Pimpri Chinchwad Education Trust's

PIMPRI CHINCHWAD COLLEGE OF ENGINEERING

SECTOR NO. 26, PRADHIKARAN, NIGDI, PUNE 411044

(An Autonomous Institute Approved by AICTE and Affiliated to SPPU, Pune)

DEPARTMENT OF E&TC ENGINEERING

Curriculum Structure and Syllabus
of
Final Year B. Tech. E&TC Engineering
(Regulations 2023)

Effective from Academic Year 2026-27

	Pimpri Chinchwad Education Trust's **Pimpri Chinchwad College of Engineering**
Course Approval Summary	

A) Board of Study- Department of E &TC

Sr. No.	Name of the Course	Course Code	Page number	Signature and stamp of BoS
1.	Robotics and Automation	BET27PC01/BET28PC01	15	
2.	Robotics and Automation Lab	BET27PC02/BET28PC02	17	
3.	Wireless communication	BET27PC03/BET28PC03	19	
4.	Wireless communication Lab	BET27PC04/BET28PC04	21	
5.	Applied AIML	BET27PC05/BET28PC05	23	
6.	MOOC	BET27PE21/ BET28PE21	25	
7.	Physical Design of VLSI Circuits	BET27PE01/ BET28PE01	27	
8.	Physical Design of VLSI Circuits Lab.	BET27PE02/ BET28PE02	29	
9.	Microwave Engineering	BET27PE03/ BET28PE03	31	
10.	Microwave Engineering Lab.	BET27PE04/ BET28PE04	33	
11.	Audio and speech processing	BET27PE05/ BET28PE05	35	
12.	Audio and speech processing Lab.	BET27PE06/ BET28PE06	36	
13.	Advanced C++ for Embedded Programming#	BET27PE07/ BET28PE07	38	
14.	Advanced C++ for Embedded Programming Lab.	BET27PE08/ BET28PE08	40	
15.	Connected, Autonomous & Electric Vehicle -II*	BET27PE09/ BET28PE09	42	
16.	Connected, Autonomous & Electric Vehicle-II Lab.	BET27PE10/ BET28PE10	44	
17.	Advanced, Low power and Emerging CMOS Technology	BET27PE11/BET28PE11	46	
18.	Advanced, Low power and Emerging CMOS Technology Lab.	BET27PE12/BET28PE12	47	
19.	5G and Beyond Wireless Networks	BET27PE13/BET28PE13	49	
20.	5G and Beyond Wireless Networks Lab.	BET27PE14/BET28PE14	51	
21.	Biomedical signal Processing	BET27PE15/BET28PE15	53	
22.	Biomedical signal Processing Lab	BET27PE16/BET28PE16	54	
23.	Product Development Process#	BET27PE17/BET28PE17	56	
24.	Product Development Process Lab.	BET27PE18/BET28PE18	58	
25.	Automotive Cyber Security	BET27PE19/BET28PE19	60	

26.	Automotive Cyber Security Lab.	BET27PE20/BET28PE20	62	
27.	Research Methodology (MOOC)	BET27EL01/ BET28EL01	64	
28.	Research Methodology Lab.	BET27EL02/ BET28EL02	66	
29.	Project	BET27EL03/ BET28EL03	70	
30.	Internship	BET27EL04/ BET28EL04	68	

Approved by Academic Council:

Chairman, Academic Council
Pimpri Chinchwad College of Engineering

Institute Vision

To be one of the top 100 Engineering Institutes of India in coming five years by offering exemplarily Ethical, Sustainable and Value-Added Quality Education through a matching ecosystem for building successful careers.

Institute Mission

1. Serving the needs of the society at large through establishment of a state-of-art Engineering Institute.
2. Imparting right Attitude, Skills, Knowledge for self-sustenance through Quality Education.
3. Creating globally competent and Sensible engineers, researchers and entrepreneurs with an ability to think and act independently in demanding situations.

EOMS Policy

"We at PCCOE are committed to offer exemplarily Ethical, Sustainable and Value Added Quality Education to satisfy the applicable requirements, needs and expectations of the Students and Stakeholders.

We shall strive for technical development of students by creating globally competent and sensible engineers, researchers and entrepreneurs through Quality Education.

We are committed for Institute's social responsibilities and managing Intellectual property.

We shall achieve this by establishing and strengthening state-of-the-art Engineering Institute through continual improvement in effective implementation of Educational Organizations Management Systems (EOMS)."

