Sanjay Ghodawat University Kolhapur



School of Engineering and Technology
Department of Electronics and Communication Engineering

B. Tech. Electronics & Communication Engineering

Curriculum Structure and Syllabus (R23)

Semester: VII-VIII

Programme structure for B. Tech: Final Year Electronics and Communication Engineering

Semester VII: Teaching Scheme

Course code	Course name	Teaching scheme (Hrs/week)			Credits assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total Credits
UECPC701	Internet of Things System Design	3	-	-	3	-	-	3
UECPC702	Satellite Communication	3	-	-	3	-	-	3
UECPC703	Microwave and Radar Engineering	3	-	-	3	-	-	3
UECPE7XX	Program Elective IV	3	-	-	3	-	-	3
USTRM701	Research Methodology	3	-	-	3	-	-	3
UXXMM0XX	Multidisciplinary Minor V	2	-	-	2	-	-	2
UECPC704	Internet of Things System Design Lab	-	4	-	-	2	-	2
UECPC705	Microwave and Radar Engineering Lab	-	4	-	-	2	-	2
UECPE7XX	Program Elective IV Lab	-	2	-	-	1	-	1
UECPR701 **OR** UECEP701 **OR** UECRE701	Project Phase I (Industry Internship with Capstone Project Track) **OR** Entrepreneurship Project Phase I (Entrepreneurship Venture Track) **OR** Research Project Phase I (Higher Opportunity Track)	-	4	-	-	2	-	2
Total		**17**	**14**	-	**17**	**5**	-	**24**

Semester VII :Evaluation Scheme

Course code	Course name	Theory Marks					Practical Marks		Total
		Evaluation (Theory)				ESE	Term work	Practical Oral/POE	
		T1	T2	FET	Total				
UECPC701	Internet of Things System Design	10	10	5	25	50	-	-	75
UECPC702	Satellite Communication	10	10	5	25	50	-	-	75
UECPC703	Microwave and Radar Engineering	10	10	5	25	50	-	-	75
UECPE7XX	Program Elective IV	10	10	5	25	50	-	-	75
USTRM701	Research Methodology	10	10	5	25	50	-	-	75
UXXMM0XX	Multidisciplinary Minor V	10	-	5	15	35	-	-	50
UECPC704	Internet of Things System Design Lab	-	-	-	-	-	25	25	50
UECPC705	Microwave and Radar Engineering Lab	-	-	-	-		25	25	50
UECPE7XX	Program Elective IV Lab	-	-	-	-	-	25	-	25
UECPR701 **OR** UECEP701 **OR** UECRE701	Project Phase I (Industry Internship with Capstone Project) **OR** Entrepreneurship Project Phase I (Entrepreneurship Venture Track) **OR** Research Project Phase I (Higher Opportunity Track)	-	-	-	-	-	50	-	50
Total									**600**

Note: The Evaluation of Project Phase I is divided into two parts (Internal Assessment)

a) Preparation and presentation of the proposal of the Project (Motivation/ Relevance, Problem Statement, Literature Survey, Objectives, Methodology and design of the project) for 25marks.

b) Students shall present a seminar on the topic relevant to the Project work for 25 marks.

Programme structure for B. Tech: Final Year Electronics and Communication Engineering (R23)

Track I: Industry Internship with Capstone Project Track

Semester VIII: Teaching Scheme

Course code	Course name	Teaching scheme			Credits assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total credits
UECPE8XX	Program Elective V	3	-	-	3	-	-	3
UXXMM0XX	Multidisciplinary Minor VI	2	-	-	2	-	-	2
UECPR801	Project Phase-II	-	8	-	-	4	-	4
UECOT801	Internship/On job Training	-	24	-	-	12	-	12
Total		**9**	**24**	**-**	**9**	**12**	**-**	**21**

Semester VIII: Evaluation Scheme

Course code	Course name	Theory Marks					Practical Marks		Total
		Evaluation (Theory)				ESE	Evaluation (Lab)		
		T1	T2	FET	Total		Term work	Practical Oral/POE	
UECPE8XX	Program Elective V	10	10	5	25	50	-	-	75
UXXMM0XX	Multidisciplinary Minor VI	10	-	5	15	35	-	-	50
UECPR801	Project Phase-II	-	-	-	-	-	50	50	100
UECOT801	Internship/On job Training	-	-	-	-	-	200	100	300
Total									**525**

Note:

- Minimum passing is 40% for all courses and evaluation head mentioned above. FET – Faculty evaluation for Theory, T1, T2, Continuous Assessment Test, Term Work , SEE - Semester End Examination, P/F – Pass/ Fail Course, AU – Audit Course
- The Program Elective V and Multidisciplinary Minor VI shall be conducted in online mode, by faculty of SGU or other institute/ University. Students can also opt a course from MOOCs platforms such as SWAYAM, NPTEL, Coursera etc. In case there is no assessment and examination conducted by the MOOCs platforms then the assessment and examination will be conducted by SGU.
- Additional Credits for Bachelor's Degree- with Double Minor :12 Credits.

  These are additional credits to be offered from the second year to the final year and will be offered as an option to students.
- Additional Credits for Bachelor's Degree- with Honors: 16-20 Credits.

  These are additional credits from the same domain to be offered from the second year to the final year and will be offered as an option to students.
- Additional Credits for Bachelor's Degree- Honors with Research: Minimum 16-20 Credits.

  These are additional credits to be offered in the final year and will be offered as an option to students.

Programme structure for B. Tech: Final Year Electronics and Communication Engineering

(R25) Track II: Entrepreneurship Venture Track

Semester VIII: Teaching Scheme

Course code	Course name	Teaching scheme			Credits assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total credits
UECPE8XX	Program Elective V	3	-	-	3	-	-	3
UXXMM0XX	Multidisciplinary Minor VI	2	-	-	2	-	-	2
UECEP801	Online Course in Advanced Technology (domain area)	-	-	-	4	-	-	4
UECEP802	Entrepreneurship project Phase II	-	24	-	-	12	-	12
Total		**5**	**24**	**-**	**9**	**12**	-	**21**

Semester VIII: Evaluation Scheme

Course code	Course name	Theory Marks					Practical Marks		Total
		Evaluation (Theory)				ESE	Evaluation (Lab)		
		T1	T2	FET	Total		Term work	Practical Oral/POE	
UECPE8XX	Program Elective V	10	10	5	25	50	-	-	75
UXXMM0XX	Multidisciplinary Minor VI		10	5	15	35	-	-	50
UECEP801	Online Course in Advanced Technology (domain area)	-	-	-	25	75	-	-	100
UECEP802	Entrepreneurship project Phase II	-	-	-	-	-	200	100	300
								Total	**525**

Note:

- Minimum passing is 40% for all courses and evaluation head mentioned above. FET – Faculty evaluation for Theory, T1, T2, Continuous Assessment Test, Term Work , SEE - Semester End Examination, P/F – Pass/ Fail Course, AU – Audit Course
- The Program Elective V and Multidisciplinary Minor VI shall be conducted in online mode, by faculty of SGU or other institute/ University. Students can also opt a course from MOOCs platforms such as SWAYAM, NPTEL, Coursera etc. In case there is no assessment and examination conducted by the MOOCs platforms then the assessment and examination will be conducted by SGU.
- Additional Credits for Bachelor's Degree- with Double Minor :12 Credits.
  These are additional credits to be offered from the second year to the final year and will be offered as an option to students.
- Additional Credits for Bachelor's Degree- with Honors: 16-20 Credits.
  These are additional credits from the same domain to be offered from the second year to the final year and will be offered as an option to students.
- Additional Credits for Bachelor's Degree- Honors with Research: Minimum 16-20 Credits.
  These are additional credits to be offered in the final year and will be offered as an option to students.

Programme structure for B. Tech: Final Year Electronics and Communication Engineering
(R25) Track III: Higher Opportunity Track
Semester VIII: Teaching Scheme

Course code	Course name	Teaching scheme			Credits assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total credits
UECPE8XX	Program Elective V	3	-	-	3	-	-	3
UXXMM0XX	Multidisciplinary Minor VI	2	-	-	2	-	-	2
UECRE801	Online Course in Advanced Technology (domain area)	-	-	-	4	-	-	4
UECRE802	Research Project Phase II	-	24	-	-	12	-	12
Total		**5**	**24**	**-**	**9**	**12**	**-**	**21**

Semester VIII: Evaluation Scheme

Course code	Course name	Theory Marks					Practical Marks		Total
		Evaluation (Theory)				ESE	Evaluation (Lab)		
		T1	T2	FET	Total		Term work	Practical Oral/POE	
UECPE8XX	Program Elective V	10	10	5	25	50	-	-	75
UXXMM0XX	Multidisciplinary Minor VI	10	-	5	15	35	-	-	50
UECRE801	Online Course in Advanced Technology (domain area)	-	-	-	25	75	-	-	100
UECRE802	Research Project Phase II	-	-	-	-	-	200	100	300
Total									**525**

Note:

- Minimum passing is 40% for all courses and evaluation head mentioned above. FET – Faculty evaluation for Theory, T1, T2, Continuous Assessment Test, Term Work , SEE - Semester End Examination, P/F – Pass/ Fail Course, AU – Audit Course
- The Program Elective V and Multidisciplinary Minor VI shall be conducted in online mode, by faculty of SGU or other institute/ University. Students can also opt a course from MOOCs platforms such as SWAYAM, NPTEL, Coursera etc. In case there is no assessment and examination conducted by the MOOCs platforms then the assessment and examination will be conducted by SGU.
- Additional Credits for Bachelor's Degree- with Double Minor :12 Credits.
  These are additional credits to be offered from the second year to the final year and will be offered as an option to students.
- Additional Credits for Bachelor's Degree- with Honors: 16-20 Credits.
  These are additional credits from the same domain to be offered from the second year to the final year and will be offered as an option to students.
- Additional Credits for Bachelor's Degree- Honors with Research: Minimum 16-20 Credits.
  These are additional credits to be offered in the final year and will be offered as an option to students.

