R.V. COLLEGE OF ENGINEERING

(Autonomous Institution Affiliated to VTU, Belagavi)
R.V. Vidyaniketan Post, Mysore Road
Bengaluru – 560 059

Bachelor of Engineering (B.E.)
Scheme and Syllabus for VII & VIII Semesters

2016 SCHEME

ELECTRONICS & COMMUNICATION ENGINEERING

Department Vision

Imparting quality technical education through interdisciplinary research, innovation and teamwork for developing inclusive & sustainable technology in the area of Electronics and Communication Engineering.

Department Mission

- To impart quality technical education to produce industry-ready engineers with a research outlook.
- To train the Electronics & Communication Engineering graduates to meet future global challenges by inculcating a quest for modern technologies in the emerging areas.
- To create centres of excellence in the field of Electronics & Communication Engineering with industrial and university collaborations.
- To develop entrepreneurial skills among the graduates to create new employment opportunities.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1. To apply concepts of mathematics, science and computing to Electronics and Communication Engineering

PEO2. To design and develop interdisciplinary and innovative systems.

PEO3. To inculcate effective communication skills, team work, ethics, leadership in preparation for a successful career in industry and R & D organizations.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO	Description
PSO1	Should be able to clearly understand the concepts and applications in the field of Communication/networking, signal processing, embedded systems and semiconductor technology.
PSO2	Should be able to associate the learning from the courses related to Microelectronics, Signal processing, Microcomputers, Embedded and Communication Systems to arrive at solutions to real world problems.
PSO3	Should have the capability to comprehend the technological advancements in the usage of modern design tools to analyze and design subsystems/processes for a variety of applications.
PSO4	Should possess the skills to communicate in both oral and written forms, the work already done and the future plans with necessary road maps, demonstrating the practice of professional ethics and the concerns for societal and environmental wellbeing.

Lead Society: Institute of Electrical and Electronics Engineers (IEEE)

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2016 SCHEME

ELECTRONICS & COMMUNICATION ENGINEERING

ABBREVIATIONS

Sl. No.	Abbreviation	Meaning
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	CE	Professional Core Elective
6.	GE	Global Elective
7.	HSS	Humanities and Social Sciences
8.	CV	Civil Engineering
9.	ME	Mechanical Engineering
10.	EE	Electrical & Electronics Engineering
11.	EC	Electronics & Communication Engineering
12.	IM	Industrial Engineering & Management
13.	EI	Electronics & Instrumentation Engineering
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	TE	Telecommunication Engineering
17.	IS	Information Science & Engineering
18.	BT	Biotechnology
19.	AS	Aerospace Engineering
20.	PH	Physics
21.	CH	Chemistry
22.	MA	Mathematics

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ELECTRONICS AND COMMUNICATION ENGINEERING

SEVENTH SEMESTER CREDIT SCHEME								
Sl. No	**Course Code**	**Course Title**	**BOS**	**Credit Allocation**				**Total Credits**
				Lecture	**Tutorial**	**Practical**	**SS**	
1	16EC71	Microwave & Radiating Systems	EC	4	0	1	0	5
2	16EC72	Broadband Wireless –LTE 4G	EC	4	0	0	0	4
3	16EC73	Minor Project**	EC	0	0	3	0	3
4	16EC7FX	Elective F (PE)	EC	4	0	0	0	4
5	16EC7GX	Elective G(PE)	EC	4	0	0	0	4
6	16G7HXX	Elective H (OE)*	Respective BOS	3	0	0	0	3
Total No. of Credits								**23**
No. Of Hrs.				**19**	**0**	**8**	**0**	**27**

** EI, EE, CV, EC, ME – 6 hrs. / week Minor Project. *Students should take other department Global Elective courses

VII Semester		
GROUP F: PROFESSIONAL ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1.	16EC7F1	Satellite Communications & GPS
2.	16EC7F2	ARM Programming & Optimization
3.	16EC7F3	Speech Processing
4.	16EC7F4	Radio Frequency Integrated Circuits Design
5.	16EC7F5	High Performance Computing
6.	16EC7F6	Integrated Photonics
7.	16EC7F7	Nanoelectronics
VII Semester		
GROUP G: PROFESSIONAL ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1.	16EC7G1	Radar & Navigation
2.	16EC7G2	Automotive Electronics
3.	16EC7G3	Multimedia Communication
4.	16EC7G4	VLSI Testing for ICs
5.	16EC7G5	High Speed digital design
6.	16EC7G6	MEMS and Smart Systems

Sl. No.	Host Dept	Course Code	Course Title
1.	BT	16G7H01	Nanotechnology
2.	CH	16G7H02	Industrial Safety and Risk Management
3.	CV	16G7H03	Intelligent Transport System
4.	CS	16G7H04	Intelligent System
5.	EC	16G7H05	Image Processing and Machine Learning
6.	EE	16G7H06	Design of Renewable Energy Systems
7.	IM	16G7H07	Systems Engineering
8.	EI	16G7H08	MEMS and Application
9.	IS	16G7H9	Introduction to Internet of Things
10.	ME	16G7H10	Industry 4.0 – Smart Manufacturing for The Future
11.	TC	16G7H11	Space Technology and Application
12.	MA	16G7H12	Advanced linear Algebra
13.	PY	16G7H13	Thin Film Nanotechnology
14.	CY	16G7H14	Engineering Material for Advance Technology
15.	HSS	16G7H15	Applied Psychology for Engineers
16.	HSS	16G7H16	Foundational Course on Entrepreneurship
17.	AS	16G7H17	Unmanned Aerial Vehicles

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ELECTRONICS AND COMMUNICATION ENGINEERING

EIGTH SEMESTER CREDIT SCHEME								
Sl. No.	**Course Code**	**Course Title**	**BOS**	**Credit Allocation**				**Total Credits**
				Lecture	**Tutorial**	**Practical**	**SS**	
1.	16EC81	Major Project	EC	0	0	16	0	16
2.	16EC82	Technical Seminar	EC	0	0	2	0	2
3.	16HS83	Innovation and Social Skills	HSS	0	0	2	0	2
Total No. of Credits								**20**
No. Of Hrs.				**0**	**0**	**40**	**0**	**40**

Credit Allocation for 2016 Scheme Semester Wise

Sl.No	Semester	Credits
1	I	25
2	II	25
3	III	25
4	IV	25
5	V	29
6	VI	28
7	VII	23
8	VII	20
TOTAL		**200**

Semester: VII						
Microwave & Radiating Systems						
Course Code	**:**	16EC71		**CIE**	**:**	100+50
Credits: L:T:P:S	**:**	4:0:1:0		**SEE**	**:**	100+50
Total Hours	**:**	46L		**SEE Duration**	**:**	3Hrs+3Hrs

Course Learning Objectives: The students will be able to

1	Apply the knowledge of fields and waves to develop concepts of transmission line theory.
2	Describe the basic operation of microwave devices.
3	Describe the radiation from isolated, linear wire antennas and from linear elements near or on a conducting surface.
4	Calculate the fundamental parameters for antennas and the radiation field from an antenna using potential functions.

Unit-I	**09 Hrs**
Transmission Lines : Introduction, transmission lines equations and solutions, termination of line by infinite line, by characteristic impedance, short circuit line, open circuit line and any load resistive impedance ,input impedance reflection and transmission coefficients, standing waves and SWR(at both load end and generator end).	
Unit – II	**09 Hrs**
Impedance Transforms and Matching: Quarter wave transforms, Smith chart construction and properties, Single stub matching. **Microwave Waveguides:** Introduction, TE, TM waves Rectangular waveguides (quantitative analysis TE, TM modes), circular waveguides (quantitative analysis), dominant modes, group velocity phase velocity, and wave impedance, Microwave cavities (quantitative analysis), resonant frequency. **S-parameters:** Introduction, properties of S matrix (qualitative analysis)	
Unit –III	**09 Hrs**
Microwave Passive Devices: Waveguide Tee's, Directional couplers, circulators, power divider, Isolators (Faraday isolator), phase shifters (Rotatory type), Attenuators (Rotatory type), (s-parameters of all devices) **Microwave Sources:** Multicavity Klystron amplifier, Reflex klystron oscillator **RF Amplifiers and Front End Modules for Communications** – Gain and Output Power, Return Loss and Reverse Isolation, Noise Figure, Harmonics, Theory of Inter-modulation Distortion and measurement, Efficiency.	
Unit –IV	**09 Hrs**
Antenna Basics: Introduction, antenna radiation mechanism, basic Antenna parameters, patterns, beam area, radiation intensity, beam efficiency, diversity and gain, antenna apertures, effective height, bandwidth, radiation, efficiency, antenna temperature and antenna field zones. **Wire Antennas:** Electric dipoles: Introduction, short electric dipole (fields, power density, power radiated, directivity, radiation resistance), Half wave dipoles(field: qualitative analysis power density, power radiated, directivity, radiation resistance).	
Unit –V	**10 Hrs**
Antenna Arrays: Introduction, pattern multiplication, Array of two isotropic point sources, N element linear array with uniform spacing and phase(Array factor), Broadside and end fire array(Directivity, location of beam with, Beam width, etc).**Antenna Types:** Folded dipole, Yagi-Uda array, parabolic reflectors, log periodic antenna, Rectangular patch antenna, horn antenna (Qualitative analysis only: Construction, working).	

Practical's: Microwave &Antenna Lab

Expected Course Outcomes:

1. Study of Reflex Klystron Source.
2. Design and Simulation of Waveguide Magic-Tee

3. Design and Simulation of a Printed Hybrid Ring.
4. Design and Simulation of Patch Antenna, Dipole and Analysis of Antenna Arrays.
5. Characterization of Microwave E-plane, H-plane and Magic Tee
6. Characterization of Directional Coupler, Circulator, Attenuator and Isolator.
7. Radiation characteristics of Microstrip Patch and Printed Dipole Antenna
8. Radiation Characteristics of Pyramidal Horn Antenna
9. Performance Analysis of Rayleigh and Rician Fading Channel Models using Matlab
10. Generation and Reception of Gold sequence, Direct Sequence Spread Spectrum in Matlab
11. Demo: Design and Simulation of a Power divider.
12. Demo: Characterization of Microwave devices with Network analyzer

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explain and summarize the working of transmission line, Waveguides , Microwave Passive Devices and Antennas
CO2:	Analyze wave propagation in transmission line, Waveguides and characterize the passive microwave components and Antennas.
CO3:	Design the transmission lines, passive microwave components and Antennas for given specification and also match the impedance.
CO4:	Evaluate S-Parameter, VSWR for transmission lines, Microwave components and radiation pattern for Antennas.

