator for given specifications.

CYCLE - I Experiments

1. Measurement of temperature/pressure/strain of physical quantities using sensors using experimental trainer kits.
2. Sense the temperature with PmodTMP3
3. Sense the ambient light with PmodALS
4. Measurement of displacement/velocity with PmodACL
5. Estimate the range for a given IR and Ultrasonic sensors

CYCLE - II Experiments

6. Determine the stability of a given system.
7. Determine the time domain specifications for a second order system.
8. Find the static error coefficients of a given loop transfer function for test input signals.
9. Test system stability using R-H criterion.
10. Effect of addition of poles and zeros to the loop transfer function

using root locus technique.

11. Estimate gain margin and phase margin for given transfer function from Bode plot.
12. Estimate gain margin and phase margin for given transfer function from Nyquist plot.
13. Design of compensators for given specifications.
14. Compare the response of second order system with and without controllers.
15. Stability analysis of digital control system using ZOH.
16. Testing observability and controllability of a given system using kalman's test.

New Experiments

1. Characteristics of D.C servo motor.
2. Measurement of IR range

Mini Project(s)

Mini projects related to sensor applications

Learning Resources / Tools:

1. Sensors Interfacing With Labview: A Practical Guide to Sensors and Actuators Data Acquisition and Interfacing Using Myrio, Createspace Independent Pub; 1 edition (28 April 2016)
2. Modeling, Analysis and Design of Control Systems in MATLAB and Simulink, Dingyü Xue, North eastern University China Yang Quan Chen, University of California, World Scientific Publishing Co., 2015

The break-up of CIE :

1.	No. of Internal Test	:	1
2.	Max. Marks for internal tests	:	12
3.	Marks for day-to-day laboratory class work	:	18

Duration of Internal Tests: 3 Hours

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Integrated Circuits and Applications Lab

SYLLABUS FOR B.E. V – SEMESTER

L:T:P (Hrs./week): 0:0:2	SEE Marks : 50	Course Code: **U19PC521EC**
Credits : 1	CIE Marks : 30	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES
Students will Design and verify circuits using IC's for the given specifications.	On completion of the course, students will be able to 1. Implementing and Testing Various Op-Amp based circuits. 2. Design and verify the combinational and sequential circuits. 3. Examine the performance of various filters and 555 timer Applications. 4. Design & verify regulator using IC723 for given specifications.

CYCLE - I Experiments

1. Measurement of parameters of Op-Amp. Voltage Follower, Inverting and Non Inverting Amplifiers, Level Translators using Op-Amp.
2. Arithmetic Circuits: Summer, Integrator Differentiator Op-Amp.
3. Active filters: LP, HP and BP using Op-Amp.
4. Op-Amp Oscillators: Astable, Monostable.
5. Triangle and Square wave Generators. Schmitt Trigger using Op-Amp.
6. Voltage Controlled Oscillator Using LM 566.
7. IC Regulators and current boosting.
8. Applications of 555 Timer.

CYCLE - II Experiments

1. Measurement of propagation delay, fan-out, Noise margin and transfer Characteristics of TTL and CMOS IC gates and open collector / drain gates.
2. Designing code converters using logic gates and standard code converters. Parity generator and checker circuit.
3. Flip-Flop conversions and latches using gates and ICs.

4. Designing Synchronous, Asynchronous up/down counters
5. Shift registers and ring counters using IC Flip-Flops & Standards IC counters.
6. Full Adders, Subtractors using logic gates and multiple bits IC Adder / Subtractor and arithmetic Circuits.
7. Mux - Demux applications.
8. Interfacing counters with 7-segment LED/LCD display units.

General Note:

1. At least 5 experiments from each part.
2. A total of not less than 10 experiments must be carried out during the semester.
3. Analysis and design of circuits, wherever possible, should be carried out using SPICE tools.

New Experiments

1. Sequence detector using Mealy and Moore type FSM.
2. PLL and its applications using IC565

Mini Project(s)

Learning Resources / Tools :

1. http://www.ti.com/lit/an/sboa092b/sboa092b.pdf
2. https://www.electrical4u.com/applications-of-op-amp/

The break-up of CIE :

1.	No. of Internal Test	:	1
2.	Max. Marks for internal test	:	12
3.	Marks for day-to-day laboratory class work	:	18

Duration of Internal Tests: 3 Hours

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Analog and Digital Communication Lab

SYLLABUS FOR B.E. V – SEMESTER

L:T:P (Hrs./week): 0:0:2	SEE Marks : 50	Course Code: **U19PC531EC**
Credits : 1	CIE Marks : 30	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES
To demonstrate analog and digital communication modulation and demodulation schemes for a given signal.	On completion of the course, students will be able to 1. Perform analog modulation and digital schemes. 2. Demonstrate source coding techniques by converting an analog signal to digital. 3. Perform multiplexing techniques. 4. Perform channel/ source coding techniques.

CYCLE - I Experiments

1. Generation and detection of Amplitude modulated signals
2. Generation and detection of Frequency modulation systems
3. Verifying the principle of pre emphasis and De emphasis
4. Frequency Division Multiplexing
5. Analog signal sampling and reconstruction.
6. Pulse modulation techniques.
7. Time division multiplexing

CYCLE - II Experiments

8. Pulse code modulation and demodulation
9. Delta modulation and demodulation
10. Channel encoding and decoding techniques
11. Data Formats/ Line coding
12. Generation and detection of ASK/FSK/PSK
13. Generation and detection of QPSK
14. Generation and detection of MSK

New Experiments

1. Characteristics of radio receiver.
2. Voice communication through analog modulation scheems

Mini Project(s)

Mini projects on communication system principles using simulation tools

Learning Resources/ Tools :

Tools: MATLAB, Simulink

1. Comunication systems by V. Chandra Sekar, SASTRA University, Oxford University Press, 2013, ISBN: 9780198078050
2. Digital Communication Systems Using MATLAB and Simulink, Second Editionby Dennis Silage
3. Communication Systems Modeling and Simulation using MATLAB and Simulink 1st Edition by K. C. Raveendranathan

The break-up of CIE :

1. No. of Internal Test	:	1
2. Max. Marks for internal test	:	12
3. Marks for day-to-day laboratory class work	:	18

Duration of Internal Tests: 3 Hours

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Mini Project - II

SYLLABUS FOR B.E. V – SEMESTER

L:T:P (Hrs./week): 0:0:2	SEE Marks : -	Course Code: **U19PW519EC**
Credits : 1	CIE Marks : 30	Duration of SEE : -

COURSE OBJECTIVES	COURSE OUTCOMES
Students should be able to 1. Learn contemporary technologies 2. Design/Develop/Implement /Solve an engineering problem in the relevant areas of Electronics and Communication Engineering	On completion of the course, students will be able to 1. Review the literature survey to identify the problem 2. Propose the solution to address the problem 3. Design/Develop/Implement /Solve the problem and test the solution 4. Demonstrate the work done in the mini project through presentation and documentation 5. Adapt to contemporary technologies

The students are required to carry out mini projects in relevant areas of electronics communication engineering such as Electronic Devices and Circuits, Embedded Systems, RF, Microwave and Wireless Communications, Communication Systems, Signal, Image and Video Processing, VLSI, Networking.