Program Electives (PEs)								
PE	**Course Code**	**Vertical I Signal Processing**	**Course Code**	**Vertical II VLSI**	**Course Code**	**Vertical III Automotive Electronics**	**Course Code**	**Vertical IV Data Science**
I	UECPE511	Digital Image Processing	UECPE521	Digital System Design using VHDL/Verilog	UECPE531	Power Electronics	UECPE541	Fundamentals of AI
II	UECPE611	Adaptive Signal Processing	UECPE621	Mixed-Signal VLSI Design	UECPE631	Industrial buses and drives	UECPE641	Data Warehousing and Mining
III	UEPC612	Computer Vision and Pattern Recognition	UECPE622	CMOS VLSI Design	UECPE632	Auto electronics	UECPE642	Machine Learning
IV	UECPE711	Signal Processing Applications in Communication	UECPE721	Low Power VLSI Design	UECPE731	Electric Vehicles	UECPE741	Augmented Reality (AR) & Virtual Reality (VR) Systems
IV lab	UECPE712	Signal Processing Applications in Communication lab	UECPE722	Low Power VLSI Design Lab	UECPE732	Electric Vehicles lab	UECPE742	Augmented Reality (AR) & Virtual Reality (VR) Systems Lab
V	UECPE811	Speech Processing	UECPE821	System on Chip Design	UECPE831	Electric Vehicle network	UECPE841	Natural Language Processing

Multidisciplinary Minor Offered by Department of Electronics & Communication Engineering

Minor in Wireless Communication				
Sr.No	**Code**	**Title of the Course**	**Credits**	**Semester**
1.	UECMM021	Electronic Communication Systems	2	III
2.	UECMM022	Electromagnetic Waves and Antennas	2	IV
3.	UECMM023	Digital Communication Fundamentals	2	V
4.	UECMM024	Wireless and Mobile Communication	2	VI
5.	UECMM025	Satellite Communication	2	VII
6	UECMM026	Next Generation Communication Network	2	VIII

Open Electives for B.Tech Programs Excluding E&C Engg.

Sr. No	Code	Course Name	Credits	Semester
1	UECOE01	Open Elective-I Semiconductor Devices	2	III
2	UECOE02	Open Elective-II Sensors & Instrumentation	2	IV
3	UECOE03	Open Elective-III Electronics Instruments & Measurements	2	V

Note:

- Students are advised to select the minor track from above list.
- Students are not allowed to select the minor track from the same department offering the major courses.

Program Elective IV							
Vertical I (Signal Processing)		**Vertical II (VLSI)**		**Vertical III (Automotive Electronics)**		**Vertical IV (Data Science)**	
Code	**Course Name**	**Code**	**Course Name**	**Code**	**Course Name**	**Code**	**Course Name**
U15PE711	Signal Processing applications in Communication	U15PE721	Low Power VLSI Design	U15PE731	Electric Vehicle	U15PE741	Augmented Reality (AR) & Virtual Reality (VR) Systems
U15PE712	Signal Processing applications in Communication lab	U15PE722	Low Power VLSI Design Lab	U15PE732	Electric Vehicle lab	U15PE742	Augmented Reality (AR) & Virtual Reality (VR) Systems lab

Theory Course

Course code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
U15PC701	Internet of Things System Design	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**
		03	-	-	03	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		Total (Marks)
U15PC701	Internet of Things System Design	**T1**	**T2**	**FET**	**Total**	**Min pass**	**Marks**	**Min pass**	
		10	10	5	25	40%	50	40%	75

Course Description:
This course deals with recent technology of Internet of Things advancing very rapidly and proving beneficial in many application areas This course starts with the principle and operation of Internet of Things architecture and basic building blocks. It also includes the systematic design process with the help of IoT standard protocols. This will equip the learners with essential skills and knowledge that are increasingly relevant in designing systems and applications to provide solutions for modern day challenges.

Pre-requisites: Digital and Wireless Communication, Microcontrollers and Embedded systems

Course Objectives:

- To understand the evolution of IoT communication systems.
- To illustrate IoT system Design process and challenges.
- To design IoT systems for various applications.
- To equip students with different sensors for IOT domain

Course Outcomes: After the successful completion of the course students will able to:

- CO1 **Define** the various concepts, terminologies and architecture of IoT systems.
- CO2 **Select** sensor for given IoT domain.
- CO3 **Illustrate** design process and mitigate the limitations in IoT applications.
- CO4 **Design** simple IoT system.

Course Contents

Module	Unit	Description	Hours
1.0		**Fundamentals of IoT systems**	**9**
	1	Evolution of IoT technology, Introduction to IoT concept and objectives, A Simplified IoT Architecture, IoT Logical Design, The Core IoT Functional Stack. IoT Enabling technologies.	
2.0		**Sensors, Endpoints, and Power Systems**	**9**
	2	Drivers Behind New Network Architectures, Comparing IoT Architectures, Design and development process of IoT systems, Sensing devices, selection criteria, Smart IoT endpoints, Sensor fusion, Energy sources and power management.	
3.0		**Embedded Platforms for IoT**	**9**
	3	Review of embedded computing basics, Overview of IoT supported Hardware platforms such as Arduino, Net Arduino, Raspberry pi, Beagle Bone, Intel Galileo boards, ESPXX and ARM cortex, Particle boards.	
4.0		**IoT Standards and Protocols**	**9**
	4.1	WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems, LoRaWAN, ZWave.	
	4.2	Protocol architecture and messaging formats of: Message Queue Telemetry Transport (MQTT), Constrained Application Protocol (CoAP). AMQP, HTTP/RESTful.	
5.0		**IoT applications and design constraints**	**9**
	5.1	Smart Metering, Agriculture applications, Health and life style managements, Smart city automation and connected cities, Automotive applications, Home automation, Digital Twins, Hospitality and Tourism applications.	
	5.2	Development Challenges, Security Challenges, Other challenges.	

Text Books

1. Arshdeep Bahga and Vijay Madisetti, “Internet of Things: A Hands-on Approach”, 2014.
2. Abhik Chaudhuri, “Internet of Things, for Things, and by Things”, Taylor & Francis, 2019.
3. Edward Ashford Lee and Sanjit Arunkumar Seshia, “Introduction to Embedded Systems: A Cyber-Physical Systems Approach”, 2E, MIT press, 2016.

References

1. John C. Shovic, “Raspberry Pi IoT Projects Prototyping Experiments for Makers”, APress 2016
2. Charles Bell, “Beginning Sensor Networks with Arduino and Raspberry Pi”, APress 2013.

Internal Assessment (T1, T2 and FET)

1. T1, T2 shall be based on first to fifth units for 10 marks.
2. FET shall be assessed for 5 marks separately.

Semester End Examination

1. Question paper will be of 50 marks which comprises of 5 questions, each carrying 10 marks
2. The duration of semester end examination shall be two hours.
3. The students need to solve all questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules

Theory Course

Course code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U15PC702	Satellite Communication	03	-	-	03	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		Total (Marks)
		T1	T2	FET	Total	Min pass	Marks	Min pass	
U15PC702	Satellite Communication	10	10	5	25	40%	50	40%	75

Course Description

This course covers basic concept of satellite communication, the subsystem of satellite communication, satellite link design and networks.

Pre-requisites: Basic Communication Engineering, Wireless communication.

Course Objectives

- To introduce the basic principles of Satellite Communication systems, orbital mechanics, launchers,etc.
- To familiarize students to different subsystems of satellites.
- To impart the basic concepts and designing of Satellite links.
- To help students understand the basics of direct broadcast satellite television.

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

CO1 **Discuss**[2] the concepts of orbit mechanics and satellite subsystems.

CO2 **Design**[4] satellite link using transmission theory.

CO3 **Elaborate**[3] different satellite networks

CO4 **Demostrate**[3] different earth orbits of non-geostationery systems

Course Contents

Module	Unit	Description	Hours
1.0		**INTRODUCTION OF SATELLITE COMMUNICATION**	**9**
	1.1	Introduction, Evolution and History of Satellite, basic concept of satellite communication, Orbital Mechanics, Keplers laws, Look angle determination- Elevation and Azimuth look angles Launch and Launch Vehicle.	
	1.2	Orbital perturbation, Orbital determination, Orbital effects in communication system performance.	
2.0		**SATELLITE SUBSYSTEM**	**9**
	2.1	Introduction, Attitude and control system(AOCS), Telemetry, Tracking, Command and Monitoring(TTCM).	
	2.2	Power systems, Communication subsystem, Satellite antennas, Equipment, reliability and space qualification.	
3.0		**SATELLITE LINK DESIGN**	**9**
	3.1	Introduction, Basic transmission Theory, Power received at receiving earth station, System Noise, Temperature and G/T Ratio, Design of Downlink and Uplink. Satellite Link Design Procedure.	
	3.2	Link Budget, Design of specified C/N : Combining C/N and C/I values in Satellite Links. (Numerical Expected).	
4.0		**LOW EARTH ORBIT AND NON GEO-STATIONARY ORBITS**	**9**
	4.1	Introduction, Orbit considerations-Low Earth Orbit, Medium Earth Orbit, Elliptical orbit, Inclined orbit, Molniya orbit, Sun Synchronous orbit, Radiation Effects, Van Allen Belts,	
	4.2	NGSO constellation design: Iridium, Teledesic. Applications- Digital DBS TV, Satellite Radio Broadcasting, Navigation Satellite, GPS Position Location Principles	
5.0		**SATELLITE NETWORKS**	**9**
	5.1	Reference architecture for satellite networks, basic characteristics of satellite networks, Onboard connectivity with transparent processing.	
	5.2	Analogue transparent switching, Frame organization, Window organization, On board connectivity with beam scanning.	

Text Books

1. Satellite Communications-Timothy Pratt, Charles Bostian, Jeremy Allnut John Wiley &Sons (II Edition) (For Unit 1,2,3,5)

2. Satellite Communications-Anil k. Maine and Varsha Agaraval, Wiley Publications

References

1.Satellite Communications- Dennis Roody McGraw Hill Fourth Edition (All Units)
2.Satellite Communications- Gerard Maral and Michel Bousquet, Wiley Publication
3. e-Resources and Digital Material:. https://nptel.ac.in/courses/117105131

Internal Assessment (T1, T2 and FET):

1. T_1 (Test 1) should be based on first two modules and T_2 (Test 2) should be based on next two modules, for 10 marks each.
2. FET shall be assessed for 5 marks separately.