Reference Books	
1	David M Pozar, "Microwave Engineering",John Wiley, 3rd Edition, 2004,ISBN-13: 978-0471644514
2	C A Balanis, "Antenna Theory and Design", John Wiley & sons, Inc. publication, 3rd Edition,2005,ISBN-13: 978-0471667827
3	National Instruments, ' Basics of Power Amplifier and Front End Module Measurements' White paper, http://www.ni.com/rf/
4	R E Collin, "Foundations of Microwave Engineering", IEEE Press on Electromagnetic and Wave Theory, 2nd Edition, ISBN-13: 978-0-7803-6031-0/ 0-7803-6031-1
5	John D.Krauss, "Antennas", McGraw-Hill International Edition, 3rd Edition, 2006.ISBN-13: 978-0071232012

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

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 marks over number of weeks is considered for 40 marks. At the end of the semester a test is conducted for 10 marks. Total marks for the laboratory is 50.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 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 complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I,

IV and V have no internal choice. Units II and III 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	2	0	0	0	0	2	0	0	2	0	1
CO2	3	2	2	1	0	0	2	0	0	2	0	1
CO3	3	3	2	2	0	0	2	0	0	2	0	1
CO4	3	3	3	3	0	0	2	0	0	2	0	1

High-3: Medium-2: Low-1

Semester: VII						
Broadband Wireless -LTE 4G						
Course Code	**:**	16EC72		**CIE**	**:**	100 Marks
Credits: L:T:P:S	**:**	4:0:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	46L		**SEE Duration**	**:**	03 Hours

Course Learning Objectives: The students will be able to

1	Identify real life channels and statistical characterization for them.
2	Identify GSM, its physical layer and call processing as well as scenarios and services.
3	Analyze the concept and applications of spread spectrum techniques including Synchronization.
4	Identify physical layer and call processing protocols for cellular CDMA.

Unit-I	**09 Hrs**
Review of Legacy Systems **Key Enablers for LTE features:** OFDM, Single carrier FDMA, Single carrier FDE, Channel Dependant Multiuser Resource Scheduling, Multiantenna Techniques, IP based Flat network Archite09ure, LTE Network Architecture. **Wireless Fundamentals:** Cellular concept, Broadband wireless channel (BWC), Fading in BWC, Modeling BWC – Empirical and Statistical models, Mitigation of Narrow band and Broadband Fading	
Unit – II	**09 Hrs**
Multicarrier Modulation: OFDM basics, OFDM in LTE, Timing and Frequency Synchronization, PAR, SC-FDE. **OFDMA and SC-FDMA:** OFDM with FDMA, TDMA, CDMA, OFDMA, SC-FDMA, OFDMA and SC-FDMA in LTE **Multiple Antenna Transmission and Reception:** Spatial Diversity overview, Receive Diversity, Transmit Diversity, Interference cancellation and signal enhancement, Spatial Multiplexing, Choice between Diversity, Interference suppression and Spatial Multiplexing	
Unit –III	**09 Hrs**
Overview and Channel Structure of LTE: Introduction to LTE, Channel Structure of LTE, Downlink OFDMA Radio Resource, Uplink SC-FDMA Radio Resource . **Downlink Transport Channel Processing:** Overview, Downlink shared channels, Downlink Control Channels, Broadcast channels, Multicast channels, Downlink physical channels, H-ARQ on Downlink	
Unit –IV	**10 Hrs**
Uplink Channel Transport Processing: Overview, Uplink shared channels, Uplink Control Information, Uplink Reference signals, Random Access Channels, H-ARQ on uplink **Physical Layer Procedures:** Hybrid – ARQ procedures, Channel Quality Indicator CQI feedback, Precoder for closed loop MIMO Operations, Uplink channel sounding, Buffer status Reporting in uplink, Scheduling and Resource Allocation, Cell Search, Random Access Procedures, Power Control in uplink.	
Unit –V	**09 Hrs**
Radio Resource Management and Mobility Management: PDCP overview, MAC/RLC overview, RRC overview, Mobility Management, Inter-cell Interference Coordination	

Course Outcomes: After completing the course, the students will be able to

CO1:	Associate terms in the system architecture to the functional standard specified in LTE 4G.
CO2:	Analyze the role of LTE radio interface protocols and EPS Data convergence protocols to set up, reconfigure and release data and voice from users.
CO3:	Demonstrate the UTRAN and EPS handling processes from set up to release including mobility management for a variety of data call scenarios.
CO4:	Test and Evaluate the Performance of resource management and packet data processing and transport algorithms.

Reference Books	
1	Arunabha Ghosh, Jan Zhang, Jefferey Andrews, Riaz Mohammed, 'Fundamentals of LTE', Prentice Hall, Communications Engg and Emerging Technologies.
2	Harri Holma and Antti Toskala,'LTE for UMTS Evolution to LTE-Advanced', Second Edition - 2011, John Wiley & Sons, Ltd. Print ISBN: 9780470660003.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 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 complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III 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	0	0	0	0	2	0	0	2	0	3
CO2	3	2	2	1	0	0	2	0	0	2	0	3
CO3	3	3	2	2	0	0	2	0	0	2	0	3
CO4	3	3	3	3	0	0	2	0	0	2	0	3

High-3: Medium-2: Low-1

VII Semester		
Mini Project		
Course Code: 16EC73		**CIE Marks: 100**
Credits: L: T: P: S:: 0:0:3:0		**SEE Marks: 100**
Hrs/week: 06		**SEE Duration: 3 Hrs**

Course Learning Objectives: The students will be able to	
1	Create interest in innovative developments and preferably interdisciplinary field.
2	Work independently, analyze, evaluate and solve the given problem.
3	Inculcate the skills for good presentation and improve the technical report writing skills.
4	Recognize the need for planning, preparation, management and financial budgeting.
5	Acquire collaborative skills through working in a team to achieve common goals.

Mini Project Guidelines:

1. Each project group will have two to four students, they can form their groups amongst their class.
2. Each group has to select a current topic that will use the technical knowledge of their program of study after intensive literature survey.
3. Guides will be allotted by the department based on the topic chosen.
4. The project should result in system/module which can be demonstrated, using the available resources in the college.
5. The CIE evaluation will be done by the committee constituted by the department. The committee shall consist of respective guide & two senior faculty members as examiners. The evaluation will be done for each student separately.
6. The final copy of the report should be submitted after incorporation of any modifications suggested by the evaluation committee

Guidelines for Evaluation:

CIE Assessment:

Evaluation will be carried out in three phases:

Phase	Activity	Weightage
I	Synopsis submission, approval of the selected topic, formulation of objectives	20%
II	Mid-term evaluation to review the progress of work and documentation	30%
III	Submission of report, Final presentation and demonstration	50%

The following are the weightages given for the various stages of the project:

1. Selection of the topic and formulation of objectives: 10%
2. Design and Development of Project methodology: 30%
3. Execution of Project: 30%
4. Presentation, Demonstration and Discussion: 20%
5. Report Writing:10%

SEE Assessment:

The following are the weightages given during SEE Examination:

1. Written presentation of synopsis:10%

2. Presentation/Demonstration of the project: 30%
3. Methodology and Discussion: 30%
4. Technical Report: 10%
5. Viva Voce: 20%

Course Outcomes of Mini Project:	
1	Define Specifications, Conceptualize, Design and implement a project
2	Communicate the work carried out as a technical report and orally
3	Work in a team and contribute to team work
4	Indulge in self-learning and be motivated for life-long learning

Semester: VII						
SATELLITE COMMUNICATIONS & GPS **(Group F: Professional Core Elective)** **(Theory)**						
Course Code	**:**	16EC7F1		**CIE**	**:**	100 Marks
Credits: L:T:P:S	**:**	4:0:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	50L		**SEE Duration**	**:**	03 Hours
Course Learning Objectives: The students will be able to						
1	Understand the Satellite orbits and orbital perturbations.					
2	Analyze link power budget calculations and losses in the atmosphere.					
3	Understand the components of the satellite in space and Earth stations					
4	Analyze Fixed Coordinate System and GPS C/A Code Signal Structure					

Unit-I	**10 Hrs**
Over View of Satellite Systems: Introduction, frequency allocation, Kepler laws, definitions, orbital element, apogee and perigee heights, orbit perturbations, inclined orbits, calendars, universal time, sidereal time, orbital plane, local mean time and sun synchronous orbits, Geostationary orbit: Introduction, antenna, look angles, polar mix antenna, limits of visibility, earth eclipse of satellite, sun transit outage.	
Unit – II	**10 Hrs**
Propagation Impairments and Space Link: Introduction, atmospheric loss, ionospheric effects, rain attenuation, other impairments. Space Link: Introduction, EIRP, transmission losses, link power budget, system noise, CNR, uplink, down link, effects of rain, combined CNR.	
Unit –III	**10 Hrs**
Space Segment: Introduction, power supply units, altitude control, station keeping, thermal control, TT&C, transponders, antenna subsystem. Earth Segment: Introduction, receive only home TV system, outdoor unit, indoor unit, MATV, CATV, Tx – Rx earth station	
Unit –IV	**10 Hrs**
GPS: Introduction, History of GPS Development, A Basic GPS Receiver, Approaches of Presentation, Software Approach, Potential Advantages of the Software Approach. **Basic GPS Concept:** Introduction, GPS Performance Requirements, Basic GPS Concept, Basic Equations for Finding User Position, Measurement of Pseudo-range, Solution of User Position from Pseudo-ranges, Position Solution with more than Four Satellites, User Position in Spherical Coordinate System, Earth Geometry, Basic Relationships in an Ellipse, Calculation of Altitude, Calculation of Geodetic Latitude, Calculation of a Point on the Surface of the Earth, Satellite Selection, Dilution of Precision. **Satellite Constellation:** Introduction, Control Segment of the GPS System, Satellite Constellation, Maximum Differential Power Level from Different Satellites, Sidereal Day, Doppler Frequency Shift, Average Rate of Change of the Doppler Frequency, Maximum Rate of Change of the Doppler Frequency, Rate of Change of the Doppler Frequency Due to User Acceleration, Kepler's Equation, True and Mean Anomaly, Signal Strength at User Location.	
Unit –V	**10 Hrs**
Earth-Centered, Earth-Fixed Coordinate System : Introduction, Direction Cosine Matrix, Satellite Orbit Frame to Equator Frame Transform, Vernal Equinox, Earth Rotation, Overall Transform from Orbit Frame to Earth-Centered, Earth-Fixed Frame, Perturbations, Correction of GPS System Time of Transmission, Calculation of Satellite Position, Coordinate Adjustment for Satellites, Ephemeris Data.: **GPS C/A Code Signal Structure:** Introduction, Transmitting Frequency, Code Division-Multiple Access (CDMA) Signals, P Code, C/A Code and Data Format, Generation of C/A Code, Correlation Properties of C/A Code, Navigation Data Bits, Telemetry (TLM) and Hand Over Word (HOW), GPS Time and the Satellite Z Count, Parity Check Algorithm, Navigation Data from sub frame 1, Navigation Data from subframes 2 and 3, Navigation Data from subframes 4 and 5–Support Data, Ionospheric Model, Tropospheric Model, Selectivity Availability (SA) and Typical Position Errors.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Analyse the basic concepts of orbital mechanics of satellites and GPS
CO2:	Apply the basic concepts to solve problems in satellites and GPS
CO3:	Analyze various transmission losses and components of space & Earth Segment
CO4:	Evaluate noise effect and Signal Structure of Satellite and GPS.