Students are required to submit a report on the Mini Project.

- Batch size shall be 2 (or) 3 students per batch.
- Allocation by department.
- Two reviews – One during 6th week and another during 12th week and final evaluation shall be conducted at the end of the semester.
- Students are required to give Presentations / Demonstration of the work during the reviews.
- Students are required to submit the report.

Grades awarded to the Mini Project - II

Outstanding	–	≥ 45 marks
Excellent	–	≥ 40 - 44 marks
Very Good	–	≥ 35 - 39 marks
Good	–	≥ 30 - 34 marks
Average	–	≥ 25 - 29 marks

OPEN ELECTIVES OFFERED BY VARIOUS DEPARTMENTS IN B.E. V SEMESTER

Dept	Title	Code	credits
ECE	Sensors for Engineering Applications	U19OE510EC	3
ECE	Mathematical Programming for Engineers	U19OE010EC	3

VASAVI COLLEGE OF ENGINEERING (AUTONOMOUS)
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IBRAHIMBAGH, HYDERABAD – 500 031

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SENSORS FOR ENGINEERING APPLICATIONS

(OPEN ELECTIVE)

SYLLABUS FOR B.E. V - SEMESTER (for other branches)

L:T:P (Hrs./week) : 3:0:0	SEE Marks : 60	Course Code: **U19OE510EC**
Credits : 3	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES
1. The student will come to know the various stimuli that are to be measured in real life instrumentation. 2. He will be able to select the right process or phenomena on which the sensor should depend on 3. He will be aware of the various sensors available for measurement and control applications.	On completion of the course, students will be able to 1. Appreciate the operation of various measuring and control instruments which they encounter in their respective fields. 2. Visualize the sensors and the measuring systems when they have to work in areas of interdisciplinary nature and also think of sensors and sensors systems when for a new situation they encounter in their career 3. Identify and select the right process or phenomena on which the sensor should depend on. 4. Know various stimuli that are to be measured in real life instrumentation.

UNIT - I

Introduction to sensors and transducers .Need for sensors in the modern world. Different fields of sensors based on the stimuli - various schematics for active and passive sensors. Static and dynamic characteristics of sensors - zero, I and II order sensors – Response to impulse, step, ramp and sinusoidal inputs. Environmental factors and reliability of sensors.

UNIT – II

Sensors for mechanical systems or mechanical sensors - Displacement - acceleration and force - flow of fluids - level indicators - pressure in fluids - stress in solids. Typical sensors - wire and film strain gauges, anemometers, piezo electric and magnetostrictive accelerometers, potentio metric sensors, LVDT.

UNIT – III

Thermal sensors – temperature – temperature difference – heat quantity. Thermometers for different situation – thermocouples thermistors – color pyrometry.

Optical sensors: light intensity – wavelength and color – light dependent resistors, photodiode, photo transistor, CCD, CMOS sensors.

Radiation detectors: radiation intensity, particle counter – Gieger Muller courter (gas based), Hallide radiation detectors.

UNIT – IV

Magnetic sensors: magnetic field, magnetic flux density – magneto resistors, Hall sensors, super conduction squids.

Acoustic or sonic sensors: Intensity of sound, frequency of sound in various media, various forms of microphones, piezo electric sensors.

UNIT – V

Electrical sensors: conventional volt and ammeters, high current sensors, (current transformers), high voltage sensors, High power sensors.

High frequency sensors like microwave frequency sensors, wavelength measuring sensors.

MEMs and MEM based sensors.

Learning Resources :

1. Doebelin, "Measurement Systems: Application and Design", McGraw Hill Kogakusha Ltd.
2. Julian W. Gardner, Vijay K. Varadan, Osama O. Awadelkarim "Microsensors, MEMS and Smart Devices", New York: Wiley, 2001.
3. Henry Bolte, "Sensors – A Comprehensive Sensors", John Wiley.
4. Jocob Fraden," Handbook of Modern Sensors, Physics, Designs, and Applications", Springer.
5. Manabendra Bhuyan," Intelligent Instrumentation Principles and Applications", CRC Press.
6. Randy Frank," Understanding Smart Sensors", Second edition, Artech House.

The break-up of CIE : Internal Tests + Assignments + Quizzes

1. No. of Internal Tests	:	2	Max. Marks for each Internal Tests	:	30
2. No. of Assignments	:	3	Max. Marks for each Assignment	:	5
3. No. of Quizzes	:	3	Max. Marks for each Quiz Test	:	5

Duration of Internal Tests: 90 Minutes

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

MATHEMATICAL PROGRAMMING FOR ENGINEERS

(OPEN ELECTIVE)

SYLLABUS FOR B.E. V – SEMESTER (for other branches)

L:T:P (Hrs./week) : 3:0:0	SEE Marks : 60	Course Code: **U19OE010EC**
Credits : 3	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES
To provide fundamental knowledge of programming language for solving problems.	On completion of the course, students will be able to 1. Generate arrays and matrices for numerical problems solving. 2. Represent data and solution in graphical display. 3. Write scripts and functions to easily execute series of tasks in problem solving. 4. Use arrays, matrices and functions in Engineering applications 5. Design GUI for basic mathematical applications.

UNIT - I : Introduction:

Basics of MATLAB,MATLAB windows, Advantages of MATLAB,on-line help, file types.

MATLAB Basics: Variables and Constants –Vectors and Matrices- Arrays - manipulation- Built-in MATLAB Functions. Creating and printing simple plots, Creating, Saving and Executing a Script File, Creating and Executing a function file.