Semester End Examination:

1. Question paper will be of 50 marks comprised of 5 questions, each carrying 10 marks.
2. The duration of semester end examination shall be 2 hours.
3. The students need to solve all 5 questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

Theory Course

Course code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
U15PC703	Microwave & Radar Engineering	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**
		03	-	-	03	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		Total (Marks)
U15PC703	Microwave & Radar Engineering	**T1**	**T2**	**FET**	**Total**	**Min pass**	**Marks**	**Min pass**	
		10	10	5	25	40%	50	40%	75

Course Description:

Microwave and Radar Engineering covers the principles of high-frequency electromagnetic wave generation, transmission, and application. It explores microwave devices (tubes, solid-state), waveguides for communication, alongside radar fundamentals, including target detection, range equations, and tracking systems.

Pre-requisites: Electromagnetic engineering concepts.

Course Objectives

- To understand the principles of high-frequency electromagnetic wave propagation.
- To know active and passive microwave components.
- To understand RADAR systems for detecting object range, speed, and angle.
- To study microwave tubes, solid-state devices for microwave communication.

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

CO1 **Classify**[2] different types of Mode propagation inside waveguides.

CO2 **Select**[3] the appropriate component for various applications.

CO3 **Apply**[3] different scattering matrices to measure microwave parameters

CO4 **Differentiate**[2] between various types of Radar systems

Course Contents

Module	Unit	Description	Hours
1.0		**Microwave Waveguides**	**9**
	1.1	Introduction to waveguide: Rectangular wave guide, TE, TM and TEM propagation modes in wave guides.	
	1.2	Power transmission in wave guide, different losses in waveguides and excitation modes in wave guides.	
2.0		**Microwave Components**	**9**
	2.1	Scattering parameters, E Plane Tee, H Plane Tee, Hybrid Tee.	
	2.2	Directional coupler. Ferrite devices, Attenuator, Isolator. Slotted line and Micro strip lines.	
3.0		**Microwave Tubes**	**9**
	3.1	Electron nature in Electromagnetic field, Klystron, Reflex Klystron, TWT's.	
	3.2	Magnetron, Forward wave cross field amplifier (construction and analytical treatment).	
4.0		**Microwave Devices**	**9**
	4.1	Microwave Tunnel diode, FET, RWH theory– LSA & InP diode.	
	4.2	PIN diode, IMPATT diode, Gunn diode.	
5.0		**Radar Systems**	**9**
	5.1	Free space Radar range equation & other forms, Radar Beacon,	
	5.2	Types – Mono-static ,Bi-static, Doppler's radar, CW radar, MTI, FMCW.	

Text Books

1. Samul Lion - Microwave Devices and Circuit, Prentice hall of India, 3rd edt. 2003.

2. Annapurna das - Microwave Engineering, TMH Publication, 3rd edition,2017.

References

1. R.E. Collin, Foundation for Microwave Engg., Wiley Pub, 2nd edition,2007.

2. David M. Pozar, Microwave Engineering, Wiley Pub, 4th edition, 2013
3. M.L. Sisodia, Microwave Active Devices, Newage publisher, 1st edition,2003.

Internal Assessment (T1, T2 and FET):

1.T_1 (Test 1) should be based on first two modules and T_2 (Test 2) should be based on next two modules, for 10 marks each.

2.FET shall be assessed for 5 marks separately.

Semester End Examination:

1.Question paper will be of 50 marks comprised of 5 questions, each carrying 10 marks.

2.The duration of semester end examination shall be 2 hours.

3.The students need to solve all 5 questions.

4.Question No.1 will be compulsory and based on entire syllabus.

5.Remaining question (Q.2 to Q.5) will be selected from all the modules.

Theory Course

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U15PE711	Program Elective-IV (Signal Processing Track) Signal Processing Applications in Communication	03	-	-	03	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		Total (Marks)
		T1	T2	FET	Total	Min pass	Marks	Min pass	
U15PE711	Program Elective-IV (Signal Processing Track) Signal Processing Applications in Communication	10	10	5	25	40%	50	40%	75

Course Description

This is advanced course in signal processing and focus on multi-rate DSP, channel estimation, modulation techniques, and adaptive filtering to optimize signal transmission. Key topics include decimators, interpolators, filter banks, spectral estimation, and equalization for fading channels. This course prepares students to handle modulation, coding, and noise reduction in communication.

Pre-requisites: Digital Signal Processing, Digital Communication

Course Objectives

- To focus on the multi-rate systems arising in the communication.
- To understand concept of adaptive filtering in communication.
- To understand the concept of spectral estimation.
- To know the concept of equalization for fading channels.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Elaborate**[3] multi-rate digital signal processing in communication.

- **CO2** **Design**[4] optimum filter using adaptive algorithms.
- **CO3** **Apply**[3] non-parametric and parametric methods for spectral analysis.
- **CO4** **Illustrate**[3] applications of signal processing in communication.

Course Contents

Module	Unit	Description	Hours
1.0		**Multi-rate Digital Signal Processing**	**9**
	1.1	Decimators, Interpolators, Frequency Transforms of Decimated and Expanded Sequences, multistage approach,	
	1.2	Poly-phase filter banks and sub-band coding. Applications of multi-rate DSP in communication. **:** sampling rate conversion, trans-multiplexers (TDM/FDM conversion).	
2.0		**Linear Prediction & Adaptive Filtering**	**9**
	2.1	Stationary random processes, Linear prediction, Wiener filters AR/ARMA lattice-ladder filters.	
	2.2	Adaptive algorithms, Application: Adaptive equalization for band-limited channels.	
3.0		**Spectral Estimation**	**9**
	3.1	Nonparametric (Welch, Bartlett) and parametric (minimum-variance) power spectrum estimation.	
	3.2	Detection & Estimation**:** Bayesian, Maximum Likelihood (ML), and Minimum Probability of Error criteria in noise. Application: wireless communication channel estimation.	
4.0		**Time-Frequency Analysis**	**9**
	4.1	Short-time Fourier transforms (STFT) and Wavelet transforms. Spread Spectrum: Direct sequence and frequency-hopped systems.	
	4.2	Application: synchronization- Time and frequency synchronization of receivers.	
5.0		**Array Processing**	**9**
	5.1	Spatial filters , Beam forming, and antenna array applications: Wireless Communication (5G/MIMO), Radar and Sonar.	

Text Books

1. J.G. Proakis & D.G. Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications". Pearson Education, 2007.
2. Fredric J Harris," Multirate Signal Processing for Communication Systems," Pearson Education, 2004.

References

1. S. Haykin, "Digital Communication Systems". John Wiley, 2014.
2. A.V. Oppenheim & R.W. Schafer, "Discrete-Time Signal Processing". PHI ,Third Edition,1998

Internal Assessment (T1 and FET)

1.T1 (Test 1) should be based on first two modules and T2 (Test 2) should be based on next two modules each for 10 marks.

2.FET shall be assessed for 5 marks separately.

End Semester Examination

1.Question paper will be of 50 marks comprise of 5 questions, each carrying 10 marks.

2.The duration of end semester examination shall be Two hours.

3.The students need to solve all 5 questions.

4.Question No.1 will be compulsory and based on entire syllabus.

5.Remaining question (Q.2 to Q.5) will be selected from all the modules.

Course Code	**Course Name**	**Teaching Scheme (Hr/week)**			**Credits Assigned**		
U15PE721	Program Elective-IV (VLSI Track) Low Power VLSI Design	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**
		03	-	-	03	-	-

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		Total (Marks)
U15PE721	Program Elective-IV (VLSI Track) Low Power VLSI Design	T1	T2	FET	Total	Min pass	Marks	Min pass	
		10	10	5	25	40%	50	40%	75

Theory Course

Evaluation Scheme

Course Description:

This course is designed to help students to understand concept of low power low voltage VLSI design. This course introduces various strategies and methodologies for designing low power circuit and systems. It describes the many issues facing designers at device levels, logic, circuit and architectural level and presents some of the techniques that has been proposed to overcome these difficulties. The course includes the future challenges that must be met

to design low power, high performance systems designs.

Pre-requisites: Electronics Devices, CMOS Devices and fundamental of digital electronics

Course Objectives

- To learn the impact of power on system performances.
- To Know about different Design approaches.
- To identify suitable techniques to reduce power dissipation in combinational and sequential circuits.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Understand**[1] the need of Low power circuit design.
- **CO2** **Analyze**[3] and design Low-Voltage Low-Power combinational circuits.
- **CO3** **Design**[2] of Low-Voltage Low-Power Memories.

Course Contents

Module	Unit	Description	Hours
1.0		**Fundamentals of Low Power Circuit**	**9**
	1.1	Need for Low Power Circuit Design, Sources of Power Dissipation – Switching Power Dissipation, Short Circuit Power Dissipation, Leakage Power Dissipation, Glitching	
	1.2	Power Dissipation, Short Channel Effects –Drain Induced Barrier Lowering and Punch Through, Surface Scattering, Velocity Saturation, Impact Ionization, Hot Electron Effect	
2.0		**Low-Power Design Approaches**	**9**
	2.1	Low-Power Design through Voltage Scaling – VTCMOS circuits, MTCMOS circuits, Architectural Level Approach –Pipelining and Parallel Processing Approaches.	
	2.2	System Level Measures, Circuit Level Measures, and Mask level Measures.	
3.0		**Low-Voltage Low-Power Adders**	**9**
	3.1	Introduction, Standard Adder Cells, CMOS Adder's Architectures – Ripple Carry Adders, Carry Look- Ahead Adders, Carry Select Adders.	

	3.2	Carry Save Adders, Low- Voltage Low-Power Design Techniques – Trends of Technology and Power Supply Voltage, Low- Voltage Low-Power Logic Styles.	
4.0		**Low-Voltage Low-Power Multipliers**	**9**
	4.1	Introduction, Overview of Multiplication, Types of Multiplier Architectures, Braun Multiplier,	
	4.2	Baugh- Wooley Multiplier, Booth Multiplier, Introduction to Wallace Tree Multiplier.	
5.0		**Low-Voltage Low-Power Memories**	**9**
	5	Basics of ROM, Low-Power ROM Technology, Future Trend and Development of ROMs, Basics of SRAM, Memory Cell, Pre-charge and Equalization Circuit, Low-Power SRAM Technologies, Basics of DRAM, Self Refresh Circuit.	