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CURRICULUM FRAMEWORK
(Regulations 2023)

LIST OF ABBREVIATIONS

Sr. No.	Abbreviation	Type of Course
1	BSC	Basic Science Course
2	ESC	Engineering Science Course
3	PCC	Programme Core Course
4	PEC	Programme Elective Course
5	MDM	Multidisciplinary Minor
6	OEC	Open Elective Course
7	VSEC	Vocational and Skill Enhancement Course
8	AEC	Ability Enhancement Course
9	EEM	Entrepreneurship/Economics/Management Course
10	IKS	Indian Knowledge System
11	VEC	Value Education Course
12	ELC	Experiential Learning Courses
13	LLC	Liberal Learning Courses

COURSE WISE CREDIT DISTRIBUTION

Sr. No.	Type of Course	No.of Courses	Total	
			NO.	%
1	Basic Science Course(BSC)	8	14	8.75
2	Engineering Science Course(ESC)	6	12	7.5
3	Programme Core Course(PCC)	26	46	28.75
4	Programme Elective Course(PEC)	13	20	12.5
5	Multidisciplinary Minor(MDM)	6	14	8.75
6	Open Elective(OEC)	3	6	3.75
7	Vocational and Skill Enhancement Course(VSEC)	4	8	5
8	Ability Enhancement Course(AEC)	2	4	2.5
9	Entrepreneurship/Economics/Management	2	4	2.5
10	Indian Knowledge System(IKS)	1	2	1.25
11	Value Education Course(VEC)	2	4	2.5
12	Experiential Learning Courses(ELC)	5	22	13.75
13	Liberal Learning Courses(LLC)	2	4	2.5
	Total	**80**	**160**	**100**

SEMESTER-WISE COURSE DISTRIBUTION

Course Distribution: Semester Wise										
Sr. No.	Type of Course	No. of Courses / Semester								Total
		1	2	3	4	5	6	7	8	
1.	Basic Science Course(BSC)	4	4	-	-	-	-	-	-	8
2.	Engineering Science Course(ESC)	4	2	-	-	-	-	-	-	6
3.	Programme Core Course(PCC)	-	1	5	5	6	4	5	-	26
4.	Programme Elective Course(PEC)	-	-	-	-	3	5	5	-	13
5.	Multidisciplinary Minor(MDM)	-	-	1	1	2	1	1	-	6
6.	Open Elective(OEC)	-	-	2	1	-	-	-	-	3
7.	Vocational and Skill Enhancement Course(VSEC)	1	1	-	1	-	1	-	-	4
8.	Ability Enhancement Course(AEC)	1	-	-	1	-	-	-	-	2
9.	Entrepreneurship/Economics/Management Course(EEM)	-	-	1	1	-	-	-	-	2
10.	Indian Knowledge System(IKS)	-	1	-	-	-	-	-	-	1
11.	Value Education Course(VEC)	-	-	1	1	-	-	-	-	2
12.	Experiential Learning Courses(ELC)	-	-	1	-	-	-	-	4	5
13.	Liberal Learning Courses(LLC)	1	1	-	-	-	-	-	-	2
Total		**11**	**10**	**11**	**11**	**11**	**11**	**11**	**4**	**80**

SEMESTER-WISE CREDIT DISTRIBUTION

Credit Distribution: Semester Wise										
Sr.No.	Type of Course	No. of Credits / Semester								Total
		1	2	3	4	5	6	7	8	
1.	Basic Science Course(BSC)	7	7	-	-	-	-	-	-	14
2.	Engineering Science Course(ESC)	7	5	-	-	-	-	-	-	12
3.	Programme Core Course(PCC)	-	2	8	8	12	8	8	-	46
4.	Programme Elective Course(PEC)	-	-	-	-	4	8	8	-	20
5.	Multidisciplinary Minor(MDM)	-	-	2	2	4	2	4	-	14
6.	Open Elective(OEC)	-	-	4	2	-	-	-	-	6
7.	Vocational and Skill Enhancement Course(VSEC)	2	2	-	2	-	2	-	-	8
8.	Ability Enhancement Course(AEC)	2	-	-	2	-	-	-	-	4
9.	Entrepreneurship/Economics/Management Course(EEM)	-	-	2	2	-	-	-	-	4
10.	Indian Knowledge System(IKS)	-	2	-	-	-	-	-	-	2
11.	Value Education Course(VEC)	-	-	2	2	-	-	-	-	4
12.	Experiential Learning Courses(ELC)	-	-	2	-	-	-	-	20	22
13.	Liberal Learning Courses(LLC)	2	2	-	-	-	-	-	-	4
Total		**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**160**

Curriculum Structure

B.Tech. E&TC Engineering

Scheme-A

Semester-VII and VIII

CURRICULUM STRUCTURE

Final Year B.Tech. (E&TC Engineering) Semester – VII (Regulation 2023)