Programming Basics: Data types-Operators – Hierarchy of operations, Relational and logical operators, if-end structure, if-else-end structure, if-elseif-else-end structure, switch-case statement, for-end loop, while-end loop, break and continue commands.

UNIT - II : Scripts and Functions

Script Files, Function Files, Debugging methods in MATLAB.

Graphics: Basic 2D plots: Printing labels- grid and axes box- Entering text in a box- Axis control-Style options-Multiple plots-subplots-specialized 2D plots: stem-,bar, hist, pi, stairs, loglog , semilog ,polar ,comet 3D plots: Mesh,Contour,Surf,Stem3,ezplot.

UNIT - III : Numerical Methods Using MATLAB

Numerical Differentiation, Numerical integration- Newton-Cotes integration formulae, Multi-step application of Trapezoidal rule, Simpson's 1/3 Rule for Numerical Integration. MATLAB functions for integration.

Linear Equations- Linear algebra in MATLAB, Solving a linear system, Gauss Elimination, Finding eigen values and eigen vectors, Matrix factorizations, Advanced topics.

UNIT - IV : Nonlinear Equations

System of Non-linear equations, Solving System of Equations Using MATLAB function fsolve, Interpolation-Lagrange Interpolation, Two dimensional Interpolation, Straight line fit using Least Square Method, Curve fitting using built-in functions ployval and polyfit, cubic fit using least square method. Finding roots of a polynomial -roots function, Newton-Raphson Method.

UNIT - V :

Solution of Ordinary differential Equations(ODEs)-The 4^{th} order Runge-kutta Method, ODE Solvers in MATLAB, Solving First –order equations using ODE23 and ODE45.

Structures and Graphical user interface(GUI): Advanced data Objects, How a GUI works, Creating and displaying a GUI. GUI components, Dialog Boxes.

Learning Resources:

1. Getting started with MATLAB "A quick introduction for scientist and engineers by Rudra Pratap, Oxford publications.
2. Advanced Guide to MATLAB-Practical Examples in Science and Engineering by S.N.Alam, S.Islam, S.K. Patel-I.K. International Publishing House Pvt. Ltd.
3. Stephen J. Chapman-"MATLAB Programming for Engineers"- 5th Edition-Cengage Learning- 2015. Getting started with MATLAB (Version 9) The Math works.
4. An Introduction to MATLAB® Programming and Numerical Methods for Engineers 1st Edition by Timmy Siauw Alexandre Bayen, Elsevier-18th April 2014.
5. https://nptel.ac.in/courses/103106118/2
6. https://www.udemy.com/numerical-methods/

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3. No. of Quizzes	: 3	Max. Marks for each Quiz Test	:	5

Duration of Internal Tests: 90 Minutes

VASAVI COLLEGE OF ENGINEERING (AUTONOMOUS) :: IBRAHIMBAGH, HYDERABAD – 500 031.
DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
SCHEME OF INSTRUCTION AND EXAMINATION **(R-19)** :: B.E. - ECE : SIXTH SEMESTER (2021 - 22)

B.E (ECE) VI – SEMESTER								
Course Code	Name of the Course	Scheme of Instruction			Scheme of Examination			
		Hours per Week			Duration in Hrs	Maximum Marks		Credits
		L	T	P/D		SEE	CIE	
THEORY								
U19PC610EC	Microprocessors and Microcontrollers	3	-	-	3	60	40	3
U19PC620EC	Digital Signal Processing	3	-	-	3	60	40	3
U19PC630EC	Computer Networks	3	-	-	3	60	40	3
U19PC640EC	Antennas and Wave Propagation	3	-	-	3	60	40	3
U19OE6XXXX	Open Elective – IV	3	-	-	3	60	40	3
U19HS040EH	Economics and Finance for Engineers	2	-	-	3	60	40	2
U19HS610EH	Skill Development - IV : Soft Skills	1	-	-	2	40	30	1
U19PE610EC	Skill Development - IV : Technical Skills	1	-	-	2	40	30	1
U19HS020EH	Human Values & Professional Ethics - II	1	-	-	2	40	30	1
PRACTICALS								
U19PC611EC	Microprocessors and Microcontrollers Lab	-	-	2	3	50	30	1
U19PC621EC	Digital Signal Processing Lab	-	-	2	3	50	30	1
U19PC631EC	Computer Networks Lab	-	-	2	3	50	30	1
U19PW619EC	Theme Based Project	-	-	2	-	-	30	1
TOTAL		**20**	**-**	**8**		**630**	**450**	**24**
GRAND TOTAL		**28**				**1080**		
Left over hours will be allocated for : Sports / Library / Mentor - Mentee Interaction / CC / RC / TC / ECA / CCA								
Note: Every student should acquire one online certification course during III – VII Semester								

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Microprocessors and Microcontrollers

SYLLABUS FOR B.E. VI – SEMESTER

L:T:P (Hrs./week): 3:0:0	SEE Marks : 60	Course Code: **U19PC610EC**
Credits : 3	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES
1. To familiarize the students on 8086µp and 8051µc architecture so as to realize the concepts of SoC built-in peripheral programming in Assembly and embedded-C to develop a system.	On completion of the course, students will be able to 1. Summarize architectural features of 8086µp. 2. Interface and program 8086µp with memory, PPI, timer and DMA. 3. Summarize architectural features of 8051µc and apply the knowledge to program 8051µc. 4. Interface and program on chip peripherals of 8051µc. 5. Interface off chip peripherals with 8051µc and design a system around 8051µc based system.

UNIT - I: 8086 ARCHITECTURE

8086 Architecture, Register Organization, Memory segmentation, Pin configuration, latching of address bus, Buffering of data bus. Minimum and Maximum mode operations; control signal interfacing for read and write operations; Organization of stack, Interrupt Vector Table

UNIT - II: 8086 INTERFACING

Memory interfacing: RAM, EPROM IC Chips
I/O interfacing: 8255 PPI, 8257 DMA interface
Interfacing programmable interval timers – 8253/8254

UNIT - III: 8051 MICROCONTROLLER

Architecture of 8051, Pin configuration, built-in ROM & RAM organization, Stack organization.

Assembly language Programming with 8051: Instruction set, Data transfer, Arithmetic, logical and Branching instructions, Addressing modes.

UNIT - IV: Peripheral & interfacing programming in Assembly & Embedded-C

8051 Timers in different modes, counter programming, 8051 Serial data communication; Interrupt programming.

Off-chip EPROM, SRAM, Expansion of I/O using 8255; Sensor interface– ADC0804, ADC0808; DAC interface.