Text Books

1. Digital Integrated Circuits, a design perspective, Jan M. Rabaey, Prentice Hall.
2. Low-Voltage, Low-Power VLSI Subsystems – Kiat-Seng Yeo, Kaushik Roy, TMH Professional Engineering.

References

1. Low Power CMOS VLSI Circuit Design – Kaushik Roy, Sharat C. Prasad, John Wiley & Sons, 2000.
2. Practical Low Power Digital VLSI Design – Gary K. Yeap, Kluwer Academic Press, 2002.

Internal Assessment (T1, T2 and FET)

1. T1 should be based on first two modules and T2 should be based on next two modules, for 10 marks each.
2. FET shall be assessed for 5 marks separately.

Semester End Examination

1. Question paper will be of 50 marks which comprises of 5 questions, each carrying 10 marks.
2. The duration of semester end examination shall be Two hours.
3. The students need to solve all 5 questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U15PE731	Program Elective-IV (Automotive Electronics Track) Electric Vehicle	03	-	-	03	-	-

Theory Course

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		Total (Marks)
		T1	T2	FET	Total	Min pass	Marks	Min pass	
U15PE731	Program Elective-IV (Automotive Electronics Track) Electric Vehicle	10	10	5	25	40%	50	40%	75

Course Description

This course introduces the fundamental concepts, principles, analysis and design of hybrid, electric and fuel cell vehicles.

Pre-requisites: Basics of Electrical & Electronics Engineering, Engineering Mathematics, Electric machines.

Course Objectives

- To understand working of different configurations of electric vehicles, and its components
- To understand hybrid vehicle configuration and performance analysis.
- To understand battery and battery management system.
- To study the concept of energy storage techniques.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Illustrate**[2] electric vehicles.
- **CO2** **Understand**[1] drive-train topologies.
- **CO3** **Classify**[3] various electrical drive trains
- **CO4** **Classify**[2] energy storage technologies and different energy management strategies.

Course Contents

Module	Unit	Description	Hours
1.0		**ELECTRIC VEHICLES**	**9**
	1	Introduction, Components, vehicle mechanics – Roadway fundamentals, vehicle kinetics, Dynamics of vehicle motion - Propulsion System Design.	
2.0		**DC & AC ELECTRICAL MACHINES**	**9**
	2	Motor and Engine rating, Requirements, DC machines, Three phase A/c machines, Induction machines, permanent magnet machines, switched reluctance machines	
3.0		**ELECTRIC VEHICLE DRIVE TRAIN**	**9**
	3	Transmission configuration, Components – gears, differential, clutch, brakes regenerative braking, motor sizing.	
4.0		**BATTERY**	**9**

	4	Basics – Types, Parameters – Capacity, Discharge rate, State of charge, state of Discharge, Depth of Discharge, Technical characteristics, Battery pack Design, Properties of Batteries.	
5.0		**BATTERY MANAGEMENT SYSTEM**	**9**
	5	General introduction to battery management system, need for BMS, BMS making storage system efficient safe and dependable, Basic function of BMS, Energy control Management, Customized battery management system, standards for BMS development. Schemes of Battery Testing: standardization of characteristic tests, capacity and charge and discharge rate test, battery cycle test, fixed rate cycle test method. Introduction to Autonomous Vehicles.	

Text Books

1. Sandeep Dhameja, "Electric Vehicle Battery Systems", Newnes, 2001
2. Iqbal Hussain, "Electric & Hybrid Vechicles – Design Fundamentals", Second Edition, CRC Press, 2011.
3. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010.

References

1. Battery Management System and Its Applications By Xiaojun Tan, Andrea Vezzini, Yuqian Fan, Neeta Khare, You Xu, Liangliang Wei
2. James Larminie, "Electric Vehicle Technology Explained", John Wiley & Sons, 2003.

Internal Assessment (T1, T2 and FET)

1.T1 should be based on first two modules and T2 should be based on next two modules, for 10 marks each.

2.FET shall be assessed for 5 marks separately..

Semester End Examination

1.Question paper will be of 50 marks which comprises of 5 questions, each carrying 10 marks.

2.The duration of semester end examination shall be Two hours.

3.The students need to solve all 5 questions.

4.Question No.1 will be compulsory and based on entire syllabus.

5.Remaining question (Q.2 to Q.5) will be selected from all the modules

Theory Course

Course code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U15PE741	Program Elective-IV (Data Science Track) Augmented Reality and Virtual Reality System	03	-	-	03	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		Total (Marks)
		T1	T2	FET	Total	Min pass	Marks	Min pass	
U15PE741	Program Elective-IV (Data Science Track) Augmented Reality and Virtual Reality System	10	10	5	25	40%	50	40%	75

Course Description: This is an intermediate course on Augmented Reality and Virtual Reality that focuses on understanding the principles, techniques, and applications of immersive technologies. The course covers AR/VR systems, interaction methods, tracking techniques, and emerging applications.

Course Objectives:

- To introduce the fundamentals of immersive technologies such as AR, VR, and MR
- To understand system architectures and interaction techniques in AR/VR
- To analyze tracking, rendering, and performance aspects of immersive systems
- To explore real-world applications and emerging trends in AR/VR

Course Outcomes:
After the successful completion of the course students will able to:

- **CO1** Explain[2] core concepts and evolution of AR, VR, and MR technologies.
- **CO2** Illustrate[2] immersive system components and architectures used in AR/VR systems.
- **CO3** Apply[3] interaction and tracking techniques in AR/VR systems.
- **CO4** Examine[4] performance, usability, and challenges of AR/VR applications.

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction to Immersive Technologies**	
	1.1	Introduction to Immersive Technologies, Reality–Virtuality Continuum (AR, VR, MR, XR), Historical evolution of AR and VR, Difference between AR,VR, MR.	9
	1.2	Components of immersive systems, Applications of AR/VR in industry, healthcare, education, defense, Online and offline AR/VR tools overview, Social, ethical, and psychological impacts of AR/VR, Health, safety, and consequences of excessive immersive usage.	
2.0		**Virtual Reality Systems and Technologies**	
	2.1	Fundamentals of Virtual Reality, Types of VR systems , VR hardware, VR input	9

		devices, VR output devices	
	2.2	VR system architecture and components, Human perception in VR, Collaborative and distributed VR environments, VR applications and use cases	
3.0		**Virtual Reality Application Development**	
	3.1	VR application development lifecycle, Comparison of VR lifecycle with SDLC, Introduction to Unity for VR development, Basics of Unreal Engine and Blueprints, 3D asset creation using Blender	9
	3.2	Scene creation, lighting, and camera setup, Interaction techniques in VR environments, Web VR and Mobile VR development, Case studies of VR applications	
4.0		**Augmented Reality Concepts and Techniques**	
	4.1	Introduction to Augmented Reality, Types of AR: Marker-based, Marker-less, Location-based, Mobile AR, Web AR, and Headset AR, Working principle of AR systems, Image processing fundamentals for AR.	9
	4.2	Feature detection and key-point extraction, AR tracking and registration techniques, Challenges and limitations of AR systems, Evaluation and performance metrics of AR applications.	
5.0		**Augmented and Mixed Reality Applications**	
	5.1	AR development tools and frameworks, Vuforia engine architecture and features, Unity with Vuforia integration, AR application design workflow, Challenges in AR deployment. Introduction to Meta.	9
	5.2	Introduction to Mixed Reality, MR hardware and software requirements, Security, privacy, and ethical issues in AR/MR, Real-world applications and case studies of AR/MR. Role of AI in AR and VR. Extended reality and applications.	

Text Books

1. Tony Parisi , “Learning Virtual Reality”, O’Reilly Media, 1st Edition, 2015
2. Dieter Schmalstieg & Tobias Höllerer, “Augmented Reality: Principles and Practice” , Pearson / Addison-Wesley, 1st Edition , 2016

References

1. Oliver Bimber and Ramesh Raskar, “Spatial Augmented Reality: Merging Real and Virtual Worlds”, First Edition, A K Peters / CRC Press, Natick, Massachusetts, 1st Edition ,2005.
2. Steve Aukstakalnis, “Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR”, First Edition, Addison-Wesley Professional, Boston, 1st Edition, 2016.
3. Vitalii Ivanov, Ivan Pavlenko and Artem Evtuhov, “Augmented Reality for Engineering Graphics”, First Edition, Springer Nature, Cham, Switzerland, 1st Edition,2023.

Internal Assessment (T1, T2 and FET)

1. T1 should be based on first two modules and T2 should be based on next two modules, for 10 marks each.
2. Fifth module will be assessed for 5 marks separately.
3. Tutorial should be assessed based on accuracy, completeness, conceptual understanding, problem-solving approach, clarity of explanation, and presentation quality.
4. Term work assessment shall be based on the overall performance of the student with every tutorial graded from time to time.
5. The grades will be converted to marks as per ‘credit and grading system’ manual and should be added and

averaged.

Semester End Exam

1. Question paper will comprise of 5 questions, each carrying 10 marks.
2. The duration of semester end examination shall be 2 hours.
3. The students need to solve all 5 questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

Theory Course

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
U01RM701	Research Methodology	Theory	Practical	Tutorial	Theory	Practical	Tutorial
		3	-	-	3	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)	End Semester Exam (ESE)	Total (Marks

U01RM701	Research Methodology	**T1**	**T2**	**FET**	**Total**	**Min pass**	**Marks**	**Min pass**	**)**
		10	10	5	25	40%	50	40%	75

Course Description

This course equips students with essential research skills including problem identification, research design, sampling, data collection, statistical analysis, hypothesis testing, and research report writing. The course emphasizes practical application and preparation for project work and higher studies.

Course Objectives

The course aims:

- To develop understanding of research fundamentals.
- To enable students to design research studies independently.
- To apply statistical tools for data analysis.
- To interpret results and draw meaningful conclusions.
- To prepare structured project reports ethically.

Course Outcomes: After the successful completion of the course students will able to:

CO1 **Explain**[2] research concepts and processes.