			Credit Scheme				Teaching Scheme(Hours/Week)				Evaluation Scheme and Marks						
Course Code	Course Type	Course Name	L	P	T	Total	L	P	T	O	FA 1	FA 2	SA	TW	PR	OR	Total
BET27PC01	PCC	Robotics and Automation	2			2	2			1	10	10	30				50
BET27PC02	PCC	Robotics and Automation Lab		1		1		2		1				25		25	50
BET27PC03	PCC	Wireless communication	2			2	2			1	10	10	30				50
BET27PC04	PCC	Wireless communication Lab		1		1		2		1				25	25		50
BET27PC05	PCC	Applied AIML		2		2		4		1				100			100
BET27PE21	PEC	MOOC	2			2	2				25	25					50
BET27PExx	PEC	PEC4	2			2	2				10	10	30				50
BET27PExx	PEC	PEC4 Lab		1		1		2						50			50
BET27PExx	PEC	PEC5	2			2	2				10	10	30				50
BET27PExx	PEC	PEC5 Lab		1		1		2						50			50
BET27MDxx	MDM	MDM5 Project		4		4		8						100		50	150
Total			**10**	**10**	**0**	**20**	**10**	**20**	**0**	**5**	**65**	**65**	**120**	**350**	**25**	**75**	**700**

#Refer separate booklet for Multidisciplinary Minor (MDM) courses

***L**-Lecture, **P**-Practical, **T**-Tutorial, **O**-Others,**FA**–Formative Assessment, **SA**-Summative Assessment, **TW**-Term Work, **OR**-Oral, **PR**-Practical*

CURRICULUM STRUCTURE

Final Year B.Tech. (E&TC Engineering) Semester – VIII (Regulation 2023)

			Credit Scheme				Teaching Scheme(Hours/Week)				Evaluation scheme and Marks					
Course Code	Course Type	Course Name	L	P	T	Total	L	P	T	Total	FA1	FA2	TW	PR	OR	Total
BET28EL01	RM1	Research Methodology (MOOC)	2			2	2			2	25	25				50
BET28EL02	RM2	Research Methodology Lab.		2		2		4		4			100			100
BET28EL03	PRJ	Project		4		4		8		8			100		50	150
BET28EL04	INTR/OJT	Internship		12		12		40		40			300		150	450
Total			**2**	**18**	**0**	**20**	**2**	**52**	**0**	**54**	**25**	**25**	**500**	**0**	**200**	**750**

L-Lecture, P-Practical, T-Tutorial, O-Others, FA–Formative Assessment, SA-Summative Assessment, TW-Term Work, OR-Oral, PR-Practical

Note: MDM5 project must be completed in Semester VII only irrespective of Schemes

Semester VII
List of Program Elective Courses (PEC-4)

Course Code	Course Name	Remark
BET27PE01	Physical Design of VLSI Circuits	**Choose any one course and its associated lab.**
BET27PE02	Physical Design of VLSI Circuits Lab.	
BET27PE03	Microwave Engineering	
BET27PE04	Microwave Engineering Lab.	
BET27PE05	Audio and Speech Processing	
BET27PE06	Audio and Speech Processing Lab.	
BET27PE07	Advanced C++ for Embedded Programming#	
BET27PE08	Advanced C++ for Embedded Programming Lab.	
BET27PE09	Connected, Autonomous & Electric Vehicle -II*	
BET27PE10	Connected, Autonomous & Electric Vehicle-II Lab.	

List of Program Elective Courses (PEC-5)

Course Code	Course Name	Remark
BET27PE11	Advanced, Low power and Emerging CMOS Technology	**Choose any one course and its associated lab.**
BET27PE12	Advanced, Low power and Emerging CMOS Technology Lab.	
BET27PE13	5G and Beyond Wireless Networks	
BET27PE14	5G and Beyond Wireless Networks Lab.	
BET27PE15	Biomedical Signal Processing	
BET27PE16	Biomedical Signal Processing Lab	
BET27PE17	Product Development Process#	
BET27PE18	Product Development Process Lab.	
BET27PE19	Automotive Cyber Security	
BET27PE20	Automotive Cyber Security Lab.	

Offered by MG Motors
#Offered by HCL limited

Curriculum Structure

B.Tech. E&TC Engineering

Scheme-B

Semester-VII and VIII

CURRICULUM STRUCTURE

Final Year B.Tech. (E&TC Engineering) Semester – VII (Regulation 2023)

			Credit Scheme				Teaching Scheme(Hours/Week)				Evaluation scheme and Marks					
Course Code	**Course Type**	**Course Name**	**L**	**P**	**T**	**Total**	**L**	**P**	**T**	**Total**	**FA1**	**FA2**	**TW**	**PR**	**OR**	**Total**
BET27EL01	RM1	Research Methodology (MOOC)	2			2	2			2	25	25				50
BET27EL02	RM2	Research Methodology Lab.		2		2		4		4			100			100
BET27EL03	PRJ	Project		4		4		8		8			100		50	150
BET27EL04	INTR/OJT	Internship		12		12		40		40			300		150	450
Total			**2**	**18**	**0**	**20**	**2**	**52**	**0**	**54**	**25**	**25**	**500**	**0**	**200**	**750**