UNIT - V: Real world interfacing & Device drivers in Embedded-C

Interfacing Seven-segment display, 2x16 LCD, 4x3 Matrix Keyboard, DC Motor, Stepper Motor, DS12887 RTC. Applications of 8086 & 8051: Speed control in Industrial, Automotive with PWM generation; Home automation.

Learning Resources:

1. Ray A.K & Bhurchandhi K.M, "Advanced Microprocessor and Peripherals," 2/e, TMH, 2007.
2. Douglas V Hall, "Microprocessors and Interfacing Programming and Hardware," 2/e, THM, 2007.
3. Mazidi M.A, Mazidi J.G & Rolin D. Mckinlay, "The 8051 Microcontroller & Embedded Systems using Assembly and C," 2/e, Pearson Education, 2007.
4. Microprocessors and Microcontrollers by Dr. Santhanu chatopadhya, IIT Kharagpur
   https://onlinecourses.nptel.ac.in/noc18_ec03/course
5. Microprocessors and Microcontrollers, IIT Kanpur.
   https://nptel.ac.in/courses/Webcourse-contents/IIT- KANPUR/microcontrollers

The break-up of CIE: Internal Tests + Assignments + Quizzes

1.	No. of Internal Tests	: 2	Max. Marks for each Internal Test	:	30
2.	No. of Assignments	: 3	Max. Marks for each Assignment	:	5
3.	No. of Quizzes	: 3	Max. Marks for each Quiz Test	:	5

Duration of Internal Tests: 90 Minutes

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Digital Signal Processing

SYLLABUS FOR B.E. VI – SEMESTER

L:T:P (Hrs./week): 3:0:0	SEE Marks : 60	Course Code: **U19PC620EC**
Credits : 3	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES
Students will apply FFT algorithms, discuss various design methods of FIR & IIR filters, describe the concepts of multirate signal processing and identify important features of TMS320C67XX DSP processors.	On completion of the course, students will be able to 1. Apply the knowledge of FFT Algorithms for computation of DFT. 2. Design of FIR filters using various methods. 3. Design of IIR filters using various methods. 4. Apply decimation and interpolation concepts for the design of sampling rate converters. 5. Study TMS320C67XX DSP processors for the design of digital filters.

UNIT - I : Fast Fourier Transform

Overview of Discrete time Fourier Transform (DTFT), Discrete Fourier transform (DFT), - Efficient computation of DFT- Properties of DFT .

FFT algorithms - Radix-2 FFT algorithms – Decimation in Time – Decimation in Frequency algorithms - in place computation- bit reversal- Use of FFT algorithms in Linear Filtering and Correlation.

UNIT - II : Digital filters (FIR) Design

Amplitude and phase responses of FIR filters – Linear phase filters – Windowing techniques for design of Linear phase FIR filters – Rectangular, Bartlet, Hamming, Blackman, Kaiser FIR filter design, realization and finite word length effects.

UNIT - III : Digital filters (IIR) Design

Butterworth and Chebychev approximation- IIR digital filter design techniques- Impulse Invariant transformation - Bilinear transform techniques- Digital Butterworth- Chebychev filters,-comparisons between FIR and IIR filters. Digital filters structures.

UNIT - IV : Multirate Digital Signal Processing

Introduction -Decimation by a Factor D- Interpolation by a Factor I- Sampling Rate Conversion by a Rational Factor I/D- Implementation of Sampling Rate Conversion- Multistage implementation of Sampling Rate Conversion- Sampling Rate Conversion by an Arbitrary factor- Application of Multirate Signal Processing.

UNIT - V : Introduction to DSP Processors

Difference between DSP and other microprocessors architectures- Importance of DSP Processors- General purpose DSP processors- TMS320C67XX processor, architecture, registers, pipelining, addressing modes and introduction to instruction set.

Learning Resources:

1. Alan V. Oppenheim & Ronald W. Schafer, "Digital Signal Processing," PHI, 2/e, 2014.
2. John G. Proakis & Dimtris G. Manolakis, "Digital Signal Processing Principles, Algorithms and Application," PHI, 4/e, 2012.
3. Ashok Ambardar, "Digital Signal Processing: A Modern Introduction," Cengage Learning, 2009.
4. Li Tan, "Digital Signal Processing: Fundamentals and Applications," Elsevier, 2012.
5. B.Venkataramani & M. Bhaskar, "Digital Signal Processor Architecture, Programming and Application," TMH, 2e 2013.
6. RulphChassaing, "Digital Signal Processing and Applications with the C6713 and C6416 DSK", John wiley& sons, 2005.
7. https://nptel.ac.in/courses/117102060/
8. https://nptel.ac.in/courses/117104070/

The break-up of CIE: Internal Tests + Assignments + Quizzes

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2. No. of Assignments	:	3	Max. Marks for each Assignment	:	5
3. No. of Quizzes	:	3	Max. Marks for each Quiz Test	:	5

Duration of Internal Tests: 90 Minutes

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Computer Networks

SYLLABUS FOR B.E. VI – SEMESTER

L:T:P (Hrs./week): 3:0:0	SEE Marks : 60	Course Code: **U19PC630EC**
Credits : 3	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES
To experience the designing and managing of communication protocols while getting a good exposure to the TCP/IP protocol suite and to understand the different topologies and configurations in the area of computer networks	On completion of the course, students will be able to 1. Analyze the network requirements for a given organization and select most appropriate network architecture. 2. Design and analyze the performance of LAN for small and medium organizations. 3. Analyze the existing routing and congestion control algorithms. 4. Identify deficiencies in existing protocols and then formulate new and better protocols. 5. Apply and use of cryptography and network security in day to day applications.

UNIT - I :

Data communication, Network Topologies: LAN, WAN, MAN, Types- Bus, Star, Ring, Hybrid. Line configurations. Reference Models: OSI, TCP/IP, ATM.

Data Link Layer: Design issues, Framing, Error Detection and Correction, Flow control

Protocols: Stop and Wait, Sliding Window, ARQ Protocols.

UNIT - II :

MAC Sub Layer: Multiple Access Protocols: ALOHA, CSMA, Wireless LAN. IEEE 802.2, 802.3, 802.11, 802.16 standards. Bluetooth, Bridges and Routers. Circuit switching: Circuit Switching Principles and concepts. Packet switching: Virtual circuit and Datagram subnets.