CO2 **Formulate**[3]research problems and hypotheses.

CO3 **Design**[4] sampling and data collection strategies.

CO4 **Apply**[3]statistical techniques for analysis and hypothesis testing.

CO5 **Prepare**[5] research reports following academic standards.

Course Contents (Common to all Branches)

Module	Unit	Description	Hours
1.0		**Introduction to Research Methodology**	
	1.1	Meaning, objectives, and characteristics of research, Types of research (basic, applied, exploratory, descriptive, analytical), Research process, Criteria of good research.	9
	1.2	Research problem formulation, Literature review, Research gap identification, Research objectives and hypotheses formulation.	

2.0		**Research Design and Sampling**	
	2.1	Research design: Meaning and types (exploratory, descriptive, causal, experimental), Variables and measurement scales (nominal, ordinal, interval, ratio).	9
	2.2	Sampling design: Census vs sampling, Probability and non-probability sampling methods, Sample size determination, Sampling errors.	
3.0		**Data Collection and Processing**	
	3.1	Primary and secondary data, Methods of data collection: observation, interview, questionnaire, schedule, case study method.	9
	3.2	Data preparation: Editing, coding, classification, tabulation, Data presentation techniques (tables, charts, diagrams).	
4.0		**Statistical Analysis and Hypothesis Testing**	
	4.1	Measures of central tendency, Measures of Variation, Measures of skewness, Correlation and regression analysis.	9
	4.2	Hypothesis testing: Null and alternative hypotheses, Type I & Type II errors, t-test, z-test, chi-square test, ANOVA (conceptual understanding).	
5.0		**Research Report Writing and Ethics**	
	5.1	Structure of research report: Title page, abstract, introduction, literature review, methodology, analysis, findings, conclusion and references.	9
	5.2	Citation styles (APA/IEEE), Plagiarism and research ethics, Intellectual property rights, Use of software tools (SPSS/Excel/LaTeX basics for report preparation).	

Text Books

1. R. Panneerselvam, **Research Methodology**, PHI Learning Pvt. Ltd
2. C.R. Kothari & Gaurav Garg, *Research Methodology: Methods and Techniques*, New Age International Publishers..
3. John W. Creswell & J. David Creswell, *Research Design: Qualitative, Quantitative and Mixed Methods Approaches*, Sage Publications

References

1. Donald R. Cooper & Pamela S. Schindler, *Business Research Methods*, McGraw-Hill Education.
2. Uma Sekaran & Roger Bougie, *Research Methods for Business: A Skill Building Approach*, Wiley India.

Internal Assessment (T1, T2 and FET)

1.T1 should be based on first two modules and T2 should be based on next two modules, for 10 marks each.

2.Fifth module will be assessed for 5 marks separately.

3. Tutorial should be assessed based on accuracy, completeness, conceptual understanding, problem-solving approach, clarity of explanation, and presentation quality.

4. Term work assessment shall be based on the overall performance of the student with every tutorial graded from time to time.

5. The grades will be converted to marks as per 'credit and grading system' manual and should be added and averaged.

Semester End Exam

1.Question paper will comprise of 5 questions, each carrying 10 marks.

2.The duration of semester end examination shall be 2 hours.

3.The students need to solve all 5 questions.

4.Question No.1 will be compulsory and based on entire syllabus.

5.Remaining question (Q.2 to Q.5) will be selected from all the modules.

Theory Course

Course code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U15MM025	Multidisciplinary Minor-V (Wireless Communication Track) Satellite Communication	02	-	-	02	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		Total (Marks)
		T1	T2	FET	Total	Min pass	Marks	Min pass	
U15MM025	Multidisciplinary Minor-V (Wireless Communication Track) Satellite Communication	-	10	5	15	40%	35	40%	50

Course Description

This course covers basic concept of satellite communication, the subsystem of satellite communication, satellite link design and applications.

Pre-requisites: Basic Communication Engineering, Wireless communication.

Course Objectives

- To introduce the basic principles of Satellite Communication systems, orbital mechanics, launchers, etc.
- To know the different subsystems of satellites.
- To introduce the basic concepts and designing of Satellite links.
- To know the basics of direct broadcast satellite television.

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

CO1 **Discuss**[2] the concepts of orbit mechanics and satellite subsystems.

CO2 **Design**[4] satellite link using transmission theory.

CO3 **Demostrate**[3] different earth orbits of non-geostationary systems

CO4 **Illustrate**[2] different satellite applications.

Course Contents

Module	Unit	Description	Hours
1.0		**INTRODUCTION OF SATELLITE COMMUNICATION**	**6**
	1.1	Introduction, Evolution and History of Satellite, basic concept of satellite communication, Orbital Mechanics, Keplers laws, Look angle determination- Elevation and Azimuth look angles Launch and Launch Vehicle.	

	1.2	Orbital perturbation, Orbital determination, Orbital effects in communication system performance.	
2.0		**SATELLITE SUBSYSTEM**	**6**
	2.1	Introduction, Attitude and control system(AOCS), Telemetry, Tracking, Command and Monitoring(TTCM).	
	2.2	Power systems, Communication subsystem, Equipment, reliability and space qualification.	
3.0		**SATELLITE LINK DESIGN**	**6**
	3.1	Introduction, Basic transmission Theory, Power received at receiving earth station, System Noise,	
	3.2	Temperature and G/T Ratio, Satellite Link Design Procedure(Uplink and Downlink).Link Budget.	
4.0		**LOW EARTH ORBIT AND NON GEO-STATIONARY ORBITS**	**6**
	4.1	Introduction, Orbit considerations-Low Earth Orbit, Medium Earth Orbit, Elliptical orbit, Inclined orbit, Molniya orbit, Sun Synchronous orbit.	
	4.2	Radiation Effects, Van Allen Belts, NGSO constellation design: Iridium, Teledesic.,	
5.0		**SATELLITE APPLICATIONS**	**6**
	5.1	C band and Ku band home satellite TV, Communication Satellite-Digital DBS TV, Satellite Radio Broadcasting, Navigation Satellite,	
	5.2	GPS Position Location Principles, Military Satellite- Weather Forecasting Satellite	

Text Books

1.Satellite Communications-Timothy Pratt, Charles Bostian, Jeremy Allnut John Wiley & Sons (II Edition) (For Unit 1,2,3,5)

2. Satellite Communications-Anil k. Maine and Varsha Agaraval, Wiley Publications

References

1.Satellite Communications- Dennis Roody McGraw Hill Fourth Edition (All Units)
2.Satellite Communications- Gerard Maral and Michel Bousquet, Wiley Publication
3. e-Resources and Digital Material:. https://nptel.ac.in/courses/117105131

Internal Assessment (T1, T2 and FET):

1.T_1 (Test 1) should be based on first two modules and T_2 (Test 2) should be based on next two modules, for 10 marks each.

2.FET shall be assessed for 5 marks separately.

Semester End Examination:

1.Question paper will be of 35 marks comprised of 5 questions, each carrying 7 marks.

2.The duration of semester end examination shall be 2 hours.

3.The students need to solve all 5 questions.

4.Question No.1 will be compulsory and based on entire syllabus.

5.Remaining question (Q.2 to Q.5) will be selected from all the modules.

Lab Course

Course code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U15PC704	Internet of Things System Design Lab	-	04	-	-	02	-

Evaluation Scheme

Course Code	Course Name	In Semester Evaluation		Semester End Exam (OE/POE)		Total (Marks)
		FEP	Min pass	Marks	Min pass	
U15PC704	Internet of Things system Design Lab	25	40%	25	40%	50

Course Description:
This course deals with recent technology of Internet of Things advancing very rapidly and proving beneficial in many application areas. The lab session will cover IoT protocols and cloud computing significance, fundamentals and operations. At the end emphasis has been given to the challenges and probable solutions in IoT system design. The lab practical sessions are also structured in such a way that students will be able to develop a small IoT system.

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

CO1 **Illustrate** design process and mitigate the limitations in IoT applications.

CO2 **Design** simple IoT system

List of Experiments

There will be minimum 10 experiments conducted on the theory syllabus.

Text Books

1. Arshdeep Bahga and Vijay Madisetti, “Internet of Things: A Hands-on Approach”, 2014.
2. Abhik Chaudhuri, “Internet of Things, for Things, and by Things”, Taylor & Francis, 2019.
3. Edward Ashford Lee and Sanjit Arunkumar Seshia, “Introduction to Embedded Systems: A Cyber-Physical Systems Approach”, 2E, MIT press, 2016.

References

1. John C. Shovic, “Raspberry Pi IoT Projects Prototyping Experiments for Makers”, APress 2016
2. Charles Bell, “Beginning Sensor Networks with Arduino and Raspberry Pi”, APress 2013.

Evaluation Scheme

1. TERM WORK assessment shall be based on the overall performance of the student with every experiment/journal graded from time to time.

2. The grades will be converted to marks as per ‘credit and grading system’ manual and should be added and averaged.

3. Based on above scheme grading and TERM WORK assessment should be done.

Lab Course

Course code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U15PC705	Microwave and Radar Engineering Lab						

		-	04	-	-	02	-

Evaluation Scheme

Course Code	Course Name	In Semester Evaluation		Semester End Exam (OE/POE)		Total (Marks)
U15PC705	Microwave and Radar Engineering Lab	FEP	Min pass	Marks	Min pass	
		25	40%	25	40%	50

Course Outcomes: After the end of this lab course students will able to,

CO1 **Select**[3] microwave components and devices for power generation and distribution.

CO2 **Make Use**[3] of Microwave test bench for measurement of microwave signal parameters.

List of Experiments

All the experiments will be based on the course content of Microwave and Radar Engineering Theory.

Text Books

1. Samul Lion - Microwave Devices and Circuit, Prentice hall of India, 3rd edt. 2003.
2. Annapurna das - Microwave Engineering, TMH Publication, 3rd edition,2017

References

1. M.L. Sisodia, Microwave Active Devices, Newagepublisher, 1st edition,2003.
2. David M. Pozar, Microwave Engineering, Wiley Pub, 4th edition, 2013

In Semester Evaluation Scheme

1. FEP assessment must be based on the overall performance of the student with every assignment/practical graded from time to time.
2. The grades will be converted to marks as per 'credit and grading system' manual and should be added and averaged.
3. Based on above scheme grading and FEP assessment should be done.