CURRICULUM STRUCTURE

Final Year B.Tech. (E&TC Engineering) Semester – VIII (Regulation 2023)

			Credit Scheme				Teaching Scheme(Hours/Week)				Evaluation Scheme and Marks						
Course Code	**Course Type**	**Course Name**	**L**	**P**	**T**	**Total**	**L**	**P**	**T**	**O**	**FA 1**	**FA 2**	**SA**	**TW**	**PR**	**OR**	**Total**
BET28PC01	PCC	Robotics and Automation	2			2	2			1	10	10	30				50
BET28PC02	PCC	Robotics and Automation Lab		1		1		2		1				25		25	50
BET28PC03	PCC	Wireless communication	2			2	2			1	10	10	30				50
BET28PC04	PCC	Wireless communication Lab		1		1		2		1				25	25		50
BET28PC05	PCC	Applied AIML		2		2		4		1				100			100
BET28PE21	PEC	MOOC	2			2	2				25	25					50
BET28PExx	PEC	PEC4	2			2	2				10	10	30				50
BET28PExx	PEC	PEC4 Lab		1		1		2						50			50
BET28PExx	PEC	PEC5	2			2	2				10	10	30				50
BET28PExx	PEC	PEC5 Lab		1		1		2						50			50
BET28MDxx	MDM	MDM5 Project		4		4		8						100		50	150
Total			**10**	**10**	**0**	**20**	**10**	**20**	**0**	**5**	**65**	**65**	**120**	**350**	**25**	**75**	**700**

#Refer separate booklet for Multidisciplinary Minor (MDM) courses

***L**-Lecture, **P**-Practical, **T**-Tutorial, **O**-Others,**FA**–Formative Assessment, **SA**-Summative Assessment, **TW**-Term Work, **OR**-Oral, **PR**-Practical*

L-Lecture, P-Practical, T-Tutorial, O-Others ,FA–Formative Assessment, SA-Summative Assessment, TW-Term Work, OR-Oral, PR-Practical

Semester VIII
List of Program Elective Courses (PEC-4)

Course Code	Course Name	Remark
BET28PE01	Physical Design of VLSI Circuits	**Choose any one course and its associated lab.**
BET28PE02	Physical Design of VLSI Circuits Lab.	
BET28PE03	Microwave Engineering	
BET28PE04	Microwave Engineering Lab.	
BET28PE05	Audio and speech processing	
BET28PE06	Audio and speech processing Lab.	
BET28PE07	Advanced C++ for Embedded Programming#	
BET28PE08	Advanced C++ for Embedded Programming Lab.	
BET28PE09	Connected, Autonomous & Electric Vehicle -II*	
BET28PE10	Connected, Autonomous & Electric Vehicle-II Lab.	

List of Program Elective Courses (PEC-5)

Course Code	Course Name	Remark
BET28PE11	Advanced, Low power and Emerging CMOS Technology	**Choose any one course and its associated lab.**
BET28PE12	Advanced, Low power and Emerging CMOS Technology Lab.	
BET28PE13	5G and Beyond Wireless Networks	
BET28PE14	5G and Beyond Wireless Networks Lab.	
BET28PE15	Biomedical signal Processing	
BET28PE16	Biomedical signal Processing Lab	
BET28PE17	Product Development Process#	
BET28PE18	Product Development Process Lab.	
BET28PE19	Automotive Cyber Security	
BET28PE20	Automotive Cyber Security Lab.	

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Course Syllabus
Programme Core Courses
Semester-VII and VIII

Program :	B. Tech. (E&TC)	Semester: VII/VIII	
Course :	Robotics and Automation	Code :	BET27PC01/ BET28PC01

Credits	Teaching Scheme (Hrs./Week)				Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	Other	FA		SA	Total
					FA1	FA2		
02	02	-	-	01	10	10	30	50

Prior knowledge of

Basic engineering mathematics, Differential equations and Integration, Basic coordinate system, is essential

Course Objectives:

This course aims at enabling students,

1. To introduce various types of Robots and the functional elements of Robotics
2. To impart knowledge of robot drive systems with Robo programming
3. To introduce students to different types of end effectors and actuators and programming logic as per robotic Applications

Course Outcomes:

After learning the course, the students should be able to:

1. Analyze the basic classification, configurations, and specifications of robots used in various applications.
2. Evaluate and apply the knowledge of robotic drives, sensors, and vision systems to develop and interpret robot programming.
3. Select and justify appropriate grippers, actuators, and drive systems for specific robotic applications based on functional requirements.
4. Design and develop an industrial robotic system by applying suitable programming logic and automation techniques.