UNIT - III :

Network Layer: Network layer Services, Routing algorithms: Shortest Path Routing, Flooding, Hierarchical routing, Broadcast, Multicast, Distance Vector Routing and Congestion Control Algorithms. Internet Working: The Network Layer in Internet, IPV4, IPV6 and Internet control protocols.

UNIT - IV :

Transport Layer: Transport Services, Elements of Transport Layer, Connection management, TCP and UDP protocols.

UNIT - V :

Application Layer: Domain Name System, SNMP, Electronic Mail, World Wide Web. Network Security: Cryptography Symmetric Key and Public Key algorithms, Digital Signatures, Authentication Protocols.

Learning Resource:

1. Andrew S Tanenbaum, "Computer Networks," 5/e, Pearson Education, 2011.
2. Behrouz A. Forouzan, "Data Communication and Networking," 5/e, TMH, 2008.
3. William Stallings, "Data and Computer Communications," 8/e, PHI, 2004.
4. S.Keshav, "An Engineering Approach to Computer Networks," 2/e, Pearson Education.
5. https://onlinecourses.nptel.ac.in/noc18_cs38/preview

The break-up of CIE: Internal Tests + Assignments + Quizzes

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Antennas and Wave Propagation

SYLLABUS FOR B.E. VI – SEMESTER

L:T:P (Hrs./week): 3:0:0	SEE Marks : 60	Course Code: **U19PC640EC**
Credits : 3	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES
1. Students will understand antenna fundamentals and parameters 2. Study the working of antennas at different frequencies 3. Acquire the knowledge of different modes of wave propagation	On completion of the course, students will be able to 1. Understand the basic principle of antennas and various antenna parameters 2. Analyse and design wire and loop antennas. 3. Analyse and design various array antennas. 4. Explain the operation of various VHF, UHF and Microwave antennas and also capable to designing the same. 5. Understand the concept of Smart antenna and various modes of wave propagation and describe the effect of atmosphere on radio wave propagation.

UNIT - I: Antenna Basics

Principles of radiation-single wire, two wire, current distribution on a thin wire antenna, retarded potential, isotropic radiator.

Antenna parameters: Radiation pattern, Beam area, Beam efficiency, radiation intensity, Antenna temperature, Antenna field regions, Gain, directivity, Antenna Polarization, effective length, Antenna Impedance, effective aperture and aperture efficiency, Friis transmission equation.

UNIT - II: Analysis of Linear and Loop Antennas

Infinitesimal dipole, region separation, Finite length dipole, Half wave dipole, quarter wave mono pole, Ground effects, small circular loop.

UNIT - III: Antenna Arrays

Introduction, Point sources, Array of two isotropic point sources, Linear

Arrays of n isotropic point sources of equal amplitude and spacing, null directions, principle of pattern multiplication, Linear broad side arrays with non uniform amplitude distributions, Binomial Array, Introduction to synthesis of antenna arrays using Schelkunoff polynomial method.

UNIT - IV: VHF, UHF and Microwave Antennas

Helical Antennas-Geometry, Helix modes, Design considerations for Helical Antenna, Horn Antenna, Reflector Antennas, Yagi_Uda Array and Log Periodic Array.

Micro strip Antennas- Basic characteristics of micro strip antennas, feeding methods, methods of analysis.

UNIT - V: Smart Antennas and Wave Propagation

Basic Concepts of Smart Antennas-Concept and benefits of smart antennas, Beam forming basics, Different modes of Radio Wave propagation used in current practice.

Learning Resources:

1. J.D. Kraus, "Antennas", McGraw Hill, 5th edition, 2007.
2. C.A. Balanis, "Antenna Theory - Analysis and Design", John Wiley, 5th edition, 2005.
3. K.D. Prasad, "Antenna and Wave Propagation", Satya Prakashan, 2009.
4. R.E. Collin, "Antennas and Radio Wave Propagation", McGraw Hill, 1985.
5. I.J. Bahl and P. Bhartia, "Micro Strip Antennas", Artech House, 1980.
6. R.K. Shevgaonkar, "Electromagnetic Waves", Tata McGraw Hill, 2005.
7. R.E. Crompton, Adaptive Antennas, John Wiley.

Nptel Links:

1. https://nptel.ac.in/courses/108101092/
2. https://nptel.ac.in/courses/117101056/

The break-up of CIE: Internal Tests + Assignments + Quizzes

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DEPARTMENT OF HUMANITIES & SOCIAL SCIENCES

Economics and Finance for Engineers

SYLLABUS FOR B.E. VI – SEMESTER

L:T:P (Hrs./week): 2:0:0	SEE Marks : 60	Course Code: **U19HS040EH**
Credits : 2	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES
The objective of the Course is to equip the prospective engineers with the concepts and tools of economics, finance, cost and taxes that facilitate business decisions.	On completion of the course, students will be able to 1. Enable students to identify the essential components such as production quantity limits, elasticity, demand and supply in business decision making. 2. Facilitate students in calculation of cost components to enable control of costs. 3. Make better investment decisions both in short and long run by understanding the financial viability of given investment proposals. 4. Analyze the given financial statements of a firm to understand the past performance and to make decisions for future. 5. Identify the impact of the new tax policies on the company's financial structure/ individual's incomes.

UNIT - I: Basics of Economics:
Scarcity Definition of Economics - Macro and Micro Economics - Managerial Economics - Meaning of a Firm - Objectives of a Firm - Demand Concept and Law of Demand -Price Elasticity of Demand (types), Income elasticity - cross elasticity - advertising elasticity - Meaning of Supply - Equilibrium Price and Quantity - Production - Cobb Doughlas Production Function - Economies of Scale. (Simple problems on computation of elasticity)

UNIT - II: Cost and Price:
Cost - Meaning -Classification of Costs -Short run and Long run costs - Cost Sheet - Break even Analysis - Methods of Pricing (Problems on Cost Sheet, Breakeven Analysis and Methods of Pricing can be asked).

UNIT - III: Sources and uses of Finance:
RBI and its role - Commercial Banks - Functions - Capital Budgeting -

Discounting and Non discounting Techniques (including simple problems) - Working Capital Management - Concepts and Components of Working Capital – determinants of working capital - Operating Cycle - estimation of working capital.