Semester End Exam: Practical Oral Exam (POE)

1. Practical oral exam will be conducted based on the experiment which will be evaluated by the external examiner.

Lab Course

Course code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
U15PE712	Program Elective-IV (Signal Processing Track)	Theory	Practical	Tutorial	Theory	Practical	Tutorial

	Signal Processing Applications in Communication Lab	-	02	-	-	01	-

Evaluation Scheme

Course Code	Course Name	In Semester Evaluation		Semester End Exam (OE/POE)		Total (Marks)
		FEP	Min pass	Marks	Min pass	
U15PE712	Program Elective-IV (Signal Processing Track) Signal Processing Applications in Communication Lab	25	40%	--	40%	25

Course Outcomes: After the end of this lab course students will able to

CO1 **Demonstrate**[3] multi-rate digital signal processing application in communication using simulation software.

CO2 **Analyze**[4] digital communication techniques over fading channels using simulation software.

List of Experiments

All the experiments will be based on the course content of Signal Processing Applications in Communication Theory.

Text Books

1. J.G. Proakis & D.G. Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications". Pearson Education, 2007.
2. Fredric J Harris," Multirate Signal Processing for Communication Systems," Pearson Education, 2004.

References

1. S. Haykin, "Digital Communication Systems". John Wiley, 2014.
2. A.V. Oppenheim & R.W. Schafer, "Discrete-Time Signal Processing". PHI ,Third Edition,1998

In Semester Evaluation Scheme

1.FEP assessment must be based on the overall performance of the student with every assignment/practical graded from time to time.

2.The grades will be converted to marks as per 'credit and grading system' manual and should be added and averaged.

3.Based on above scheme grading and FEP assessment should be done.

Semester End Exam: Practical Oral Exam (POE)

1.Practical oral exam will be conducted based on the experiment which will be evaluated by the external examiner.

Lab Course

Course code	Course Name	Teaching Scheme (Hr/week)	Credits Assigned

U15PE722	Program Elective-IV (VLSI Track) Low Power VLSI Design Lab	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**
		-	02	-	-	01	-

Evaluation Scheme

Course Code	**Course Name**	**In Semester Evaluation**		**Semester End Exam (OE/POE)**		**Total (Marks)**
U15PE722	Program Elective-IV (VLSI Track) Low Power VLSI Design Lab	**FEP**	**Min pass**	**Marks**	**Min pass**	
		25	40%	-	40%	25

Course Description

This course is designed to help students to understand concept of low power low voltage VLSI design. This course introduces various strategies and methodologies for designing low power circuit and systems. It describes the many issues facing designers at device levels, logic, circuit and architectural level and presents some of the techniques that has been proposed to overcome these difficulties. The course includes the future challenges that must be met to design low power, high performance systems designs.

Pre-requisites: Electronics Devices, CMOS Devices and fundamental of digital electronics

.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Understand**[1] the need of Low power circuit design.
- **CO2** **Analyze**[3] and design Low-Voltage Low-Power combinational circuits.
- **CO3** **Design**[2] of Low-Voltage Low-Power Memories.
- **CO4** **Gain**[2] the knowledge of architectural approaches.

Note: All experiments are based on the above said syllabus (Min 10)

Text Books

1. CMOS Digital Integrated Circuits – Analysis and Design – Sung-Mo Kang, Yusuf Leblebici, TMH, 2011.
2. Low-Voltage, Low-Power VLSI Subsystems – Kiat-Seng Yeo, Kaushik Roy, TMH Professional Engineering.

References

1. Introduction to VLSI Systems: A Logic, Circuit and System Perspective – Ming-BO Lin, CRC Press, 2011.
2. Low Power CMOS VLSI Circuit Design – Kaushik Roy, Sharat C. Prasad, John Wiley & Sons, 2000.
3. Practical Low Power Digital VLSI Design – Gary K. Yeap, Kluwer Academic Press, 2002.

Evaluation Scheme

1. TERM WORK assessment shall be based on the overall performance of the student with every experiment graded from time to time.
2. The grades will be converted to marks as per 'credit and grading system' manual and should be added and averaged.

3.Based on above scheme grading and TERM WORK assessment should be done

Lab Course

Evaluation Scheme

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U15PE732	Program Elective-IV (Automotive Electronics Track) Electric Vehicle Lab	-	02	-	-	01	-

Course Code	Course Name	In Semester Evaluation		Semester End Exam (OE/POE)		Total (Marks)
		FEP	Min pass	Marks	Min pass	
U15PE732	Program Elective-IV (Automotive Electronics Track) Electric Vehicle Lab	25	40%	-	40%	25

Course Description

This course introduces the fundamental concepts, principles, analysis and design of hybrid, electric and fuel cell vehicles.

Pre-requisites: Basics of Electrical & Electronics Engineering, Engineering Mathematics, Electric machines.

Course Objectives

- To understand working of different configurations of electric vehicles, and its components
- To understand hybrid vehicle configuration and performance analysis.
- To understand battery and battery management system.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** Apply knowledge of EV drivetrain architecture to describe components and their functions in various electric drivetrain
- **CO2** Interpret knowledge to describe characteristics of different battery types

All Experiments are based on course content

Text Books

1. Sandeep Dhameja, “Electric Vehicle Battery Systems”, Newnes, 2001
2. Iqbal Hussain, “Electric & Hybrid Vechicles – Design Fundamentals”, Second Edition, CRC Press, 2011.
3. Mehrdad Ehsani, Yimin Gao, Ali Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals”, CRC Press, 2010.

References

1. Battery Management System and Its Applications By Xiaojun Tan, Andrea Vezzini, Yuqian Fan, Neeta Khare, You Xu, Liangliang Wei
2. James Larminie, “Electric Vehicle Technology Explained”, John Wiley & Sons, 2003.

In Semester Evaluation Scheme

1.FEP assessment must be based on the overall performance of the student with every assignment/practical graded from time to time.

2.The grades will be converted to marks as per 'credit and grading system' manual and should be added and averaged.

3.Based on above scheme grading and FEP assessment should be done.

Semester End Exam: Practical Oral Exam (POE)

1.Practical oral exam will be conducted based on the experiment which will be evaluated by the external examiner.

Lab Course

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
U15PE742	Program Elective-IV (Data Science Track) Augmented reality & Virtual reality System Lab	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**
		-	02	-	-	01	-

Evaluation Scheme

Course Code	Course Name	In Semester Evaluation		End Semester Exam (OE/POE)		Total (Marks)
U15PE742	Program Elective-IV (Data Science Track) Augmented reality & Virtual reality System Lab	Term work	Min pass	Marks	Min pass	
		25	40%	-	40%	25

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Evaluate**[5] AR/VR applications based on interaction, tracking, and performance.
- **CO2** **Design**[6] and develop a complete AR/VR application.

List of Experiments
All the experiments will be based on the course content of **ARVR Systems**.

References

1. Oliver Bimber and Ramesh Raskar, Spatial Augmented Reality: Merging Real and Virtual Worlds, First Edition, A K Peters/CRC Press, Natick, Massachusetts, 2005.
2. Burdea and Coiffet, Virtual Reality Technology, Second Edition, Wiley-IEEE Press, Hoboken, New Jersey, 2003.

Evaluation Scheme:

1. TERM WORK assessment must be based on the overall performance of the student with every assignment graded from time to time.

2. The grades will be converted to marks as per 'credit and grading system' manual and should be added and averaged.

3. Based on above scheme grading and TERM WORK assessment should be done.

Semester VIII: Teaching Scheme

Track I: Industry Internship With Capstone Project Track

Course code	Course name	Teaching scheme			Credits assigned			
		Th	Pr	Tu	Th	Pr	Tu	Total credits
U15PE8XX	Program Elective V	3	-	-	3	-	-	3
UXXMM0XX	Multidisciplinary Minor VI	2	-	-	2	-	-	2
U15PR801	Project Phase II	-	8	-	-	4	-	4
U15OT801	Internship/On job Training	-	24	-	-	12	-	12
	Total	**5**	**32**	**-**	**5**	**16**	**-**	**21**

Th: Theory, Pr: practical, Tu: Tutorial

Semester VIII: Evaluation Scheme

Track I: Industry Internship With Capstone Project Track

Course code	**Course name**	***Theory Marks***					**Practical Marks**		**Total**
		Evaluation (Theory)				**ESE**	**Evaluation (Lab)**		
		T1	**T2**	**FET**	**Total**		**Term work**	**Practical Oral/POE**	
U15PE8XX	Program Elective V	10	10	5	25	50	-	-	75
UXXMM0XX	Multidisciplinary Minor VI	-	10	5	15	35	-	-	50
U15PR801	Project Phase II	-	-	-	-	-	50	50	100
U15OT801	Internship/On job Training	-	-	-	-	-	200	100	300
								TOTAL	**525**

* Minimum passing is 40% for all courses and evaluation head mentioned above. FET – Faculty evaluation for Theory, T1, T2, Continuous Assessment Test, FEP, Faculty Evaluation for Practical, ESE - End Semester Examination, P/F – Pass/ Fail Course, AU – Audit Course

- Additional Credits for Bachelor's Degree- with Double Minor 12 Credits.
  These are additional credits to be offered from the second year to the final year and will be offered as an option to students.
- Additional Credits for Bachelor's Degree- with Honors: 16-20 Credits.
  These are additional credits from same domain to be offered from the second year to the final year and will be offered as an option to students.
- Additional Credits for Bachelor's Degree- Honors with Research: Minimum 16-20 Credits.
  These are additional credits to be offered in the final year and will be offered as an option to students.

Program Elective V							
Vertical I (Signal Processing)		**Vertical II (VLSI)**		**Vertical III (Automotive Electronics)**		**Vertical IV (Data Science)**	
Code	**Course Name**	**Code**	**Course Name**	**Code**	**Course Name**	**Code**	**Course Name**
U15PE811	Speech Processing	U15PE821	System on Chip Design	U15PE831	Electric Vehicle network	U15PE841	Natural Language Processing

Note: The Program Elective V and Multidisciplinary Minor VI shall be conducted in online mode, by faculty of SGU or other institute/ University. Students can also opt a course from MOOCs platforms such as SWAYAM, NPTEL, Coursera etc equivalent to above courses. In case there is no assessment and examination conducted by the MOOCs platforms then the assessment and examination will be conducted by SGU.