Detailed Syllabus:

Unit	Description	Duration [Hrs]
1	**Basic Concepts in Robotics** Definition, anatomy and structure of robots; specifications and classifications; 1D–5D concepts of robotics; comparison between industrial and mobile robots; Industry 4.0 and the role of autonomous robots; safety measures and standards; industrial applications of robots.	06
2	**Sensors and Vision Systems in Robotics** **Sensors in robotics**—principles and applications of IMU, camera, position, velocity, force, torque, proximity, and range sensors. **Introduction to machine vision in robotics:** shape and color identification, optical character recognition (OCR), and drowsiness detection using vision-based systems.	08
3	**Actuators and End Effectors :** **An overview of actuators**: Electric hydraulic and pneumatic Actuators Specifications and characteristics of Stepper motors AC motors; DC motors and servomotors, BLDC Motors. **End Effectors :** Robot end effectors interface, Robot Grippers: Classification, Design and Selection	08
4	**Robot Kinematics and Robo Programming Methods** **Robot Kinematics :**Basic fundamentals of direct kinematics & inverse kinematics for industrial robots for position and orientation **Robo Algorithms and programs** : • Speed control robot, • Direction control robot • Line Following Algorithms based robot, • Pick and Place application robot, • Tracking Robot	08
	Total	30
Self-learning: Choice of contents lies with course faculty with prior ap proval in course coordinator meeting.		

Text Books:

1. "Robotics: Modelling, Planning and Control" by Bruno Siciliano and Lorenzo Sciavicco (latest edition: 3rd edition, published in 2020)
2. Introduction to Robotics: Mechanics and Control" by John Craig (latest edition: 4th edition, published in 2019)
3. Industrial Robotics: Technology, Programming, and Applications" by Mikell P. Groover and Mitchell Weiss (latest edition: 2nd edition, published in 2020)
4. Robotics: Control, Sensing, Vision, and Intelligence" by K.S. Fu, R.C. Gonzalez, and C.S.G. Lee (latest edition: 1st edition, published in 2019)

Reference Books:

1. Robotics: State of the Art and Future Challenges" edited by Sukhan Lee and Bradley Hayes (latest edition: 2021)
2. Robotics: Control, Sensing, Vision, and Intelligence" by K.S. Fu, R.C. Gonzalez, and C.S.G. Lee (latest edition: 1st edition, published in 2019)
3. Robotics and Control" by R.K. Mittal and I.J. Nagrath (latest edition: 1st edition, published in 2018)
4. Robotics: Control, Sensing, Vision, and Intelligence" by K.S. Fu, R.C. Gonzalez, and C.S.G. Lee (latest edition: 1st edition, published in 2019)

NPTEL Courses Link

1. Robotics (IIT Kharagpur) : https://nptel.ac.in/courses/112105249
2. Robotics Automation (IIT Bombay): https://nptel.ac.in/courses/112101098
3. Introduction to robotics (IIT Madras): https://nptel.ac.in/courses/107106090

Program: B. Tech. (E&TC)					Semester			VII/VIII
Course: Robotics and Automation Lab					Code: BET27PC02/ BET28PC02			
Teaching Scheme Hrs /Week					Evaluation Scheme			
Credit	**Lecture**	**Practical**	**Tutorial**	**Other**	**TW**	**OR**	**PR**	**Total**
1	-	2	-	01	25	25		50

Prior knowledge of:
Sensors, Control Systems and basic programming is essential

Course Objectives:
The objective of this laboratory is to provide the student with:

.1. To learn and understand the basics of fundamentals of robotics systems.
2. To be acquainted with a different configuration of the robotics system
3. To write program for robotic Application

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

1. Analyze the configuration, structure, and functional components of robotic systems in industrial applications.
2. Implement programs that integrate sensors and vision systems for robotic automation.
3. Design robotic programs utilizing advanced algorithms and control logic for industrial processes.

Detailed Syllabus

Expt. No.	List of Experiments (any 10 Experiments)
1	To analyze basic robot concepts using virtual simulation.
2	To develop programs for robot movement in all directions.
3	To design a robot simulation that follows a black line using sensors.
4	To create a robot simulation that detects and avoids obstacles.
5	To design methods to control robot speed through programming.
6	To implement programmed techniques to control robot direction.
7	To analyze basic robot concepts using virtual simulation.
8	To explore the configuration and motion characteristics of a robotic manipulator.
9	To present an industrial visit report related to robotic applications.
10	To demonstrate shape identification using a machine vision system.
11	To demonstrate Color identification using a machine vision system.
12	To demonstrate optical character recognition **(OCR)** using a machine vision system.
13	To program a robot for a pick-and-place application.
14	To program and demonstrate a robotic sorting system based on sensor or vision inputs.