UNIT - IV: Understanding Financial Statements:
Financial Statements- Meaning - Types - Purpose - Ratios (Liquidity, Solvency & Profitability Ratios including problems)

UNIT - V: Direct & Indirect Taxes:
Heads of Income - Income from Salaries - Income from House Property - Income from Business - Income from Capital Gains -Income from Other Sources – old and new regime tax rates and calculation of tax - Latest Tax Rates - GST -CGST - SGST - IGST - GST network.

Learning Resources:

1. S.P.Jain and K.LNarang., "Cost Accounting", Kalyani Publishers, Twentieth Edition Revised– 2008.
2. S.P.Jain and K.L Narang., "Financial Accounting", Kalyani Publishers –2002.
3. Mehta P.L.,"Managerial Economics: Analysis,Problems and Cases", Thirteenth Edition, Sultan Chand and Sons, Nineteenth Edition - 2013.
4. M.Y.Khan and P.K. Jain., "Financial Management – Text, Problems and Cases", Mc Graw Hill Education Private Limited, New Delhi.
5. Vinod KSinghania and Kapil Singhania., "Direct Taxes Law and Practice", Taxmann Publications, Sixtieth Edition - 2018.
6. Dr.Vinod K Singhania., "Students' Guide to GST and Customs Law", Taxmann Publications, Edition - 2018.
7. Muralidharan., "Modern Banking", Prentice Hall of India.
8. Accounting for Managers by Narayana swamy

Reference Books:

1. M. L. Seth., "Micro Economics", *Lakshmi Narain Agarwal.*
2. Dr. R.P. Rustagi., "Fundamentals of Financial Management"Taxmann Publications.
3. Dr. D.M. Mithani, "Money Banking International Trade & Public Finance", Himalaya Publishing House - 2014.
4. Rajesh., "Banking Theory and Practice", Tata Mc Graw Hill Publishing

The break-up of CIE: Internal Tests + Assignments + Quizzes

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IBRAHIMBAGH, HYDERABAD – 500 031

DEPARTMENT OF HUMANITIES AND SOCIAL SCIENCES

Human Values and Professional Ethics-II

COMMON FOR ALL BRANCHES – B.E. VI - SEMESTER

L:T:P (Hrs./week): 1:0:0	SEE Marks : 40	Course Code: **U19HS020EH**
Credits : 1	CIE Marks : 30	Duration of SEE : 2 Hours

COURSE OBJECTIVES	COURSE OUTCOMES
The course will enable the students to :- 1. Create an awareness on the interrelation between Society, Ethics and Human Values 2. Understand how ethical dilemmas apply to real life scenarios 3. Develop ethical human conduct and professional competence. 4. Understand the role of good ethical practices and apply it in a project	At the end of this course, the student will be able to 1. Identify ethical risks in everyday life and in societies that can lead to unethical choices, such as structures that diffuse responsibility or a group that has collectively de-stigmatized unethical behaviour 2. Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, and the objective presentation of data. 3. Assess their own ethical values and the social context of problems and articulate what makes a particular course of action ethically defensible 4. Demonstrate knowledge of ethical values in non-classroom activities, such as service learning, internships, and field work integrate, synthesize, and apply knowledge of ethical dilemmas and resolutions in academic settings, including focused and interdisciplinary research

UNIT-I: NORMATIVE ETHICS & SOCIETAL ETHICS

This unit deals with normative ethics, the branch of moral philosophy, or ethics, concerned with criteria of what is morally right and wrong. It includes the formulation of moral rules that have direct implications for what human actions, institutions, and ways of life should be like. This unit also covers societal ethics which is the systematic reflection on the moral dimensions of social structures, systems, issues, and communities.

UNIT-II: PROFESSIONAL ETHICS - NEED FOR ETHICAL CODES

This unit covers the code of Professional Ethics- it is designed to ensure that students learn the necessary skills that groom them to behave like employees should, one that is socially acceptable and respectful of one

another. It establishes the rules for behavior and sends a message to every employee that universal compliance is expected.

UNIT-III: PRIVACY

This unit covers "Cyber ethics" - the code of responsible behavior on the Internet. Just as we are taught to act responsibly in everyday life with lessons such as "Don't take what doesn't belong to you" and "Do not harm others," we must act responsibly in the cyber world as well.
The basic rule is "Do not do something in cyberspace that you would consider wrong or illegal in everyday life."

UNIT-IV: MEDIA AND MEDICAL ETHICS

This unit covers Media and Medical ethics is the best division of applied ethics dealing with the specific ethical principles and standards of media (including broadcast media, film, theatre, the arts, print media and the internet) and medicine (practice of clinical medicine and related scientific research)

MODE OF DELIVERY

• Questionnaires • Quizzes • Case-studies • Observations and practice • Home and classroom assignments	• Discussions • Skits • Short Movies/documentaries • Team tasks and individual tasks • Research based tasks • Project

Relevant Websites, CD's and Documentaries

- https://plato.stanford.edu/

Learning Resources:

learn.talentsprint.com

The break-up of CIE: Internal Tests + Assignments + Quizzes

1. No. of Internal Tests	: 1	Max. Marks for each Internal Test	:	20
2. No. of Assignments	: 1	Max. Marks for each Assignment	:	5
3. No. of Quizzes	: 1	Max. Marks for each Quiz Test	:	5

Duration of Internal Tests: 90 Minutes

VASAVI COLLEGE OF ENGINEERING (AUTONOMOUS)
ACCREDITED BY NAAC WITH 'A++' GRADE
IBRAHIMBAGH, HYDERABAD - 500 031

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Microprocessors and Microcontrollers Lab

SYLLABUS FOR B.E. VI – SEMESTER

L:T:P (Hrs./week): 0:0:2	SEE Marks : 50	Course Code: **U19PC611EC**
Credits : 1	CIE Marks : 30	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES
1. To enable the students with 8086µp and 8051µc based programming with built in peripheral and interfacing off chip peripherals to develop an interface system using µVision5 IDE & simulate on proteus 7.2.	On completion of the course, students will be able to 1. Apply knowledge in writing the programs using Masm assembler tool for 8086 Microprocessor. 2. Apply knowledge in writing the programs in assembly using µVision5 for 8051µc. 3. Interface on chip peripherals of 8051µc using modern tool. 4. Interface off chip peripherals and I/O with interrupt programming to arrive at designs in implementing mini projects.