Reference Books	
1	Dennis Roddy, "Satellite Communications", McGraw-Hill, 4th Edition, 2006, ISBN 0-07-146298-8
2	Timothy Pratt, Charles Bostian and Jeremy Allnutt, "Satellite Communications", John Wiley & Sons, 2nd Edition, 2003, ISBN: 978-0-471-37007-9
3	James Bao-Yen, Tsui, "Fundamentals of Global Positioning System Receivers: A Software Approach", John Wiley,2nd Edition , 2005, ISBN: 978-0-471-70647-2
4	K. N. Raja Rao, "Fundamentals of Satellite Communication", PHI Learning Pvt. Ltd, 2nd Edition, ISBN, 8120324013

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 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 complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III 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**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**
CO2	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**
CO3	**3**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**
CO4	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**

Low-1 Medium-2 High-3

Semester: VII						
ARM PROGRAMMING & OPTIMIZATION **(Group F: Professional Core Elective)** **(Theory)**						
Course Code	**:**	16EC7F2		**CIE**	**:**	100 Marks
Credits: L:T:P:S	**:**	4:0:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	50L		**SEE Duration**	**:**	03 Hours

Course Learning Objectives: The students will be able to	
1	Discuss the basic principles of ARM system design.
2	Identify the major hardware components ARM data path architecture.
3	Identify the design issues ARM based embedded system with the basic knowledge of firmware, embedded OS & ARM architectures.
4	Analyze the execution of instructions/program knowing the basic principles of ARM architecture and assembly language.
5	Compare programs written in C & assembly to execute on ARM platform.

Unit-I	**10 Hrs**
Introduction, Data Path Architecture, Registers, Modes, Exceptions **ARM Instructions:** Data processing instructions, Branch instructions, Load store instructions, software interrupt instructions, program status register instructions, loading constants, ARMv5E extension, and conditional execution.**Thumb Instructions:** Thumb register usage, ARM Thumb inter working, Other branch instructions, data processing instructions, single register load store instructions, multiple register load store instructions, stack instructions, software interrupt instruction.	
Unit – II	**10 Hrs**
Programming in C for ARM: Overview of C Compilers and optimization, basic C data types, C looping structures, register allocation, function calls, pointer aliasing, structure arrangement, bit fields, unaligned Data and Endianess, division, floating point, inline functions and inline assembly, portability issues.	
Unit –III	**10 Hrs**
Writing and Optimizing ARM Assembly Code: Writing assembly code, profiling and cycle counting, instruction scheduling, register allocation, conditional execution, looping constructs, Bit manipulation, efficient switches. Handling unaligned data	
Unit –IV	**10 Hrs**
Digital Signal Processing on ARM: Representing a digital signal, Introduction to DSP on the ARM, FIR filters, Realization of filters on ARM7 and Cortex M3, IIR Filters, Realization of filters on ARM7 and Cortex M3, CMSIS DSP Library	
Unit –V	**10 Hrs**
Exception and Interrupt Handling Exception Handling, Interrupts, Non-nested Interrupt handler, Re-entrant Interrupt handler Firmware & Boot loader Embedded **Operating Systems** Fundamental Components, Simple Operating System	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Describe the programmer's model of ARM processor and analyse the instruction set architecture to realize complex operations.
CO2:	Apply the optimization methods available for ARM architectures to design embedded software to meet given constraints with the help of modern engineering tools.
CO3:	Realize real time signal processing applications & primitive OS operations on different ARM architectures by making use of software libraries.
CO4:	Engage in self-study to formulate, design, implement, analyze and demonstrate an application realized on ARM development boards through assignments.

Reference Books	
1	Andrew N Sloss, Dominic Symes, Chris Wright, "ARM System Developers Guide", Elsevier, Morgan Kaufman publishers, 2008, ISBN-13:9788181476463
2	David seal, "ARM Architecture Reference Manual", Addison-Wesley, 2nd Edition, 2009, ISBN-13:9780201737196
3	Steve Furber, "ARM System on Chip Architecture", Pearson Education Limited,2nd Edition, ISBN-13:9780201675191
4	Technical reference manual for ARM processor cores, including Cortex, ARM 11, ARM 9 & ARM 7 processor families.
5	User guides and reference manuals for ARM software development and modeling tools.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 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 complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III 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	2	2	3									
CO2	3	2	2	3				2	2			
CO3	2	2	3	3				2	2			
CO4	3	3	3	3	2	3	2	3	3	3	2	3

High-3: Medium-2: Low-1

Semester: VII						
SPEECH PROCESSING **(Group F: Professional Core Elective)** **(Theory)**						
Course Code	**:**	16EC7F3		**CIE**	**:**	100 Marks
Credits: L:T:P:S	**:**	4:0:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	50L		**SEE Duration**	**:**	03 Hours

Course Learning Objectives: The students will be able to

1	Develop the students mathematical, scientific, and computational skills relevant to the field of biomedical signal processing.
2	Enhance the students ability in formulating problems and designing analysis tools for biological signals.
3	Increase the students awareness of the complexity of various biological phenomena and cultivate an understanding of the same
4	Foster effective interaction skills and teamwork communication

Unit-I	**10 Hrs**
Introduction to digital speech signal processing: Digitization and recording, Human speech production and source filter model, Place and manner at articulation, Articulatory and acoustic phonetics, Uniform tube modeling of speech processing, Human auditory system, Speech perception.	
Unit – II	**10 Hrs**
Time Domain Models for Speech Processing: Time dependent representation of speech, Short time average zero crossing rate, Speech vs. silence discrimination using energy and zero crossing, pitch period estimation using parallel processing approach, short time autocorrelation function, Short time average magnitude difference function, Pitch period estimation using autocorrelation function.	
Unit –III	**10 Hrs**
Short Time Fourier Analysis: introduction, Definitions and properties, Fourier transform interpretation, linear filtering interpretation, Sampling rates of X(ejw) in time and frequency, Filter bank summation method of short time synthesis, Spectrographic displays.	
Unit –IV	**10 Hrs**
Feature extraction: Extraction of Fundamental frequency, Frequency domain fundamental frequency detection algorithm, Segmental and supra segmental features of speech signal, Cepstral transform coefficients parameters extraction, Mel-frequency Cepstral coefficients, MFCC features vector.	
Unit –V	**10 Hrs**
Speech based Applications: Text to speech synthesis, Automatic speech recognition, Statistical modelling of automatic speech recognition, and Speech based technology development for e learning.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Analyze the basic signal processing techniques in biological signals
CO2:	Apply basic mathematical, scientific and computational skills necessary to analyze biomedical signals.
CO3:	Formulate and solve basic problems in biomedical signal analysis.
CO4:	Design of Signal processing algorithm to be used in DSP Processor

Reference Books

1	L R Rabiner and R W Schafer, "Digital Processing of Speech Signals", Pearson Education 2004. ISBN: 0-13-213603-1
2	Sadoaki Furui, "Digital Speech Processing, Synthesis and Recognition", Second Edition,Mercel Dekk er 2002. ISBN-13: 978-0824704520
3	Rabiner and B.Juang,"Fundamentals of Speech Recognition," Pearson Education, 2004, ISBN-13: 978-0130151575
4	Thomas F. Quatieri ,"Discrete-Time Speech Signal Processing: Principles and Practice", Prentice Hall; 1 edition (10 November 2008),ISBN:0-13-242942-X
5	L. R. Rabiner and R. W. Schafer , "Theory and Applications of Digital Speech Processing", Pearson; 1 edition (3 March 2010),ISBN: 978-0136034285

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 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 complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III 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**	**2**	**1**	**3**	**2**	**1**	**2**	**2**	**3**	**3**	**3**
CO2	**3**	**3**	**3**	**2**	**3**	**1**	**1**	**1**	**3**	**1**	**3**	**3**
CO3	**3**	**3**	**3**	**2**	**3**	**1**	**1**	**1**	**2**	**1**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**2**	**1**	**3**	**3**

High-3: Medium-2: Low-1

Semester: VII						
Radio Frequency Integrated Circuits Design						
Course Code	**:**	16EC7F4		**CIE**	**:**	100 Marks
Credits: L:T:P:S	**:**	4:0:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	50L		**SEE Duration**	**:**	03 Hours

Course Learning Objectives: The students will be able to	
1	Define and demonstrate the importance of radio frequency design.
2	Analyze the functionality and design issues of RF circuits and systems.
3	Design and implement RF transceiver.
4	Evaluate the different performance parameters used in RF design.

Unit-I	**10 Hrs**
Introduction to RF Design and Wireless Technology - various disciplines in RF design, RF design hexagon. **Basic concepts in RF design -** Units in RF design, Nonlinearity and Time Variance, Effects of nonlinearity – harmonic distortion, gain compression – 1 dB compression point, desensitization, blocking, cross modulation, intermodulation – third intercept point, cascaded nonlinear stages – IM spectra in a cascade.	
Unit – II	**10 Hrs**
Noise in RF circuits - Representation of noise in circuits – input referred noise, Noise figure, Noise figure of cascaded stages, Noise figure of lossy circuits, Sensitivity, dynamic range – spurious free dynamic range (SFDR). **Transceiver architectures** – channel selection and band selection, Heterodyne – constant LO and constant IF downconversion, problem of image, image rejection vs channel selection, dual IF topology, Homodyne – simple homodyne and homodyne with quadrature down conversion, issues in homodyne receivers, Image Reject – Hartley & Weaver architecture. Transmitter architectures - Direct conversion and two-step transmitters.	
Unit –III	**10 Hrs**
Passive impedance transformation – Quality factor, series to parallel conversion, basic matching networks- L, T, Pi-match networks, tapped inductor and capacitor networks **Low noise Amplifier -** Performance parameters, Problem of Input matching, CS stage with inductive load, Cascode CS stage with inductive degeneration (MOSFET circuits only), Noise figure calculation.	
Unit –IV	**10 Hrs**
Mixer - Performance parameters, Mixer noise figures, single balanced and double balanced (active and passive) – working (MOSFET circuits only) **Oscillators** - Performance parameters, Feedback view and one port view of oscillators, Cross coupled oscillator, three point oscillators, (MOSFET circuits only), Ring oscillators.	
Unit –V	**10 Hrs**
Phase Locked Loops - Basic concepts - Phase detector, Type I PLL, Dynamics of simple PLL, Drawbacks of simple PLL, Type II PLLs - PFD, charge pump, charge pump PLL, PFD/CP Nonidealities (concepts only) – Up and Down Skew and Width Mismatch, Charge Injection and clock feedthrough.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Investigate the functionality of a typical RF system.
CO2:	Analyze CMOS circuits and its impact on Radio frequency IC design.

CO3:	Design and implement RF transceiver chain with specification.
CO4:	Evaluate the different performance parameters used in RF design using CAD tools.