Track II: Entrepreneurship Venture Track

Course code	Course name	Teaching scheme (Hrs/week)			Credits assigned			
		Th	Pr	Tu	Th	Pr	Tu	Total
U15PE8XX	Program Elective V	3	-	-	3	-	-	3
UXXMM0XX	Multidisciplinary Minor VI	2	-	-	2	-	-	2
U15EP801	Online Course in Advanced Technology (domain area)	-	-	-	4	-	-	4
U15EP802	Entrepreneurship project Phase II	-	24	-	-	12	-	12
	Total	**5**	**24**	**-**	**9**	**12**	**-**	**21**

Th: Theory, Pr: practical, Tu: Tutorial

Semester VIII: Evaluation Scheme

Track II: Entrepreneurship Venture Track

Course code	Course name	*Theory Marks*					Practical Marks		Total
		Evaluation (Theory)				ESE	Evaluation (Lab)		
		T1	T2	FET	Total		Term work	Practical Oral/POE	
U15PE8XX	Program Elective V	10	10	5	25	50	-	-	75
UXXMM0XX	Multidisciplinary Minor VI	-	10	5	15	35	-	-	50
U15EP801	Online Course in Advanced Technology (domain area)	-	-	-	25	75	-	-	100
U15EP802	Entrepreneurship project Phase II	-	-	-	-	-	200	100	300
								Total	**525**

* Minimum passing is 40% for all courses and evaluation head mentioned above. FET – Faculty evaluation for Theory , T1, T2, Continuous Assessment Test, FEP, Faculty Evaluation for Practical, ESE - End Semester Examination, P/F – Pass/ Fail Course, AU – Audit Course

- Additional Credits for Bachelor's Degree- with Double Minor 12 Credits.
  These are additional credits to be offered from the second year to the final year and will be offered as an option to students.

- Additional Credits for Bachelor's Degree- with Honors: 16-20 Credits.
  These are additional credits from same domain to be offered from the second year to the final year and will be offered as an option to students.

- Additional Credits for Bachelor's Degree- Honors with Research: Minimum 16-20 Credits.
  These are additional credits to be offered in the final year and will be offered as an option to students.

Program Elective V							
Vertical I (Signal Processing)		**Vertical II (VLSI)**		**Vertical III (Automotive Electronics)**		**Vertical IV (Data Science)**	
Code	**Course Name**	**Code**	**Course Name**	**Code**	**Course Name**	**Code**	**Course Name**
U15PE701	Speech Processing	U15PE702	System on Chip Design	U15PE703	Electric Vehicle network	U15PE704	Natural Language Processing

Note: The Program Elective V and Multidisciplinary Minor VI shall be conducted in online mode, by faculty of SGU or other institute/ University. Students can also opt a course from MOOCs platforms such as SWAYAM, NPTEL, Coursera etc equivalent to above courses. In case there is no assessment and examination conducted by the MOOCs platforms then the assessment and examination will be conducted by SGU.

Semester VIII: Teaching Scheme

Track III: Higher Opportunity Track

Course code	Course name	Teaching scheme (Hrs/week)			Credits assigned			
		Th	Pr	Tu	Th	Pr	Tu	Total
U15PE8XX	Program Elective V	3	-	-	3	-	-	3
UXXMM0XX	Multidisciplinary Minor VI	2	-	-	2	-	-	2
U15RE801	Online Course in Advanced Technology (domain area)	-	-	-	4	-	-	4
U15RE802	Research Project Phase II	-	24	-	-	12	-	12
	Total	**5**	**24**	**-**	**9**	**12**	**-**	**21**

Th: Theory, Pr: practical, Tu: Tutorial

Semester VIII: Evaluation Scheme

Track III: Higher Opportunity Track

Course code	Course name	*Theory Marks*					Practical Marks		Total
		Evaluation (Theory)				ESE	Evaluation (Lab)		
		T1	T2	FET	Total		Term work	Practical Oral/POE	
U15PE8XX	Program Elective V	10	10	5	25	50	-	-	75
UXXMM0XX	Multidisciplinary Minor VI	-	10	5	15	35	-	-	50
U15RE801	Online Course in Advanced Technology (domain area)	-	-	-	25	75	-	-	100
U15RE802	Research Project Phase II	-	-	-	-	-	200	100	300
								Total	**525**

* Minimum passing is 40% for all courses and evaluation head mentioned above. FET – Faculty evaluation for Theory , T1, T2, Continuous Assessment Test, FEP, Faculty Evaluation for Practical, ESE - End Semester Examination, P/F – Pass/ Fail Course, AU – Audit Course

- Additional Credits for Bachelor's Degree- with Double Minor 12 Credits.

These are additional credits to be offered from the second year to the final year and will be offered as an option to students.

- Additional Credits for Bachelor's Degree- with Honors: 16-20 Credits.

These are additional credits from same domain to be offered from the second year to the final year and will be offered as an option to students.

- Additional Credits for Bachelor's Degree- Honors with Research: Minimum 16-20 Credits.

These are additional credits to be offered in the final year and will be offered as an option to students

Program Elective V							
Vertical I (Signal Processing)		**Vertical II (VLSI)**		**Vertical III (Automotive Electronics)**		**Vertical IV (Data Science)**	
Code	**Course Name**	**Code**	**Course Name**	**Code**	**Course Name**	**Code**	**Course Name**
U15PE701	Speech Processing	U15PE702	System on Chip Design	U15PE703	Electric Vehicle network	U15PE704	Natural Language Processing

Note: The Program Elective V and Multidisciplinary Minor VI shall be conducted in online mode, by faculty of SGU or other institute/ University. Students can also opt a course from MOOCs platforms such as SWAYAM, NPTEL, Coursera etc equivalent to above courses. In case there is no assessment and examination conducted by the MOOCs platforms then the assessment and examination will be conducted by SGU.

Syllabus

Theory Course

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U15PE811	Program Elective-V (Signal Processing Track) Speech Processing	03	-	-	03	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		Total (Marks)
		T1	T2	FET	Total	Min pass	Marks	Min pass	
U15PE811	Program Elective-V (Signal Processing Track) Speech Processing	10	10	5	25	40%	50	40%	75

Course Description

This is advanced course in signal processing and aim of the course is to introduce the characteristics of speech signals and the related time and frequency domain methods for speech analysis and speech compression.

Pre-requisites: Signals & Systems**,** Digital Signal Processing

Course Objectives

- To introduce the models for speech production.
- To develop time and frequency domain techniques for estimating speech parameters.
- To introduce a predictive technique for speech compression
- To understand speech recognition, synthesis and speaker identification.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Elaborate**[3] the nature of speech, model and implementation.
- **CO2** **Analyze**[4] the time domain and frequency domain methods to characterize the speech signal and to process the speech .
- **CO3** **Apply**[3] linear predictive coding for Speech Analysis..
- **CO4** **Illustrate**[3] the applications of speech processing

Course Contents

Module	Unit	Description	Hours
1.0		**Speech Production**	**9**
	1.1	Speech production mechanism, Classification of speech, sounds, nature of speech signal, models of speech production.	
	1.2	Speech signal processing: purpose of speech processing, digital models for speech signal, Digital processing of speech signals.	
2.0		**Time Domain Speech Analysis**	**9**
	2.1	Time domain parameters of speech, methods for extracting the parameters, short time energy, short time zero crossing, Auto correlation function, Pitch estimation.	
3.0		**Frequency Domain Speech Analysis**	**9**
	3.1	Short time Fourier analysis, filter bank analysis, spectrographic analysis Formant Estimation & Analysis.	
	3.2	Cepstral Analysis: AR Model, ARMA model. LPC Analysis: LPC model	
4.0		**Speech Coding**	**9**
	4.1	Linear Predictive Coding of Speech: Formulation of linear prediction problem in time domain, solution of normal equations, Interpretation of linear prediction in auto correlation and spectral domains.	
5.0		**Applications of Speech Processing**	**9**
	5.1	Fundamentals of Speech recognition, Speech segmentation. Text-to- speech conversion, speech enhancement.	
	5.2	Speaker Verification, Language Identification, Issues of Voice transmission over Internet.	

Text Books

1. Rabiner and Schafer, “Digital Speech Processing” , Prentice Hall, 1978.
2. L. Rabiner and B. H. Juang,” Fundamentals of Speech Recognition”, Prentice Hall, 1993.

References

1. Nelson Morgan and Ben Gold, “Speech and Audio Signal Processing : Processing and Perception Speech and Music”, July 1999, John Wiley & Sons.
2. J.L Flanagan,”Speech Analysis Synthesis and Perception “, 2nd Edition – Sprenger Vertag, 1972.

Internal Assessment (T1 and FET)

1.T1 (Test 1) should be based on first two modules and T2 (Test 2) should be based on next two modules each for 10 marks.

2.FET shall be assessed for 5 marks separately.

End Semester Examination

1.Question paper will be of 50 marks comprise of 5 questions, each carrying 10 marks.

2.The duration of end semester examination shall be Two hours.

3.The students need to solve all 5 questions.

4.Question No.1 will be compulsory and based on entire syllabus.

5.Remaining question (Q.2 to Q.5) will be selected from all the modules.

Theory Course

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U15PE821	Program Elective-V (VLSI Track) System On Chip Design	03	-	-	03	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		Total (Marks)
		T1	T2	FET	Total	Min pass	Marks	Min pass	
U15PE821	Program Elective-V (VLSI Track) System On Chip Design	10	10	5	25	40%	50	40%	75

Course Description

This course contains units to carry out arithmetic and logic calculations, fast storage in terms of registers and associated control logic to get instructions from memory and execute them. A number of devices can be interfaced with them to develop a complete system application. In single chip computers, integrating processor, memory and other peripheral modules into a single System-on-Chip (SoC). The single chip solution makes the footprint of the computational element small in the overall system package, eliminating the necessity of additional chips on board. While the simpler microcontrollers are cheap, their capabilities (in terms of program size and analog and digital peripherals) are also limited. Such processors may be suitable for small applications like microcontroller and PIC.