Cycle – I:

Assembly language programming for 8086 µP using Assembler

1. Execution of basic programs on 8086 microprocessor (8 bit and 16 bit arithmetic operations).
2. Programs for data transfer, String searching and sorting

Embedded C programming for 8051 µC using Keil IDE and Proteus for on-chip interface.

3. Programs related to arithmetic instructions.
4. Programs related to logical instructions.
5. Timer and counter programming.
6. Square wave generation with variable duty cycle (PWM).
7. Interrupt programming.

Cycle – II:

Embedded C programming with 8051 using Keil IDE & Proteus for off chip peripheral interface.

8. Serial communication using RS 232 UART protocols.
9. Sensor interfacing with off chip ADC applications.
10. Transducer interfacing with off chip DAC applications.
11. Program to control stepper motor
12. LCD display interfacing (4-bit and 8-bit mode).
13. Keypad interfacing.
14.

Mini project

Mini project based on applications that possibly can be developed using 8051μC by interfacing with on-chip and off-chip peripherals.

New Experiments :

1. User centric Authentication Module.
2. Home automation system

The break-up of CIE :

1.	No. of Internal Test	:	1
2.	Max. Marks for internal test	:	12
3.	Marks for day-to-day laboratory class work	:	18

Duration of Internal Tests: 3 Hours

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Digital Signal Processing Lab

SYLLABUS FOR B.E. VI – SEMESTER

L:T:P (Hrs./week): 0:0:2	SEE Marks : 50	Course Code: **U19PC621EC**
Credits : 1	CIE Marks : 30	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES
Students will develop C & MATLAB programs for operation of sequences, design and obtain the frequency response of various digital filters and to implement techniques of multirate processing.	On completion of the course, students will be able to 1. Develop MATLAB files for the verification of system response. 2. Design and analyze the digital filters using MATLAB. 3. Verify the functionality of FFT algorithms. 4. Experiment with multirate techniques using MATLAB & CCS. 5. Design and Implement the digital filters on DSP processor.

CYCLE - I Experiments

1. Basic matrix operations and Generation of test signals.
2. Linear Convolution
3. Circular convolution
4. Discrete Fourier Transform(DFT) and Fast Fourier Transform(FFT)
5. FIR filter design using different windows
6. IIR filter design: Butter worth, Chebyshev type 1 and 2: LPF, HPF, BPF & BSF filter.
7. Interpolation and Decimation.
8. I/D conversion using multistage.

Conduct any Six experiments from Cycle-I

CYCLE - II Experiments

9. Study of procedure to work in real- time.
10. Solutions of difference equations.
11. Linear Convolution.
12. Circular Convolution.
13. Discrete Fourier Transform(DFT)
14. Implementation of FIR filters.
15. Implementation of IIR filters.
16. Decimation and Interpolation.

Conduct any Six experiments from Cycle-I

New Experiments

1. Sine wave generation using CCS.
2. Raster Experiments for Image processing using CCS.

Mini Project(s)

Develop various programs for designing signal processing applications.

Learning Resources/Tools

1. MATLAB 2018a and TMS320C6748 OMAP Processor with CCS version 7.
2. Paul B. Zbar, Albert P. Malvino, Michael A. Miller, "Basic Electronics, A Text - Lab Manual", Vinay K. Ingle and John G. Proakis, “Digital Signal Processing using MATLAB”, 4/e, Cengage learning, 2012.
3. Digital signal processing using MATLAB for students and researchers, John W. Leis, A John Wiley & Sons, Inc., Publication,1966.
4. B. Venkataramani and M. Bhaskar,” Digital Signal Processor architecture, programming and application”, 6/e, TMH, 2013.
5. Rulph Chassaing, “Digital Signal Processing and Applications with the C6713 and C6416 DSK”, John wiley & sons, 2005.

The break-up of CIE :

1. No. of Internal Test	:	1
2. Max. Marks for internal test	:	12
3. Marks for day-to-day laboratory class work	:	18

Duration of Internal Tests: 3 Hours

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Computer Networks Lab

SYLLABUS FOR B.E. VI – SEMESTER

L:T:P (Hrs./week): 0:0:2	SEE Marks : 50	Course Code: **U19PC631EC**
Credits : 1	CIE Marks : 30	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES
To provide comprehensive knowledge of networking devices, tools and skills required to implement, test and trouble computer networks	On completion of the course, students will be able to 1. Implement IP addressing schemes and different sub netting scenarios. 2. Perform basic configurations of networking devices like switches and routers 3. Build and implement simple networking topologies and troubleshooting the networks. 4. Implement and troubleshoot virtual LANs and inter-VLAN routing. 5. Implement and test routing protocols like RIPv1, RIPv2, single-area and multi-area OSPF.

CYCLE - I Experiments

1. Getting started with Packet Tracer tool and Internetworking Operating System.
2. Implementation of different sub netting scenarios and IP addressing schemes
3. Basic configuration of networking devices
4. Building and troubleshooting different networking topologies
5. Building and testing Wired Local Area Networks
6. Building and testing Wireless Local Area Networks
7. Implementation and understanding of different servers like HTTP, TFP, TFTP and DNS

CYCLE - II Experiments

8. Creating and testing Wide Area Networks
9. Implementation of routing protocols
10. Implementation of Virtual Local Area Networks (VLAN) and inter VLAN routing
11. Testing and troubleshooting networks with Protocol Data Units
12. Implementation of access lists for traffic control in networking
13. Implementation of Gateway protocols (Boarder Gateway Protocols)
14. Experiments on DATA LINK LAYER

New Experiments

1) Introduction to IOT using Packet tracer
2) IOT-Connecting things using Packet tracer

Mini Project(s)

1) Case Study: Vasavi College of Engineering Campus wide LAN network

Learning Resources / Tools :

1. Packet tracer
2. CCNA module 1CCNA Routing and Switching: Introduction to Networks
3. CCNA module-2 CCNA Routing and Switching: Routing and Switching Essentials www.netacad.com

The break-up of CIE :

1. No. of Internal Test	:	1
2. Max. Marks for internal test	:	12
3. Marks for day-to-day laboratory class work	:	18

Duration of Internal Tests: 3 Hours

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Theme Based Project

SYLLABUS FOR B.E. VI – SEMESTER

L:T:P (Hrs./week): 0:0:2	SEE Marks : -	Course Code: **U19PW619EC**
Credits : 1	CIE Marks : 30	Duration of SEE :