Reference Books	
1	Behzad Razavi, "RF Microelectronics ", 2nd Edition Pearson Education, 2012
2	Thomas H Lee , "The Design of CMOS Radio Frequency Integrated Circuits",2nd Edition, Cambridge University Press, 2004
3	John Rogers ,Calvin Plett, "Radio Frequency Integrated Circuits Design", Artech House, 2003
4	Bosco Leung, "VLSI for Wireless Communications", Pearson Education, 2004

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 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 complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III 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	0	0	0	0	0	0	0	0	0	2
CO2	3	2	0	0	0	0	0	0	0	0	0	2
CO3	3	3	2	0	2	0	0	3	2	0	0	2
CO4	3	3	0	0	2	0	0	0	0	0	0	2

High-3: Medium-2: Low-1

Semester: VII						
HIGH PERFORMANCE COMPUTING **(Group F: Professional Core Elective)** **(Theory)**						
Course Code	**:**	16EC7F5		**CIE**	**:**	100 Marks
Credits: L:T:P:S	**:**	4:0:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	50L		**SEE Duration**	**:**	03 Hours

Course Learning Objectives: The students will be able to	
1	To review the trends in parallel programming.
2	To demonstrate the basic ideas of multiprocessing and parallel operations with case studies.
3	To expose to basics of parallel programming.
4	To demonstrate parallel programming using MPI, OpenAcc and OpenMP.

Unit-I	**10 Hrs**
Multiprocessors and Thread level parallelism: Introduction, Symmetric shared memory architectures; Performance of symmetric shared-memory multiprocessors, Distributed shared memory and directory-based coherence, Basics of synchronization, Models of memory consistency.	
Unit – II	**10 Hrs**
Data-Level Parallelism in Vector, SIMD, and GPU Architectures: Introduction, Vector Architecture, SIMD Instruction Set Extensions for Multimedia, Graphics Processing Units, Detecting and Enhancing Loop-Level Parallelism, Mobile versus Server GPUs and Tesla versus Core i7.	
Unit –III	**10 Hrs**
Introduction to Parallel Programming: Motivation, Scope of Parallel Computing, Principles of Parallel Algorithm design: Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for containing Interaction Overheads, Parallel Algorithms Models.	
Unit –IV	**10 Hrs**
Programming Using the Using Message Passing Paradigm: Principles of Message Passing Programming, Building Blocks, MPI, Topologies and Embedding, Overlapping Communication with computation, Collective Communication and computation operations, Groups and Communicators.	
Unit –V	**10 Hrs**
GPU Programming using OpenACC: Serial to parallel programming using OpenACC: A Simple Data-Parallel Loop, Task-Parallel Example, Amdahl's Law and Scaling, Parallel Execution and Race Conditions, Lock-Free Programming, Controlling Parallel Resources. **Pipelining data transfers with OpenACC:** Introduction to Pipelining, Mandelbrot Generator, Pipelining Across Multiple Devices.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explore the fundamentals of high-performance computing concepts.
CO2:	Analyze the performance of parallel programming.
CO3:	Design parallel computing constructs for different applications.
CO4:	Demonstrate Parallel computing concepts for suitable applications.

Reference Books	
1	Introduction to Parallel Computing, Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, 2nd Edition, 2013, Pearson Education, ISBN 13: 9788131708071.

2	CUDA Programming: A Developers Guide to Parallel Computing with GPUs, Shane Cook, 1st Edition, 2013, Morgan Kaufmann, ISBN:9780124159334.
3	Parallel Programming with Open ACC, Rob Farber, 1st Edition, 2016, Morgan Kaufmann (MK) Publication, ISBN :9780124103979.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Semester End Evaluation (SEE); Theory (100 Marks)

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

High-3: Medium-2: Low-1

Semester: VII						
INTEGRATED PHOTONICS **(Group F: Professional Core Elective)** **(Theory)**						
Course Code	**:**	16EC7F6		**CIE**	**:**	100 Marks
Credits: L:T:P:S	**:**	4:0:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	50L		**SEE Duration**	**:**	03 Hours

Course Learning Objectives: The students will be able to	
1	Learn the fundamental principles of photonics and light-matter interactions
2	Explain and illustrate light guiding, calculate wave propagation in waveguide systems
3	Calculate characteristics of optical resonators
4	Develop the ability to formulate problems related to photonic structures/processes and analyze them

Unit-I	**10 Hrs**
Introduction to EM theory: EM wave in dielectric media, Monochromatic EM waves, Absorption and Dispersion, Pulse propagation in Dispersive media, Polarization of light, Reflection and Refraction, Optics in Anisotropic media.	
Unit – II	**10 Hrs**
Photonic-crystal optics: Optics of Dielectric layered media, 1D & 2D Photonic crystals.	
Unit –III	**10 Hrs**
Guided wave optics: Planar mirror waveguides, 2D waveguides, Photonic-Crystal waveguides, Optical coupling in waveguides.	
Unit –IV	**10 Hrs**
Resonator optics: Planar-Mirror Resonators, 2D & 3D resonators, Microresonators.	
Unit –V	**10 Hrs**
Non-linear optics: Non-linear media, Second-order Non-linear optics, Third-order Non-linear optics.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Define and explain the propagation of light in conducting and non-conducting media.
CO2:	Define and explain the physics governing laser behaviour and light matter interaction
CO3:	Apply wave optics and diffraction theory to a range of problems
CO4:	Calculate properties of and design modern optical fibres and photonic crystals.

Reference Books	
1	B.E.A. Saleh, M.C. Teich, "Fundamentals of Photonics", Wiley India Pvt Ltd; 2nd edition, 2012, ISBN: 9788126537747
2	A. Yariv and P. Yeh," Photonics - Optical Electronics in Modern Communications"; Oxford University Press, 6th Edition, ISBN: 0195179463
3	John D. Joannopoulos, Steven G. Johnson, Joshua N. Winn, and Robert D. Meade, "Photonic Crystals – Molding the Flow of Light", Princeton University Press; 2nd Revised edition, 2013, ISBN-10: 0691124566
4	M. Jamal Deen and P.K. Basu, "Silicon Photonics - Fundamentals and Devices", John Wiley & Sons Ltd.,3rd Edition 2010,ISBN: 0-321-26977-2

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 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 complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III 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**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**
CO2	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**
CO3	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**
CO4	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**

High-3: Medium-2: Low-1

Semester: VII						
NANOELECTRONICS **(Group F: Professional Core Elective)** **(Theory)**						
Course Code	**:**	16EC7F7		**CIE**	**:**	100 Marks
Credits: L:T:P:S	**:**	4:0:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	50L		**SEE Duration**	**:**	03 Hours

Course Learning Objectives: The students will be able to

1	Develop substantial understanding of contemporary relevance and potential of nanoelectronics;
2	Develop appreciation of how factors like scaling and dimension lead to novel behaviour of nanoelectronic components;
3	Develop understanding of the importance of quantum ideas and their place in modelling of nanoelectronic phenomena and devices;
4	Expose to a variety of nanoelectronic phenomena, nanoelectronic components and their possible applications.

Unit-I	**10 Hrs**
Review of Electrons Quantum mechanics: Electrons wave particle duality**,** Wave equation, Wave packets and uncertainty, Schrodinger's Equation, The Time Independent Schrödinger Equation, Stationary States, The Infinite Square Well, The Harmonic Oscillator	
Unit – II	**10 Hrs**
Free and confined electrons: Free electrons, One-Dimensional space, three-dimensional space, Electrons Confined to a Bounded Region of Space, and Quantum Numbers, Periodic boundary conditions, Fermi level and Chemical potential	
Unit –III	**10 Hrs**
Partially Confined Electrons: Finite Potential Wells, Parabolic well, triangular well, Electrons Confined to Atoms, Quantum Dots, Wires, and Wells, Electrons in periodic potential, Kronig-Penney of Band structure	
Unit –IV	**10 Hrs**
Tunnel junctions and applications of tunneling: Tunneling Through a Potential Barrier, Potential Energy Profiles for Material Interfaces, Applications of Tunneling, Field Emission, Gate—Oxide Tunneling and Hot Electron Effects in MOSFETs, Scanning Tunneling Microscope, Double Barrier Tunneling and the Resonant Tunneling Diode	
Unit –V	**10 Hrs**
Coulomb blockade and the single-electron transistor: Tunnel Junction Excited by a Current Source, Coulomb Blockade in a Quantum Dot Circuit, The Single-Electron Transistor, Single-Electron Transistor Logic, Other SET and FET Structures, Carbon Nanotube Transistors (FETs and SETs), Semiconductor Nanowire FETs and SETs, Molecular SETs and Molecular Electronics	

Course Outcomes: After completing the course, the students will be able to

CO1:	Define novel behaviour of nanoelectronic devices and quantum behaviour of matter at the nano scale & modelling of nanoelectronic devices.
CO2:	Comprehend principles of devices such as tunneling diodes, single electron transistor, spintronic devices.
CO3:	Analysis fundamental concepts and methods of Analysis quantum tunneling, resonant tunneling, Coulomb blockade, density of quantum states, quantum statistics and quantum modelling.

CO4:	Evaluate nano scale effects in futuristic electron devices & quantum level computing

Reference Books	
1	George W. Hanson, "Fundamentals of Nanoelectronics", Pearson, 1e, (2009), ISBN: 978-8131726792
2	Charles P. Poole, Jr., Frank J. Owens, "Introduction to Nanotechnology", Wiley (15 January 2007), ISBN:978-8126510993
3	Rainer Waser,"Nanoelectronics and Information Technology", Wiley VCH; 3rd Revised edition edition(2012), ISBN: 978-3527409273
4	Chattopadhyay K.K, "Introduction to Nanoscience and Nanotechnology", PHI(2009), ISBN: 978-8120336087

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 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 complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III 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				1	2					2
CO2	3	2	1			1	2					2
CO3	3	3	2		2	1	2					2
CO4	3	3	3	2	2	1	2					2

High-3: Medium-2: Low-1

Semester: VII						
RADAR & NAVIGATION **(Group G: Professional Core Elective)** **(Theory)**						
Course Code	**:**	16EC7G1		**CIE**	**:**	100 Marks
Credits: L:T:P:S	**:**	4:0:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	48L		**SEE Duration**	**:**	03 Hours

Course Learning Objectives: The students will be able to	
1	Understand the basic operation of pulse and CW radar systems.
2	Evaluate the radar performance based on pulse width, peak power and beam width.
3	Choose suitable tracking radar for a given problem.
4	Understand the working of phased array radars and navigational aids

Unit-I	**10 Hrs**
Radar and Radar Equation: Introduction, Radar block diagram and operation, frequencies, applications, types of displays, derivation of radar equation, minimum detectable signal, probability of false alarm and threshold detection, radar cross-section, system losses.	
Unit – II	**10 Hrs**
CW Radar: Doppler Effect, CW Radar, applications, FM – CW radar, altimeter, Multiple Frequency Radar. Pulse Radar – MTI, Delay Line Canceller, Multiple Frequencies, Range-gated Doppler Filters, Non-coherent MTI, Pulse Doppler Radar	
Unit –III	**10 Hrs**
Tracking Radar: Sequential lobing, conical scanning, monopulse, phase comparison monopulse, tracking in range, comparison of trackers.	
Unit –IV	**09 Hrs**
Detection: Introduction, Matched Filter, Detection Criteria, Detector characteristics.	
Unit –V	**09 Hrs**
Phased Arrays: Basic concepts, feeds, phase shifters, frequency scan arrays, multiple beams, applications, advantages and limitations. Navigational Aids: Direction Finder, VOR, ILS and Loran	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the basic operation of pulse and CW radar systems.
CO2:	Evaluate the radar performance based on pulse width, peak power and beam width.
CO3:	Choose suitable tracking radar for a given problem.
CO4:	Select appropriate criterion for detecting a target.