Self-learning: Choice of contents lies with course faculty with prior ap proval in course coordinator meeting.

Reference Books :

1. Robotics: A Project-Based Approach" by MJ. Dominique, 2nd Edition, 2021.
2. Robot Modeling and Control" by Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, 3rd Edition, 2020
3. Introduction to Robotics: Mechanics and Control" by John J. Craig, 4th Edition, 2019.
4. Robotics, Vision and Control: Fundamental Algorithms in MATLAB" by Peter Corke, 2nd Edition,

Program :	B. Tech. (E&TC)	Semester: VII/VIII
Course :	Wireless Communication	Code : BET27PC03/ BET28PC03

Credits	Teaching Scheme (Hrs./Week)				Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	Other	FA		SA	Total
					FA1	FA2		
02	02	-	-	01	10	10	30	50

Prior knowledge of
a. Analog and Digital Communication
b. Basics of signal processing
is essential.

Course Objectives:
This course aims at enabling students,
1. To familiarize the concepts of wireless communication.
2. To teach students the fundamentals of multipath fading and propagation models.
3. To describe the diversity and MIMO schemes as applied in wireless communication.

Course Outcomes:
After learning the course, the students should be able to:
1. **Analyze** cellular system for improving coverage and performance in wireless communication network.
2. **Evaluate** fading channel characteristics to assess their effects on wireless system performance and capacity.
3. **Assess** multicarrier modulation system parameters to determine their impact on SNR and BER performance.
4. **Synthesize** multiple antenna wireless system techniques including diversity, MIMO detection, spatial multiplexing, and beamforming to enhance channel capacity and communication performance.

Detailed Syllabus:

Unit	Description	Duration [Hrs]
1	Evolution of Wireless Systems and Cellular Concepts Overview of wireless communication and evolution from 1G → 5G, Wireless system components and architecture, Cellular concept: frequency reuse, channel assignment, handoff strategies, Interference and system capacity, Trunking and Grade of Service (GoS), Techniques to improve coverage and capacity: cell splitting, sectoring, micro/pico/femtocells, Overview of multiple access techniques: FDMA, TDMA, CDMA, OFDMA (conceptual) ,Overview of GSM and CDMA system architecture	07
2	Channel Characteristics and Fading model: Propagation mechanisms: reflection, refraction, diffraction, scattering, Large-scale path loss models and log-normal shadowing, Small-scale and multipath fading, Doppler shift and coherence parameters, Statistical multipath models: Rayleigh, Rician, Nakagami, Narrowband and wideband fading models,Power delay profile, average and RMS delay spread, Flat vs. frequency-selective; slow vs. fast fading, Average fade duration and level crossing rate, Channel capacity of flat and frequency-selective fading channels	08
3	Multicarrier Modulation and OFDM Systems Introduction and challenges in multicarrier systems, Principles of OFDM,OFDM transceiver model: IFFT/FFT operations, Cyclic prefix and its role in ISI mitigation, PAPR problem and reduction techniques, SNR and BER performance in OFDM systems, Inter-carrier interference (ICI) and mitigation, SC-FDMA and its use in LTE uplink.	07
4	Diversity techniques and MIMO technology: Multiple antenna wireless systems: system model and motivation, Types of diversity: antenna, frequency, time, Deep fade analysis and diversity order, Receiver combining: MRC, EGC, SC, MIMO channel model and capacity Zero-Forcing and MMSE receivers, Beamforming and spatial multiplexing, BLAST architectures (V-BLAST, D-BLAST),Distributed MIMO and cooperative communication, Applications in LTE and 5G systems	08
	Total	30

Self-learning: Choice of contents lies with course faculty with prior ap proval in course coordinator meeting.

Text Books:

1. Rappaport, T.S., Wireless Communications: Principles and Practice, 2018, (Reprint),Pearson Education, Noida, India.
2. Aditya K. Jagannatham, Principles of Modern Wireless Communications Systems, 2015, 1stEdition, McGraw-Hill Education, India.

Reference Books:

1. Andrea Goldsmith, Wireless Communications, 2020, 2nd Edition, Cambridge University Press 2015, McGraw Hill Education
2. T L Singal, Wireless Communications, 2014, (Reprint), Tata McGraw Hill Education, 1st edition, New Delhi, India.
3. Keith Q T Zhang, Wireless Communications: Principles, Theory and Methodology,2016, 1st edition, John Wiley & Sons, West Sussex, UK.