Pre-requisites: Basic of Digital System Design

Course Objectives

- To introduce architecture and design concepts underlying system on chips.
- To gain knowledge of system on chip design validation and testing.
- To gain the hardware-software design of a modest complexity chip.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Understand**[1] SoC design methodology.
- **CO2** **Design**[5] simpler processors.
- **CO3** **Describe**[3] knowledge in arithmetic building blocks and memory architectures.

Course Contents

Module	Unit	Description	Hours
1.0		**System Architecture**	**9**
	1.1	Components of the system, Processor architectures, Memory and addressing, system, SoC design requirements and specifications, design integration,	
	1.2	Design Complexity, cycle time, die area and cost, ideal and practical scaling, area-time-power trade-off in processor design, Configurability	
2.0		**Processor Selection For SoC**	**9**
	2.1	Soft processors, processor core selection. Basic concepts – instruction set, branches, interrupts and exceptions. Basic elements in instruction handling,	
	2.2	Minimizing pipeline delays. reducing the cost of branches, Robust processors, Vector processors, VLIW processors.	
3.0		**Memory Design**	**9**
	3.1	SoC external memory, SoC internal memory, Scratch pads and cache memory, cache organization and write policies, strategies for line replacement at miss time,	
	3.2	Multilevel caches, SoC memory systems, board based memory systems, simple processor/memory interaction.	
4.0		**Inter Connect Architectures And SoC Customization**	**9**
	4.1	Introduction, Bus architectures, SoC standard buses, AMBA, Core Connect, Processor customization, approaches, Reconfigurable technologies,	
	4.2	Mapping designs onto reconfigurable devices, FPGA based design, Architecture of FPGA, FPGA interconnect technology, FPGA memory, Floor plan and routing	
5.0		**FPGA Architectures and Testing**	**9**
	5	Spartan-III FPGA (XC3S400), Testing: Fault models, path sensitization, random test, design for testability, Built-In-Self- Test(BIST) and Boundary scan. Types of On-chip interfaces, Wishbone interface, Avalon Switch Matrix, OPB Bus Interface, Creating a Customized Microcontroller, FPGA-based Signal Interfacing and Conditioning.	

Text Books

1. RochitRajsunah,System-on-a-chip:DesignandTest,ArtechHouse,2007.

References

1. Wayne Wolf, “Modern VLSI Design – System – on – Chip Design”, Prentice Hall, 3rd Edition, 2008
2. Wayne Wolf , “Modern VLSI Design – IP based Design”, Prentice Hall, 4th Edition.

Internal Assessment (T1, T2 and FET)

1.T1 should be based on first two modules and T2 should be based on next two modules, for 10 marks each.

2.FET shall be assessed for 5 marks separately..

Semester End Examination

1.Question paper will be of 50 marks which comprises of 5 questions, each carrying 10 marks.

2.The duration of semester end examination shall be Two hours.

3.The students need to solve all 5 questions.

4.Question No.1 will be compulsory and based on entire syllabus.

5.Remaining question (Q.2 to Q.5) will be selected from all the modules.

Theory Course

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U15PE831	Program Elective-V (Automotive Electronics Track) Electric Vehicles Network	03	-	-	03	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		Total (Marks)
		T1	T2	FET	Total	Min pass	Marks	Min pass	
U15PE831	Program Elective-V (Automotive Electronics Track) Electric Vehicles Network	10	10	5	25	40%	50	40%	75

Course Description

This course covers the principles, methodologies, and practical aspects of electric vehicle (EV) design, focusing on the integration of key components and systems. Students will gain insights into EV architecture, vehicle dynamics, Battery management, energy management, safety considerations, and emerging trends in EV technology.

Pre-requisites: Basics of Electrical & Electronics Engineering, Engineering Mathematics, Electric machines.

Course Objectives

- To understand the fundamentals of Electric Vehicle (EV) and Hybrid Electric Vehicle (HEV) concepts.
- To analyze the design and control of EV and HEV systems
- To study and evaluate energy management strategies in EVs and HEVs
- To examine battery management systems (BMS) and charging technologies

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Discuss**[2] the requirement for functioning EV
- **CO2** **Design**[6] EVs based on their requirement
- **CO3** **Analyze**[4] the energy management strategies,
- **CO4** **Estimate**[5] Battery management and charge control system

Course Contents

Module	Unit	Description	Hours
1.0		**EV Concept**	**9**
	1	EV Technology, State-of-the Art EVs & HEVs, Comparison of EV Vs IC Engine. EV System, EV Configuration: Fixed & variable gearing, single & multiple motor drives, In-wheel drives. Major Issues and requirements in EV	
2.0		**EV Traction system**	**9**
	2	Concept of electric traction, electric components used in hybrid and electric vehicles, Configuration and control of Motor drives, drive system efficiency. Design of a Electric vehicles & Hybrid Electric Vehicle (HEV)	
3.0		**Energy Management Strategies**	**9**
	3	Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.	
4.0		**SoC Estimation of Battery**	**9**
	4	relation between SoC, SoP, SoE, classic estimation methods, Open circuit method, difficulty in SoC estimation, common complicated estimation method, Estimation error	
5.0		**EV Charge control**	**9**
	5	Charge control methods, effect of charge control on battery performance, charging circuits, key indicators of charging characteristics, Constant current and constant voltage charging method, fast charging, ultra-fast charging. Design of battery parameters measurement system, safety control, stability of BMS, Battery fault diagnosis.	

Text Books

1. Fundamentals and Applications of Lithium-ion Batteries in Electric Drive Vehicles By Jiuchun Jiang
2. Battery Management System and Its Applications By Xiaojun Tan
3. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.

References

1. M. Ehsani, Y.Gao, S.Gay and Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Desing, CRC Press 2005.
2. Sheldon S. Williamson, Energy Management and Strategies for Electric and plug-in Hybrid Electric Vehicles Springer, 2013.

Internal Assessment (T1, T2 and FET)

1.T1 should be based on first two modules and T2 should be based on next two modules, for 10 marks each.

2.FET shall be assessed for 5 marks separately..

Semester End Examination

1.Question paper will be of 50 marks which comprises of 5 questions, each carrying 10 marks.

2.The duration of semester end examination shall be Two hours.

3.The students need to solve all 5 questions.

4.Question No.1 will be compulsory and based on entire syllabus.

5.Remaining question (Q.2 to Q.5) will be selected from all the modules

Theory Course

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U15PE841	Program Elective-V (Data Science Track) Natural Language Processing	03	--	-	03	--	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					Semester End Exam (SEE)		Total (Marks)
		T1	T2	FET	Total	Min pass	Marks	Min pass	
U15PE841	Program Elective-V (Data Science Track) Natural Language Processing	10	10	5	25	40%	50	40%	75

Course description :

Course should be able to deliver fundamental knowledge of Natural Language Processing and applying knowledge to implement real time problems in fields of natural languages.

Pre-requisite: NLP requires a foundational blend of programming, mathematics, and linguistics

Course Objectives

- To understand the field of natural language processing
- To study the capabilities and limitations of current natural language technologies,
- To describe the model linguistic phenomena with formal grammars.
- To understand the concepts NLP techniques to design real world

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** Understand field of natural language processing.
- **CO2** Analyze capabilities and limitations of current natural language technologies,
- **CO3** Apply the model linguistic phenomena with formal grammars
- **CO4** Apply NLP techniques to design real world NLP applications such as text categorization, text summarization, information extraction

Course Contents

Module	Unit	Description	Hours
1.0		Introduction to Natural Language Processing	**9**
	1	History of NLP, Generic NLP system, levels of NLP, Knowledge in L1, L2 language processing, Ambiguity in Natural language , stages in NLP, challenges of NLP.	
2.0		Word Level Analysis	**9**
	2	Morphology analysis –survey of English Morphology, Inflectional morphology & Derivational morphology, Lemmatization, Regular expression, finite automata, finite state transducers (FST) , Morphological parsing with FST, Lexicon free FST Porter stemmer. N –Grams- N-gram language model, N-gram for spelling correction	
3.0		Syntax Analysis	**9**
	3	Part-Of-Speech tagging (POS)- Tag set for English (Penn Treebank) , Rule based POS tagging, Stochastic POS tagging, Issues –Multiple tags & words, Unknown words. Introduction to CFG, Sequence labeling: Hidden Markov Model (HMM), Maximum Entropy, and Conditional Random Field (CRF).,	
4.0		**Semantic Analysis**	**9**
	4	Lexical Semantics, Attachment for fragment of English- sentences, noun phrases, Verb phrases, prepositional phrases, Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy, WordNet, Robust Word Sense Disambiguation (WSD) ,Dictionary based approach ,Pragmatics	
5.0		**Natural Language processing with deep learning**	**9**
	5	Introduction to deep learning, Neural network models for language understanding tasks, Machine translation, use of tool like tensor flow	

Text Books:

1 Speech and Language Processing Daniel Jurafsky, James H. Martin Prentice Hall Third Edition 2008

2 Foundations of Statistical Natural Language Processing Christopher D.Manning and Hinrich Schutze, MIT Press, 1999 Second Edition 1999

3 Natural Language Processing and Information Retrieval Siddiqui and Tiwary U.S , Oxford University Press -- 2008

Online References

1 www.geeksforgeeks.org https://www.geeksforgeeks.org/fundamentals-ofalgorithms/ #Analysis of Algorithms

2 www.tutorialspoint.com https://www.tutorialspoint.com/design_and_analys is_of_algorithms/index.htm

3 www.w3schools.in https://www.w3schools.in/category/datastructures-tutorial

Evaluation Scheme

Internal Assessment (T1, T2 and FET):

1.T1 (Test 1) should be based on first two modules and T2 (Test 2) should be based on next two modules, for 10 marks each.

2.FET shall be assessed for 5 marks separately.

Semester End Examination:

1.Question paper will be of 50 marks comprise of 5 questions, each carrying 10 marks.

2.The duration of semester end examination shall be 2 hours.

3.The students need to solve all 5 questions.

4.Question No.1 will be compulsory and based on entire syllabus.

5.Remaining question (Q.2 to Q.5) will be selected from all the modules