Reference Books	
1	Williams. B. Ribbens, "Understanding Automotive Electronics", Elsevier science, 6th Edition, Newness publication,2003, ISBN-9780080481494.
2	Robert Bosch, "Automotive Electronics Handbook", John Wiley and Sons, 2004
3	Nicolas Navet, F Simonot-Lion "Automotive Embedded Systems Handbook", Industrial Information Technology Series, CRC press.
4	Uwekiencke and lars Nielsen, "Automotive Control Systems Engine, Driveline and vehicle", Springer, 2nd Edition, 2005, ISBN 0-387-95368X

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted

online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 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 complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III 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**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO2	**3**	**2**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO3	**3**	**2**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO4	**3**	**1**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	

Semester: VII						
AUTOMOTIVE ELECTRONICS **(Group G: Professional Core Elective)** **(Theory)**						
Course Code	**:**	16EC7G2		**CIE**	**:**	100 Marks
Credits: L:T:P:S	**:**	4:0:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	48L		**SEE Duration**	**:**	03 Hours

Course Learning Objectives: The students will be able to

1	Acquire the knowledge of automotive domain fundamentals, need of Electronics and communication interfaces in Automotive systems.
2	Apply various types of sensors, actuators and Motion Control techniques in Automotive systems
3	Understand digital engine control systems and Embedded Software's and ECU's used in automotive systems.
4	Analyse the concepts of Diagnostics, safety and advances in Automotive electronic Systems.

Unit-I	**10 Hrs**
Fundamentals of Automotive: Use of Electronics in Automotive, Evolution of Electronics in Automotive, Automotive Systems, The Engine, Engine Control, Internal Combustion Engines, Spark Ignition Engines and Alternative Engines. Ignition System, Ignition Timing, Drivetrain, Suspensions, Brakes and Steering Systems, Demonstration of Four Cylinder manual transmission Engine. **Basics of electronic engine control:** Motivation for Electronic Engine Control – Exhaust Emissions, Fuel Economy, Concept of an Electronic Engine control system, Definition of General terms, Definition of Engine performance terms, Engine mapping, Effect of Air/Fuel ratio, spark timing and EGR on performance, Control Strategy, Electronic Fuel control system, Analysis of intake manifold pressure, Electronic Ignition.	
Unit – II	**10 Hrs**
Automotive Sensors and Actuators: System Approach to Control and Instrumentation: Concept of A System, Analog and Digital Systems, Basic Measurement Systems, Analog and Digital Signal Processing, Automotive Control System Applications of Sensors and Actuators, **Sensors:** Air Flow Sensor, Engine Crankshaft Angular Position Sensor, Throttle Angle Sensor, Temperature Sensor, Sensors for Feedback Control, Sensors for Driver Assistance System: Radar, Lidar, Video Technology. **Actuators:** Solenoids, Piezo Electric Force Generators, Electric Motors and Switches.	
Unit –III	**10 Hrs**
Digital Engine Control Systems: Digital Engine control features, Control modes for fuel Control (Seven Modes), EGR Control, Electronic Ignition Control - Closed Loop Ignition timing, Spark Advance Correction Scheme, Integrated Engine Control System - Secondary Air Management, Evaporative Emissions Canister Purge, Automatic System Adjustment, System Diagnostics. **Vehicle Motion Control:** Typical Cruise Control System, Digital Cruise Control System, Digital Speed Sensor, Throttle Actuator, Digital Cruise Control configuration, Cruise Control Electronics (Digital only), Antilock Brake System (ABS)	
Unit –IV	**09 Hrs**
Automotive Communication Systems: Automotive networking: Bus systems, Technical principles, network topology. Buses in motor vehicles: CAN, Flex Ray, LIN, Ethernet, IP, PSI5, MOST, D2B and DSI. **Automotive Embedded Software Development** Fundamentals of Software and software development lifecycles. Overview of AUTOSAR methodology and principles of AUTOSAR Architecture. Use of MoTeC M800 ECU in engine management and data Acquisition Solutions.	
Unit –V	**09 Hrs**

Diagnostics and Safety in Automotive:
Timing Light, Engine Analyzer, Electronic Control System Diagnostics: Onboard diagnostics, Off-board diagnostics, Expert Systems, Occupant Protection Systems – Accelerometer based Air Bag systems, Case study on ON-BOARD, OFF-BOARD diagnostics.
Advances in Automotive Electronic Systems: Alternative Fuel Engines, Electric and Hybrid vehicles, Fuel cell powered cars, Collision Avoidance Radar warning Systems, Navigation: Navigation Sensors, Radio Navigation, dead reckoning navigation, Video based driver assistance systems, Night vision Systems

Course Outcomes: After completing the course, the students will be able to	
CO1:	Acquire the knowledge of automotive domain fundamentals, need of Electronics and communication interfaces in Automotive systems.
CO2:	Apply various types of sensors, actuators and Motion Control techniques in Automotive systems
CO3:	Analyze digital engine control systems and Embedded Software's and ECU's used in automotive systems.
CO4:	Illustrate the concepts of Diagnostics, safety and advances in Automotive electronic Systems.

Reference Books	
1	Understanding Automotive Electronics, Williams. B. Ribbens, 6th Edition, 2003, Elsevier science, Newness publication, ISBN-9780080481494.
2	Automotive Electronics Handbook, Robert Bosch, 2004, John Wiley and Sons,

Continuous Internal Evaluation (CIE); Theory (100 Marks)
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Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 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 complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III 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	0	0	0	1	2					2
CO2	3	2	1	0	0	1	2					2
CO3	3	3	2	0	2	1	2					2
CO4	3	3	3	2	2	1	2					2

Low-1 Medium-2 High-3

Semester: VII						
MULTIMEDIA COMMUNICATION (Group G: Professional Core Elective) (Theory)						
Course Code	**:**	16EC7G3		**CIE**	**:**	100 Marks
Credits: L:T:P:S	**:**	4:0:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	48L		**SEE Duration**	**:**	03 Hours

Course Learning Objectives: The students will be able to	
1	Understand the basics of analog and digital video: video representation and transmission
2	Analyze analog and digital video signals and systems
3	Analyze the fundamental video processing techniques & acquire the basic skill of designing video compression
4	Design video transmission systems: error control and rate control

Unit-I	**10 Hrs**
Multimedia Communications: multimedia information representation, multimedia networks, multimedia applications, network QoS and application QoS	
Unit – II	**10 Hrs**
Text and image compression,, compression principles, text compression- Runlength,Huffman, LZW, Image compression- GIF, TIFF and JPEG.	
Unit –III	**10 Hrs**
Audio and video compression: Introduction, audio compression, DPCM, ADPCM, APC, LPC, video compression, video compression principles,	
Unit –IV	**09 Hrs**
Video compression standards: H.261, H.263, MPEG, MPEG 1, MPEG 2, MPEG-4 and Reversible VLCs,	
Unit –V	**09 Hrs**
The Internet: Introduction, IP datagrams, fragmentation, Ip address, ARP and RARP, QoS. Transport Protocol: Introduction, TCP/IP, TCP, UDP, RTP and RTCP.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Describe and describe various multimedia data.
CO2:	Analyze the representation of multimedia data.
CO3:	Describe the concept involved in MPEG4 standards.
CO4:	Develop algorithms for protocols like RTP,RTCP for multimedia communication .over mobile networks.

Reference Books	
1	Fred Halsall, "Multimedia Communications", Pearson education, 2001. ISBN: 8131709949, 978-8131709948
2	K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, "Multimedia Communication Systems", Pearson education, 2004.ISBN: 013031398X978-0130313980
3	Raif steinmetz, Klara Nahrstedt, "Multimedia: Computing, Communications and Applications", Pearson education, 2002,ISBN: 3540408673, 978-3540408673
4	John Billamil, Louis Molina, "Multimedia : An Introduction", PHI, 2002, ISBN: 1575765578, 978-1575765570

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 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 complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III 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	1	2	1	0	0	0					1
CO2	3	2	2	1	0	1	0					1
CO3	3	2	2	1	0	1	0					1
CO4	3	1	2	1	0	1	0					

Semester: VII						
VLSI TESTING FOR ICS **(Group G: Professional Core Elective)** **(Theory)**						
Course Code	**:**	16EC7G4		**CIE**	**:**	100 Marks
Credits: L:T:P:S	**:**	4:0:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	48L		**SEE Duration**	**:**	03 Hours
Course Learning Objectives: The students will be able to						
1	Understand different types of faults associated with logic circuits and types of testing by employing fault models to the logic circuits.					
2	Understand advanced methods of simulation and digital testing algorithms and use the appropriate methods for achieving fault coverage specifications in design.					
3	Explain the concepts Design for Testability					
4	Recognize different techniques in Built In Self-Test (BIST) such as MBIST and LBIST**.**					

Unit-I	**10 Hrs**
Introduction to Testing- Introduction to Testing, Role of testing VLSI circuits, VLSI trends affecting testing, Faults in digital circuits. **Fault Modeling**- Functional Testing, Structural Testing, Types of Fault Models, Stuck-at Faults, Bridging Faults, cross point faults, Fault Equivalence, Fault Dominance	
Unit – II	**10 Hrs**
Fault Simulation- Fault Simulation algorithm- Serial, Parallel, Deductive and Concurrent Fault Simulation. **Testability Measure** - Controllability, Observability, SCOAP measures for combinational and sequential circuits.	
Unit –III	**10 Hrs**
ATPG for Combinational Circuits- Path Sensitization Methods, Roth's D- Algorithm, Boolean Difference, Complexity of Sequential ATPG, Time Frame Expansion. **Design for Testability**- Ad-hoc, Structured DFT- Scan method, Scan Design Rules, Overheads of Scan Design, partial scan methods, multiple chain scan methods.	
Unit –IV	**09 Hrs**
Self-test And Test Algorithms-Built-In self-Test, test pattern generation for BIST, response compaction - Parity checking, Ones counting, Transition Count, Signature analyser (SISR and MISR). Circular BIST, BIST Architectures.	
Unit –V	**09 Hrs**
Memory Testing-Testable Memory Design Test Algorithms, Reduced Functional Faults-MARCH and MAT+ algorithm. Test generation for Embedded RAMs. MBIST..	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Attain knowledge about testing, fault modeling & collapsing.
CO2:	Explore various fault simulation methods.
CO3:	Evaluate the significance of combinational ATPG and sequential test pattern generation.
CO4:	Get complete knowledge about different methods of LBIST and MBIST associated with testing.