NPTEL Link : https://nptel.ac.in/courses/117104115

Program: B. Tech. (E&TC)						Semester		VII/VIII
Course: Wireless Communication Lab						Code: BET27PC04/BET28PC04		
Teaching Scheme Hrs/Week					Evaluation Scheme			
Credit	**Lecture**	**Practical**	**Tutorial**	**Other**	**TW**	**OR**	**PR**	**Total**
1	-	2	-	1	25	-	25	50

Prior knowledge of:
a. Analog and Digital Communication, Signal processing
b. A suitable simulation tools is essential.

Course Objectives:
The objective of this laboratory is to provide the student with:
1. To enable them to explain the basic concepts of cellular communication, propagation, fading, OFDM, and MIMO systems.
2. To guide students in performing simulations and experiments to analyze wireless system performance.
3. To help students develop practical skills for designing and improving modern wireless communication systems.

Course Outcomes:
After completing the course, the students should be able to:
1. **Analyze** frequency reuse, path loss, and fading models through simulation to determine their impact on received signal strength, coverage, and communication reliability in cellular networks
2. **Evaluate** OFDM and SC-FDMA system performance, including BER, ICI, and PAPR reduction techniques, to improve spectral efficiency and signal quality.
3. **Design** advanced MIMO and beamforming schemes, including diversity and SFBC-OFDM, to enhance channel capacity and overall wireless system performance.

Detailed Syllabus

Guidelines:
1.Perform the suitable 10 assignments to meet the given COs.
2.Expt. No. 17 is mandatory.

Expt. No.	List of Experiments
1	To analyze the cellular frequency reuse concept fulfilling the following objectives: Finding the co-channel cells for a particular cell. Finding the cell clusters within certain geographic area.(Virtual Lab.IIT)
2	To apply the path loss prediction formula with the objectives: 1. Calculation of received signal strength as a function of distance of separation, antenna height and carrier frequency. 2.To understand the impact of :-Transmitter Power, Path loss exponent, Carrier frequency, Receiver antenna height, Transmitter antenna height. (Virtual Lab.IIT)
3	To simulate Hata model for urban, sub-urban and city environment and analyze the impact of frequency and distance on received signal strength.
4	Implementation of Jakes Rayleigh fading channel model
5	To Simulate BER performance over a Rayleigh fading wireless channel with BPSK/QPSK transmission for given SNR.
6	To simulate BER performance over a Rayleigh fading wireless channel with OFDM for given SNR.
7	To simulate a Link Budget for a mobile network in your area.
8	To design OFDM transmitter and receiver in GNU radio.
9	Inter Carrier Interference (ICI) mitigation in OFDM system
10	Study and analysis of peak to average power ratio (PAPR) reduction schemes in OFDM system.
11	Study and analysis of peak to average power ratio (PAPR) using SC-FDMA

12	Channel estimation schemes for OFDM system
13	Study and analysis of beamforming schemes for MIMO system
14	Study and analysis of diversity schemes for MIMO system
15	Implementation of SFBC-OFDM
16	Field visit to nearby MTSO/Base station and prepare a report.
17	To present a recent research paper in the area of mobile/wireless communication.

- ***Self-learning: Choice of contents lies with course faculty with prior approval in course coordinator meeting.***

Reference Books :

1. Theodore S Rappaport, "Wireless Communications Principles & Practice" Second Edition, Pearson Education,2010.
2. Jagannatham, A. K., "Principles of Modern Wireless Communication Systems", McGraw-Hill Education,1st Edition,2015.
3. Travis Collins, Robin Getz, Di Pu, Alexander Wyglinski "Software-Defined Radio for Engineers" 1st edition 2018.
4. Robert W. Stewart, Kenneth W. Barlee, Dale S. W. Atkinson, Louise A. Crockett "Software-Defined Radio using MATLAB & Simulink and the RTL-SDR",2nd edition 2017.

Websites:

1. https://in.mathworks.com/help/comm/
2. https://www.gnuradio.org/
3. http://vlabs.iitkgp.ac.in/fcmc/

Program: B. Tech. (E&TC)					**Semester: VII/VIII**			
Course: Applied AIML					**Code: BET27PC05/ BET28PC05**			
Teaching Scheme Hrs/Week					**Evaluation Scheme and Marks**			
Credit	**Lecture**	**Practical**	**Tutorial**	**Other**	**TW**	**OR**	**PR**	**Total**
2	-	4	-	1	100	-	-	100

Teaching Scheme:

- Practical: 4 hours/week, Total: 4 hours/week (2 Credits)

Total Evaluation Scheme: 100 Marks

- Term Work (TW): 100 (60 Marks for experiment and 40 Marks for Mini-Project)

Duration: 60 Hours

- Practical: 36 Hours & Mini Project: 24 Hours

Prior knowledge of:

Fundamentals of Artificial Intelligence & Machine Learning (AI & ML) **is essential**

Course Objectives:

The objective of this laboratory is to provide the student with:

1. Understand key concepts of data preprocessing, EDA, and foundational ML tools.
2. Apply ML and DL algorithms to real-world datasets using Python/MATLAB.
3. Analyze model behaviour using evaluation metrics and visualization methods.
4. Create end-to-end AI solutions through a practical mini-project.