COURSE OBJECTIVES	COURSE OUTCOMES
Students should be able to 1. Learn contemporary technologies 2. Design/Develop/Implement /Solve an engineering problem in the relevant areas of Electronics and Communication Engineering	On completion of the course, students will be able to 1. Review the literature survey to identify the problem 2. Propose the solution to address the problem 3. Design/Develop/Implement /Solve the problem and test the solution 4. Demonstrate the work done in the mini project through presentation and documentation 5. Adapt to contemporary technologies

A. Guidelines for theme based projects

Course for conducting theme-based projects as per the following:

- Batch size shall be 2 (or) 3 students per batch.
- Allocation by department based on their academic performance.
- Themes shall be different for each batch i.e., sometimes main theme may be same, but sub topic shall be independent as for as possible. In case of big size theme, part of the theme can be allotted to different groups for final integration.
- Output of the theme based project should be demonstrable / measurable / outcome based.
- Two overall coordinators for each section for theme based project supervision and faculty supervisors for different batches should be assigned.
- Two reviews – one after six weeks and another one after twelve weeks and final evaluation shall be conducted at the end of the semester.

B. Rubrics for evaluation of theme based project

Review of work progress	-	10 Marks
Project work carried out	-	10 Marks
Discussion of Results	-	10 Marks
Presentation and Demonstration skills	-	10 Marks
Report preparation and submission	-	10 Marks

C. Grades awarded to the theme based project.

Outstanding	–	≥ 45 marks
Excellent	–	≥ 40 - 44 marks
Very Good	–	≥ 35 - 39 marks
Good	–	≥ 30 - 34 marks
Average	–	≥ 25 - 29 marks

OPEN ELECTIVES OFFERED BY VARIOUS DEPARTMENTS IN

B.E. VI SEMESTER

Dept	Title	Code	Credits
ECE	Internet of Things and Applications	U19OE610EC	3
ECE	Introduction to Mobile Communications	U19OE620EC	3

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Internet of Things and Applications

(OPEN ELECTIVE – IV)

SYLLABUS FOR B.E. VI - SEMESTER (for other branches)

L:T:P (Hrs./week) : 3:0:0	SEE Marks : 60	Course Code: **U18OE610EC**
Credits : 3	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES
1. The purpose of this course is to impart knowledge on IoT Architecture, practical constrains. 2. To study various protocols And to study their implementations	On completion of the course, students will be able to 1. Understand the Architectural Overview of IoT 2. Enumerate the need and the challenges in Real World Design Constraints 3. Compare various IoT Protocols. 4. Build basic IoT applications using Raspberry Pi. 5. Understand IoT usage in various applications.

UNIT - I : OVERVIEW

Introduction to IoT – Improving Quality of life.

IoT-An Architectural Overview, M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT.

UNIT - II : Real-World Design Constraints

Real-World Design Constraints- Introduction, Technical Design constraints-hardware is popular again, Data representation and visualization, Interaction and remote control. Power Management in IoT device, Power conditioning using energy harvesting.

UNIT - III : IOT PROTOCOLS

Introduction to MQTT, Quality of services in MQTT,standards and security in MQTT.

Introduction and implementation of AMQP, Implementation of CoAP and MDNS.

UNIT - IV : Device for IoT

Choice of Microcontroller, Introduction to Raspberry Pi ,Features of Pi, Programming platform, Phython programming for Pi. Building basic IoT Applications using Raspberry Pi.

UNIT - V : IoT case studies

Smart Cities and Smart Homes, Connected Vehicles, Agriculture, Healthcare, Activity Monitoring.

Learning Resources:

1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1 st Edition, Academic Press, 2014.
2. Peter Waher, "Learning Internet of Things", PACKT publishing, BIRMINGHAM – MUMBAI
3. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer
4. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118- 47347-4, Willy Publications
5. https://nptel.ac.in/courses/106105166/5
6. https://nptel.ac.in/courses/108108098/4

The break-up of CIE : Internal Tests + Assignments + Quizzes

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Introduction to Mobile Communications

(OPEN ELECTIVE - IV)

SYLLABUS FOR B.E. VI - SEMESTER (for other branches)

L:T:P (Hrs./week) : 3:0:0	SEE Marks : 60	Course Code: **U18OE620EC**
Credits : 3	CIE Marks : 40	Duration of SEE : 3 Hours

COURSE OBJECTIVES	COURSE OUTCOMES
1. To understand the technology trends changing from generation to generation. 2. To have an insight into the various propagation models and the effects of fading. 3. To understand the multiple access techniques and Mobile communication system specifications.	On completion of the course, students will be able to 1. Analyze various methodologies to improve the cellular capacity. 2. Identify various Propagation effects. 3. Identify the effects of fading and multi path propagation. 4. Categorize various multiple access techniques for Mobile Communications. 5. Analyze the specifications of GSM based Mobile Communication Systems.

UNIT - I:

Introduction to Wireless Communication Systems: Evolution of Mobile Radio Communications, Examples of Wireless Communications Systems, Trends in Cellular Radio and Personal Communication Systems.

The Cellular Concept – System Design Fundamentals: Introduction, Frequency Reuse, Channel Assignment Strategies, Handoff Strategies, Interference and System Capacity, Improving Coverage and Capacity in Cellular Systems.

UNIT - II:

Mobile Radio Propagation - Large Scale Path Loss: Introduction to Radio wave Propagation, Free Space Propagation Model, Reflection, Ground Reflection (Two-Ray) Model, Diffraction, Scattering.

UNIT - III:

Mobile Radio Propagation - Small Scale Fading and Multipath: Small Scale Multipath Propagation, Small – Scale Multipath Measurements, Parameters of

Mobile Multipath Channels, Types of Small-Scale Fading, Rayleigh and Ricean Distributions.

UNIT -IV:

Multiple Access Techniques for Wireless Communications: Introduction, Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA), Space Division Multiple Access (SDMA).

UNIT -V:

Wireless Systems and Standards: Global System for Mobile (GSM) – Services and features, System architecture, GSM Radio subsystem, channel types, Frame structure for GSM.

Learning Resources:

1. Theodore S. Rappaport, Wireless Communications Principles and Practices, 2nd edition, Pearson Education.
2. David Tse, Pramodh Viswanath, Fundamentals of Wireless Communication, 2005, Cambridge University Press.
3. Name of the course: Introduction to Wireless and Cellular Communications
   Course url: https://swayam.gov.in/nd1_noc19_ee48/preview

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