Reference Books	
1	L. T. Wang, C. W. Wu, and X. Wen, VLSI Test Principles and Architectures, Morgan Kaufmann, 2006, ISBN-13: 978-0-12-370597-6, ISBN-10: 0-12-370597-5.
2	Parag.K.Lala "Digital Circuit Testing and Testability" Academic Press.
3	M. L. Bushnell and V. D. Agrawal, *Essentials of Electronic Testing for Digital, Memory, and Mixed-Signal VLSI Circuits*, Kluwer Academic Publishers, 2000, ISBN: 0-7923-7991-8.
4	M. Abramovici, M. A. Breuer, and A. D. Friedman, Digital Systems Testing and Testable Design, Computer Science Press, 1990, ISBN: 0-7167-8179-4.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 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 complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III 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	2	2	2	0	2	0	0			1		1
CO2	2	2	2	1	2	0	0			1		1
CO3	2	3	2	2	2	0	0			1		1
CO4	2	3	2	3	2	0	0			1		1

Low-1 Medium-2 High-3

Semester: VII						
HIGH SPEED DIGITAL DESIGN **(Group G: Professional Core Elective)** **(Theory)**						
Course Code	**:**	16EC7G5		**CIE**	**:**	100 Marks
Credits: L:T:P:S	**:**	4:0:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	48L		**SEE Duration**	**:**	03 Hours
Course Learning Objectives: The students will be able to						
1	Understand analog circuit principles relevant to high speed digital design.					
2	Analyze power distribution and noise in Power supply network and signaling over transmission lines.					
3	Demonstrate the functionality of different clocked and non clocked digital circuits and memory elements.					
4	Analyze the performance of clocked, non clocked and latching circuits.					

Unit-I	**10 Hrs**
The Interconnect: Introduction, Interconnect Modelling, Resistance, Capacitance, Inductance, Skin Effect, Temperature Dependence, Interconnect Impact: Delay, Energy, Crosstalk, Inductive Effects, An Aside on Effective Resistance and Elmore Delay, Interconnect Engineering, Width, Spacing, and Layer, Repeaters, Crosstalk Control, Low-Swing Signalling, Regenerators, Logical Effort with Wires.	
Unit – II	**10 Hrs**
Introduction to high speed digital design: Frequency, time and distance issues in digital VLSI design. Capacitance and inductance effects, high speed properties of logic gates, speed and power. Modeling of wires, geometry and electrical properties of wires, Electrical models of wires, transmission lines, lossless LC transmission lines, lossy RLC transmission lines and special transmission lines.	
Unit –III	**10 Hrs**
Power distribution and Noise: Power supply network, local power regulation, IR drops, area bonding. On-chip bypass capacitors and symbiotic bypass capacitors. Power supply isolation. Noise sources in digital systems, power supply noise, crosstalk and inter symbol interference. Power distribution on chips.	
Unit –IV	**09 Hrs**
Clocked & non clocked Logics:Non clocked Logic Styles: Static CMOS, DCVS Logic, Non-Clocked Pass Gate Families**Clocked Logic Styles**: Single-Rail Domino Logic, Dual-Rail Domino Structures	
Unit –V	**09 Hrs**

Latching Strategies: Basic Latch Design, and Latching single-ended logic and Differential Logic, Race Free Latches for Pre-charged Logic Asynchronous Latch Techniques, DDR memories.

Course Outcomes: After completing the course, the students will be able to	
CO1:	Investigate the special requirements that are imposed on high speed digital design.
CO2:	Analyze the characteristics of transmission lines and high speed latches and circuits.
CO3:	Analyze the Signaling convention in transmission media and high speed digital logics.
CO4:	Evaluate the performance of various transmission lines and high speed digital circuits.

Reference Books	
1	William S. Dally & John W. Poulton, "Digital Systems Engineering", Cambridge University Press, 1998. ISBN 0-521-59292-5
2	Neil H. E. Weste David Money Harris, "CMOS VLSI Design: A Circuit and Systems Perspective" Pearson Publication, 4th Edition,2011, ISBN 13: 978-0-321-54774-3
3	Kerry Bernstein, Keith M. Carrig, Christopher M. Durham, Patrick R. Hansen, David Hogenmiller, Edward J. Nowak, Norman J. Rohrer., "High Speed CMOS Design Styles", Kluwer Academic Publishers in 1999, ISBN 978-1-4613-7549-4.
4	Masakazu Shoji, "High Speed Digital Circuits", Addison Wesley Publishing Company, 1996. *ISBN* 978-0201634839.
5	Howard Johnson & Martin Graham, "High Speed Digital Design" A Handbook of Black Magic, Prentice Hall PTR, 1993.
6	Jan M.Rabaey, Anantha Chadrakasan, Borivoje Nikolic, "Digital Integrated Circuits: A Design Perspective", (2/e), Pearson 2016, ISBN-13: 978-0130909961.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 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 complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III 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	0	0	0	1	2					2
CO2	3	2	1	0	0	1	2					2
CO3	3	3	2	0	2	1	2					2
CO4	3	3	3	2	2	1	2					2

Low-1 Medium-2 High-3

Semester: VII						
MEMS AND SMART SYSTEMS **(Group G: Professional Core Elective)** **(Theory)**						
Course Code	**:**	16EC7G6		**CIE**	**:**	100 Marks
Credits: L:T:P:S	**:**	4:0:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	48L		**SEE Duration**	**:**	03 Hours

Course Learning Objectives: The students will be able to

1	Explain the operation principles of advanced micro- and smart systems.
2	Describe the technology to fabricate advanced micro- and smart systems.
3	Understand different methods to fabricate MEMS devices.
4	Present the basics of implementation of MEMS into products

Unit-I	**10 Hrs**
Introduction to Micro and Smart Systems: Introduction, Microsystem vs MEMS, Smart Materials, structures and system, Integrated Microsystems, Application of Smart Materials and Microsystems. Feynman's vision, Evolution of micro-manufacturing. Multi-disciplinary aspects. Applications areas. Commercial products. **Modelling:** Scaling issues, Scaling in geometry, Scaling in rigid body dynamics, scaling in electrostatic forces, scaling in electromagnetic forces, scaling in electricity, scaling in fluid dynamics. scaling effects in the optical domain, scaling in biochemical phenomena.	
Unit – II	**10 Hrs**
Micro and Smart Devices and Systems: Principles Definitions and salient features of sensors, actuators, and systems. Sensors: silicon capacitive accelerometer, piezo-resistive pressure sensor, Actuators: silicon micro-mirror arrays, magnetic micro relay, piezo-electric based inkjet printhead, electro-thermal actuator. portable blood analyzer, fiber optic sensors,Electrostatic Comb drive, Microsystems at Radio frequency.	
Unit –III	**10 Hrs**
Materials: Introduction, Substrates and Wafers, Active substrate materials, Si as a substrate material, Si compounds, Si Piezoresistors, Gallium Arsenide, Quartz, Piezoelectric Crystals and Polymers. **Micro Manufacturing and Material Processing:** Silicon wafer processing, Oxidation , CVD, PVD , lithography, thin-film deposition, etching (wet and dry), wafer-bonding, and metallization, Silicon micromachining: surface, bulk , bonding based process flows.	
Unit –IV	**09 Hrs**
Electronics Circuits for Micro and Smart Systems: Electronic Amplifiers, Signal Conditioning Circuits: Differential Amplifier, Instrumentation Amplifier, Wheatstone Bridge, Phase Locked Loop, Analog to Digital Conversion, Practical Signal Conditioning Circuits: Differential Charge Measurement, Switched Capacitor circuits, Circuits for frequency measurement shifts.	
Unit –V	**09 Hrs**
Electronics, Circuits and Packaging: Micro Systems Packaging, objectives and special issues in micro system packaging, Types of Microsystem Packages ,Packaging Technologies **Case study of devices** Cantilevers, Pressure sensors, accelerometers, micro heater.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Describe main principles of MEMS and smart systems.
CO2:	Demonstrate confidence in MEMS and smart systems through practical experience using typical modern Computer Aided Design software for this task.
CO3:	Apply a concept of a micro- and smart systems into a real device considering the scaling laws and boundary conditions involved.

CO4:	Evaluate the principles and processes involved in the implementation of MEMS devices

Reference Books	
1	Tai-Ran Tsu, "MEMS & Microsystems: Design and Manufacture", Tata Mc-Graw-Hill.ISBN-13:9780070487093
2	K.J.Vinoy, G.K.Ananthasuresh, S.Gopalakrishnan, K.N.Bhat, "Micro and Smart Systems", Wiley India, ISBN: 9788126527151
3	S. D. Senturia, "Microsystems Design", Kluwer Academic Publishers, Boston, USA, 2001, ISBN 0-7923-7246-8.
4	Minhang Bao, "Analysis and Design Principles of MEMS Devices", Elsevier, Amsterdam, Netherlands, ISBN 0-444-51616-6.

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Semester End Evaluation (SEE); Theory (100 Marks)

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CO-PO Mapping												
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CO1	3	3	2	3	2	0	1			0		1
CO2	0	0	2	0	2	1	1		2	0		1
CO3	3	1	2	3	2	1	1	1	1	1		1
CO4	1	3	3	3	2	1	1	1	1	1		1

Low-1 Medium-2 High-3

Semester: VII						
IMAGE PROCESSING AND MACHINE LEARNING (Group H: Global Elective)						
Course Code	**:**	16G7H05		**CIE**	**:**	100 Marks
Credits: L:T:P:S	**:**	3:0:0:0		**SEE**	**:**	100 Marks
Total Hours	**:**	40L		**SEE Duration**	**:**	03 Hours

Course Learning Objectives: The students will be able to	
1	Understand the major concepts and techniques in image processing and Machine Learning
2	To explore, manipulate and analyze image processing techniques
3	To become familiar with regression methods, classification methods, clustering methods.
4	Demonstrate image processing and Machine Learning knowledge by designing and implementing algorithms to solve practical problems

Unit-I	**08 Hrs**
Introduction to image processing: Images, Pixels, Image resolution, PPI and DPI, Bitmap images, Lossless and lossy compression, Image file formats, Color spaces, Bezier curve, Ellipsoid, Gamma correction, Advanced image concepts	
Unit – II	**08 Hrs**
Basics of Python & Scikit image: Basics of python, variables & data types, data structures, control flow & conditional statements, uploading & viewing an image, Image resolution, gamma correction, determining structural similarities.	
Unit –III	**08 Hrs**
Advanced Image processing using Open CV Blending Two Images, Changing Contrast and Brightness Adding Text to Images Smoothing Images , Median Filter ,Gaussian Filter ,Bilateral Filter ,Changing the Shape of Images ,Effecting Image Thresholding ,Calculating Gradients , Performing Histogram Equalization	
Unit –IV	**08 Hrs**
Machine Learning Techniques in Image Processing Bayesian Classification, Maximum Likelihood Methods, Neural Networks; Non-parametric models; Manifold estimation, Support Vector Machines, Logistic Regression	
Unit –V	**08 Hrs**
Introduction to object Tracking , Modeling & Recognition Exhaustive vs. Stochastic Search, Shapes, Contours, and Appearance Models. Mean-shift tracking; Contour-based models, Adaboost approaches: Face Detection / Recognition, Tracking.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Gain knowledge about basic concepts of Image Processing
CO2:	Identify machine learning techniques suitable for a given problem
CO3:	Write programs for specific applications in image processing
CO4:	Apply different techniques for various applications using machine learning techniques.

Reference Books	
1	Practical Machine Learning and Image Processing: For Facial Recognition, Object Detection, and Pattern Recognition Using Python, Himanshu Singh, 1st Edition, Apress , ISBN:978-1-4842-4149-3

2	Pattern Recognition and Machine Learning, Christopher Bishop, 1st Edition, Springer, 2008, ISBN: 978-0387-31073-2
3	Computer Vision: A modern Approach, David Forsyth and Jean Ponce, 2nd Edition, Prentice Hall India 2004, ISBN: 978-0136085928
4	Machine Vision: Theory Algorithms Practicalities, E.R. Davies, 2nd Edition, Elsevier, ISBN: 978-0-12-386908-1.
5.	Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods Pearson Education, 3rd Edition, ISBN 978-81-317-2695-2.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 60 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10. **Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the 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 consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

VIII Semester		
Major Project		
Course Code: 16ECP81		**CIE Marks: 100**
Credits: L: T: P: S:: 0:0:16:0		**SEE Marks: 100**
Hrs/week: 32		**SEE Duration: 3 Hrs**

Course Learning Objectives: The students will be able to	
1	Acquire the ability to make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
2	Acquire the skills to communicate effectively and to present ideas clearly and coherently to a specific audience in both written and oral forms.
3	Acquire collaborative skills through working in a team to achieve common goals.
4	Self-learn, reflect on their learning and take appropriate action to improve it.
5	Prepare schedules and budgets and keep track of the progress and expenditure.

Major Project Guidelines:

The project topic, title and synopsis have to be finalized and submitted to their respective internal guide(s) before the beginning of the 8th semester.
The detailed Synopsis (approved by the department **Project Review Committee**) has to be submitted during the 1st week after the commencement of 8th semester.

Batch Formation:

- Students are free to choose their project partners from within the programme or any other programme.
- Each student in the team must contribute towards the successful completion of the project. The project may be carried out In-house / Industry / R & D Institution.
- ***The project work is to be carried out by a team of two to four students , in exceptional cases where a student is placed in a company and offered an internship through the competitive process or student is selected for internship at national or international level through competitive process,*** the student can work independently.
- ***The students are allowed to do either a project for full 5 days in the industry or full 5 days in the college.***
- ***In case the project work is carried out outside Bengaluru, such students must be available during Project Evaluation process scheduled by the respective departments and they must also interact with their guide regularly through Email / Webinar / Skype etc.***

Project Topic Selection:

The topics of the project work must be in the ***field of respective program areas or in line with CoE's(Centre of Excellence) identified by the college*** or **List of project areas as given by industry/Faculty. The projects as far as possible should have societal relevance with focus on sustainability.**

Project Evaluation:

- Continuous monitoring of project work will be carried out and cumulative evaluation will be done.
- The students are required to meet their internal guides once in a week to report their progress in project work.
- **Weekly Activity Report** (WAR) has to be maintained in the form of a diary by the project batch and the same has to be discussed with the Internal Guide regularly.
- In case of ***Industry project***, during the course of project work, the internal guides will have continuous interaction with external guides and will visit the industry at least twice during the project period.
- For CIE assessment the project groups must give a final seminar with the draft copy of the project report.
- The presentation by each group will be for 20-30 minutes and every member of the team needs to justify the contributions to the project.
- The project team is required to submit Hard copies of the detailed Project Report in the prescribed format to the department.
- For CIE 50% weightage should be given to the project guide and 50% weightage to the project evaluation committee.
- Before the final evaluations the project group is required to produce a No dues certificate from Industry, Central Library and Department.

Course Outcomes of Major Project:	
1	Apply knowledge of mathematics, science and engineering to solve respective engineering domain problems.
2	Design, develop, present and document innovative/multidisciplinary modules for a complete engineering system.
3	Use modern engineering tools, software and equipment to solve problem and engage in life-long learning to follow technological developments.
4	Function effectively as an individual, or leader in diverse teams, with the understanding of professional ethics and responsibilities.

CIE Assessment:

The following are the weightings given for the various stages of the project.

1. Selection of the topic and formulation of objectives 10%
2. Design and Development of Project methodology 25%
3. Execution of Project 25%
4. Presentation, Demonstration and Results Discussion 30%
5. Report Writing & Publication 10%

SEE Assessment:

The following are the weightages given during Viva Examination.

1. Written presentation of synopsis 10%
2. Presentation/Demonstration of the project 30%
3. Methodology and Experimental Results & Discussion 30%
4. Report 10%
5. Viva Voce 20%

VIII Semester		
Technical Seminar		
Course Code: 16ECS82		**CIE Marks: 50**
Credits: L: T: P: S:: 0:0:2:0		**SEE Marks: 00**
Hrs/week: 4		**SEE Duration: NA**

Course Learning Objectives: The students will be able to	
1	Recognize recent developments in specific program and in multidisciplinary fields.
2	Summarize the recent technologies and inculcate the skills for literature survey.
3	Demonstrate good presentation skills.
4	Plan and improve the Technical Report writing skills.
5	Support Group discussion and Team work.

General Guidelines for the Seminar

1. The seminar has to be presented by individual student.
2. The topic of the seminar should be from current thrust area along with consultation with the guide.
3. The topic can be based on standard papers (like IEEE/ACM/CSI etc.) in the thrust area for the selected topic.
4. Presenting/publishing this paper in conference/ Journal will be given weightage in CIE.
5. The student needs to submit both hard & soft copy of the seminar report.
6. **As Outcome of Technical Seminar, each student has to prepare a technical paper out of seminar topic.**

Course Outcomes of Technical Seminar:	
1	Communicate effectively on complex engineering problems and demonstrate contextual knowledge to assess societal and environmental contexts.
2	Identify, formulate, review research literature, analyze and Design solutions for complex engineering problems using appropriate techniques with effective documentation.
3	Analyze, interpret and synthesize the information to provide valid conclusions with innovative ideas and ethical principles.
4	Apply the knowledge of engineering specialization to suggest solutions to complex engineering problems and recognize the need for technological changes.

Evaluation of CIE Marks:

1. Relevance of the topic 10%
2. Literature Survey 10%
3. Presentation 40%
4. Report 20%
5. Paper Publication 20%

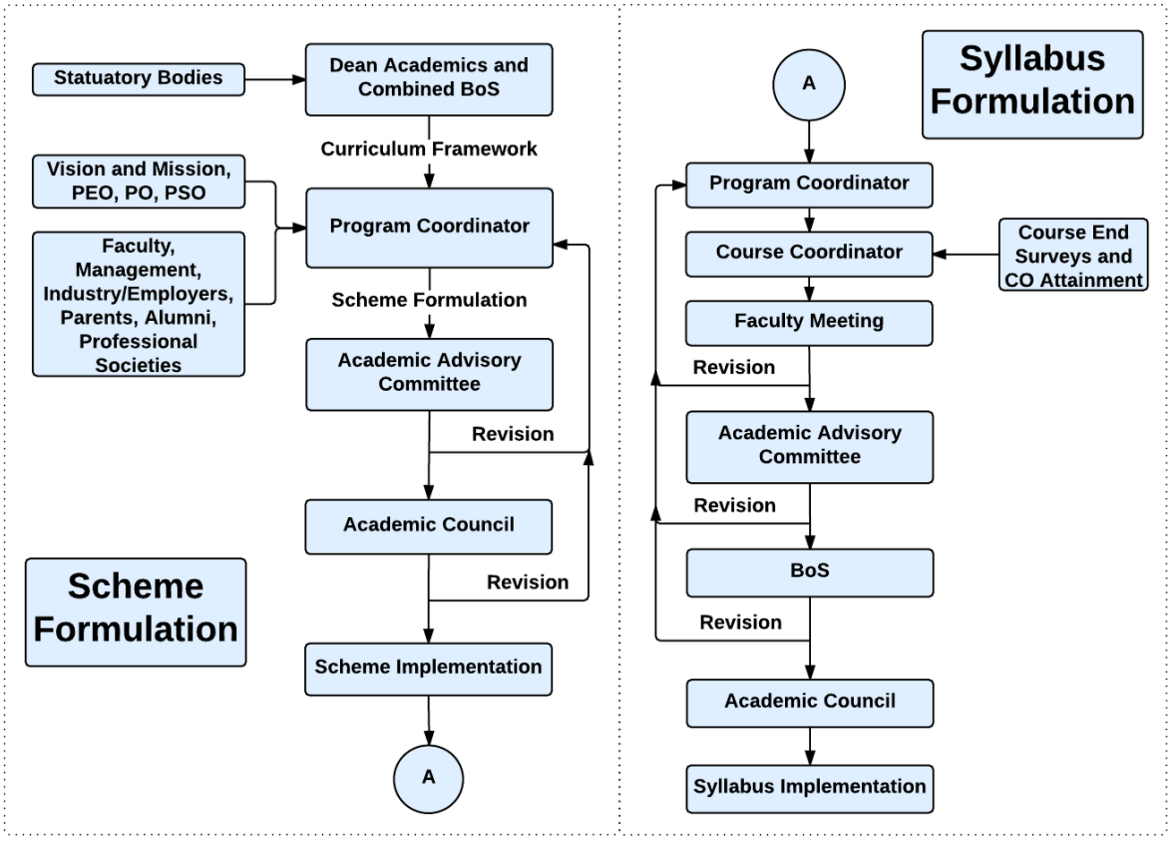
VIII Semester		
Innovation & Social Skills		
Course Code: 16HSS83		**CIE Marks: NA**
Credits: L: T: P: S:: 0:0:1:0		**SEE Marks: NA**
Hrs/week: 2		**SEE Duration: NA**
Course Learning Objectives: The students will be able to		
1	To provide a platform for the students to exhibit their organizational capabilities, team building, ethical values and extra mural abilities.	
2	To encourage to carryout innovative ideas and projects.	
3	Take part in societal and community building activities.	
4	Make self-learning, ethics and lifelong learning a motto.	

Guidelines

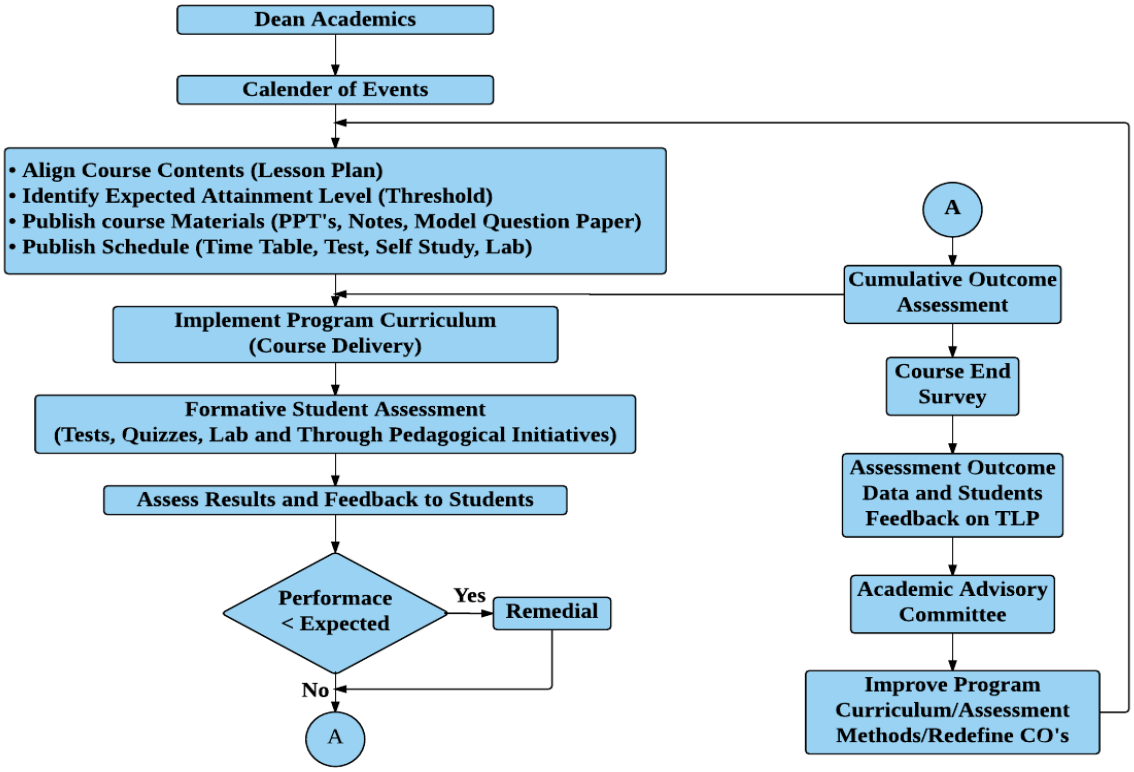
1. The HSS will be evaluated individually based on the broad parameters which include the progress made by student during 3rd& 4th year in innovative projects, Seminar, Paper Presentation, Field activity & other Co-curricular activities.
2. Students shall submit a report and documents as a proof his/her achievements.

Course Outcomes of Innovation & Social Skills:	
1	Apply the knowledge and skills for solving societal issues
2	Plan to work in team in various areas with inclusive effort and sustainability
3	Organize various events and use managerial and budgeting abilities
4	Demonstrate leadership qualities and ethics

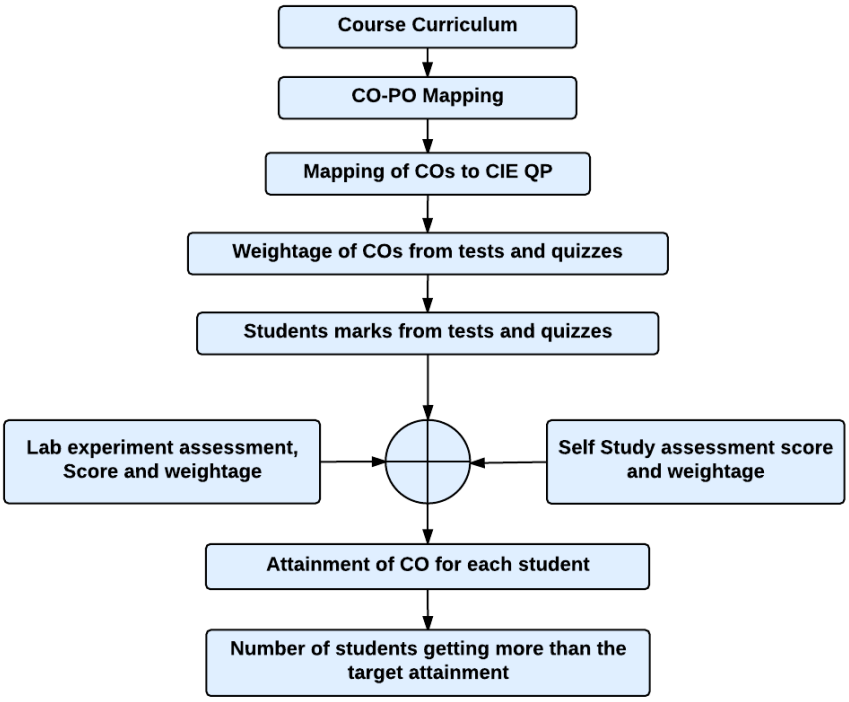
Curriculum Design Process



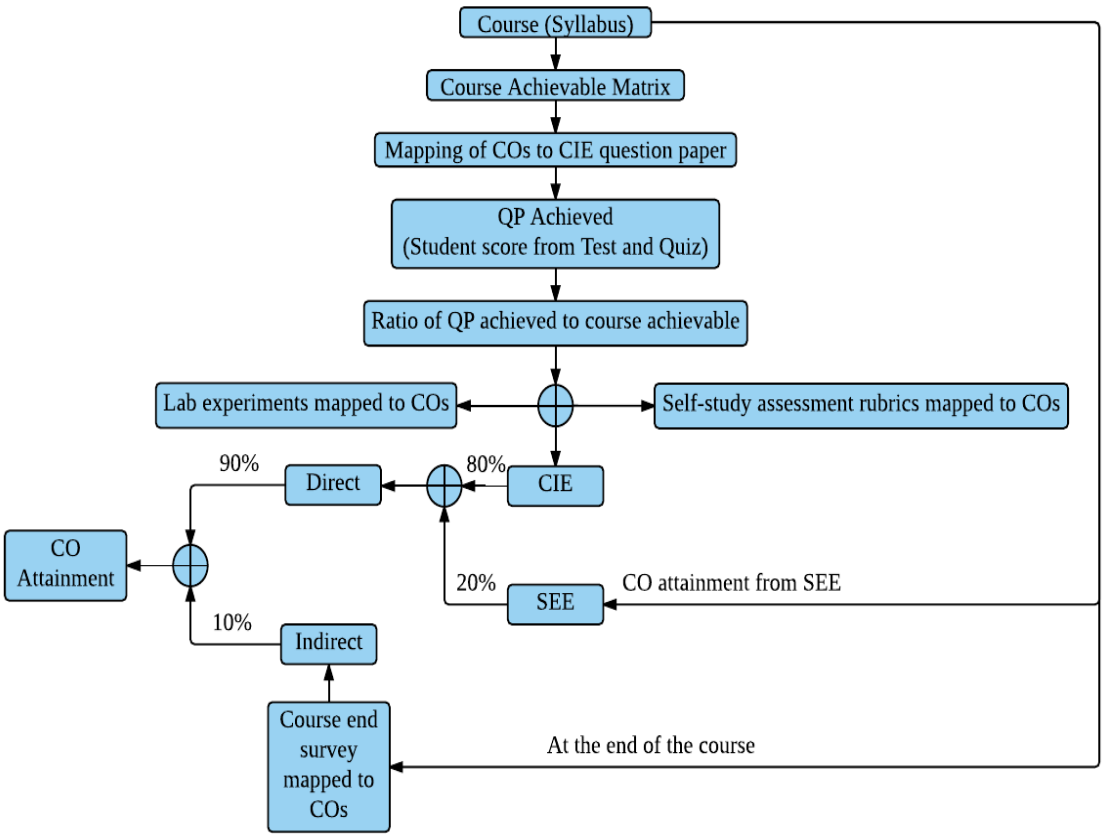
Academic Planning and Implementation



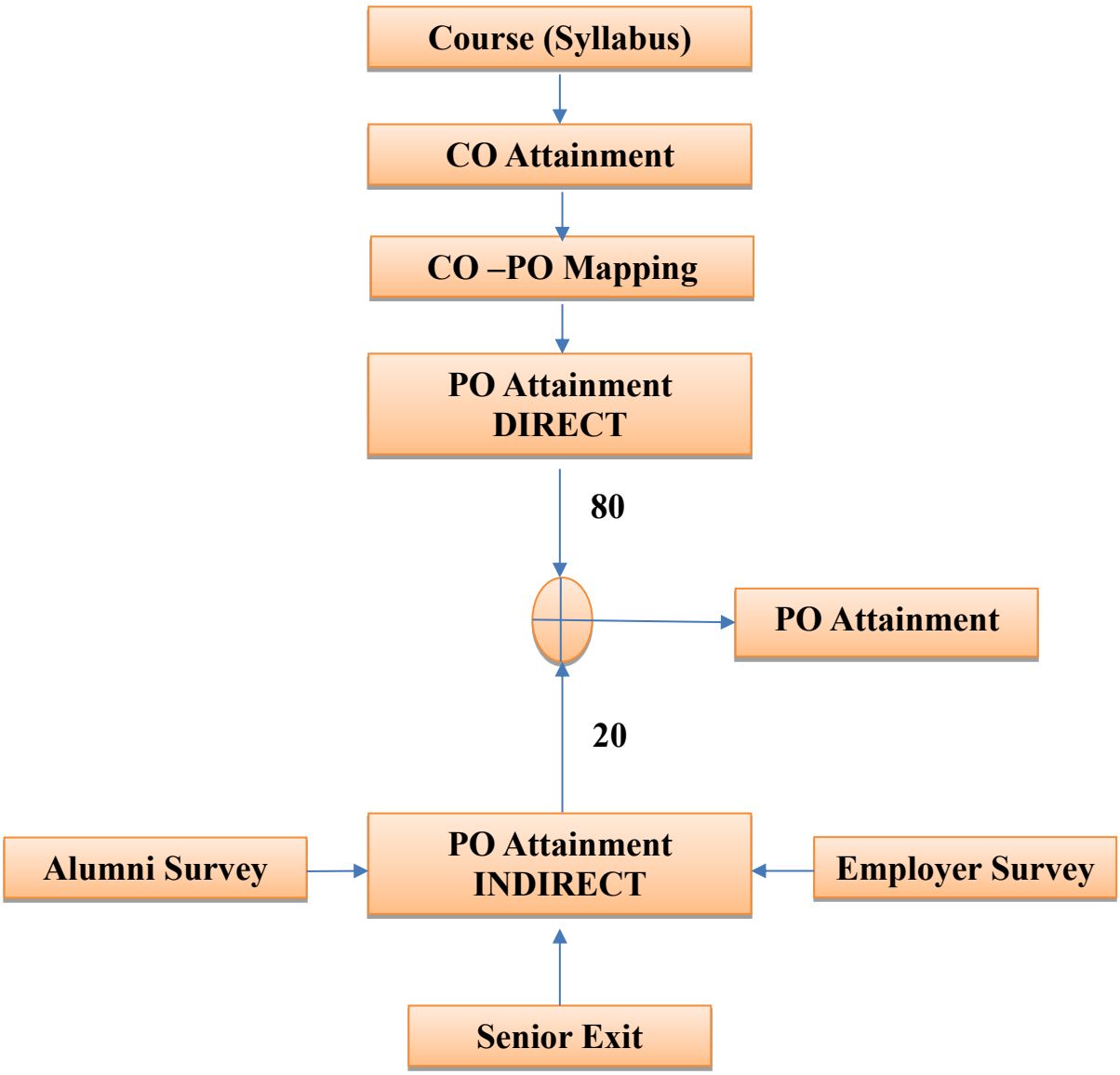
PROCESS FOR COURSE OUTCOME ATTAINMENT



Final CO Attainment Process



Program Outcome Attainment Process



Guidelines for Fixing Targets

- The target may be fixed based on last 3 years' average attainment

PROGRAM OUTCOMES (POs)

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation for the solution of complex engineering problems.

2. **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet t h e specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

4. **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.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling to complex engineering activities, with an understanding of the limitations.

6. **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.

7. **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.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with t h e society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **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.

12. **Life-long learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.