Course Outcomes:

After completing the course, the students should be able to:

1. **Apply** preprocessing and EDA techniques to prepare datasets for modeling.
2. **Analyze** ML/DL models for classification, regression, and signal/image tasks.
3. **Evaluate** model performance using standard metrics and diagnostic plots.
4. **Develop** a complete Applied AIML project with implementation, analysis, and deployment.

Guidelines: Total Six Experiments is to be performed to meet the above outcomes along with the Mini-Project

Term Work: 100 Marks

1. **Continuous assessment of Practical Work (Part A): 60 Marks**
   - Each experiment in Part A is assessed out of 10 marks.
   - Total marks for Part A practical performance = 60 Marks.
2. **Part B (Mini-Project): 40 Marks**
3. The final Term Work marks will be based on overall performance, documentation, and viva.

Detailed Syllabus:

Part A

Guidelines: Total Six Experiments is to be performed.
Any 3 from Experiment 1 to 5, Any 2 from Experiment 6 to 8, Any 1 from Experiment 9 to 10

Expt. No.	**List of Experiments using MATLAB or Python**
1	**Preprocessing & Exploratory Data Analysis (EDA):** Use Case: *Air Quality Monitoring for Smart Cities*
2	**Regression Models:** Use Case: Predicting Energy Output of a Power Plant
3	**Classification (SVM / Random Forest):** Use Case: Email Spam Detection
4	**Clustering (K-Means / DBSCAN):** Use Case: Customer Segmentation
5	**PCA Visualization:** Use Case: Industrial Fault Pattern Analysis

6	**ANN Implementation:** Use Case: Heart Disease Risk Prediction
7	**CNN for Image Classification:** Use Case: Tomato Leaf Disease Detection
8	**LSTM for Signals:** Use Case: ECG Arrhythmia Detection
9	**Transfer Learning:** Use Case: Real-Time Mask/No-Mask Detection
10	**Model Deployment:** Use Case: Customer Churn Prediction Web App

Part B

Mini-Project based on Practical Applications

Students will implement the suggested Mini-Project Topic. This can be implemented using MATLAB or Python with any of the Hardware.

The project should include:

1. **Identify Case study:** Define and formulate a problem/case studies using AI/ML.
2. **Implementation in MATLAB or Python:** Develop a solution using both programming environments.
3. **Visualization & Analysis:** Interpret results using graphical representations
4. **Deployment on Hardware:** Deploying the model on any of the processor/hardware Boards
5. **Report & Presentation:** Submit a brief report and demonstrate the project.

- ***Self-learning: Choice of contents lies with course faculty with prior approval in course coordinator meeting.***

Reference Books:

1. Jake Vander Plas and O'Reilly, "Python Data Science Handbook: Essential Tools for Working with Data", O'Reilly Media, Inc. 2019
2. Aurelien Geron "Hands on Machine Learning with SciKit-Learn, Keras and TensorFlow", O'Reilly, Second Edition, 2019.
3. Phil Kim," MATLAB Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence", APress, 2017.
4. Introduction to Neural Networks using MATLAB, S. N. Sivanandam, Sumathi, S. N. Deepa, McGraw Hill, 2006.

Online Resources:

1. NPTEL: Deep Learning for Computer Vision https://onlinecourses.nptel.ac.in/noc25_cs93/
2. NPTEL: Machine Learning and Deep Learning - Fundamentals and Applications https://onlinecourses.nptel.ac.in/noc25_ee181/preview
3. SWAYAM: NPTEL - Machine Learning Course https://swayam.gov.in/nd1_noc20_cs46/
4. MathWorks: Teaching Data Science with MATLAB https://www.mathworks.com/academia/courseware/teaching-data-science-with-matlab.html

Program:	B. Tech. (E&TC)			Semester:			VII/VIII
Course:	MOOC			Code:			BET27PE21/BET28PE21
Credits	Teaching Scheme (Hrs/Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
2	2	-	-	25	25	-	50

Prior Knowledge:
NA

Course Objectives: This course aims at enabling students,

1. To impart knowledge of self-learning
2. To build lifelong learning approach

Course Outcomes: After learning the course, the students should be able to:

1. Build self-learning through peer group learning and positive collaboration
2. Explore different learning styles, difficulties & solutions through modern tools

Guidelines for Students:

1. Individual student can register for MOOC course of their interest offered by E&TC program.
2. Student may be permitted to enroll for MOOCs only through the SWAYAM/NPTEL portal.
3. For a 2 credit course, the minimum duration of the MOOC should be 8 weeks.
4. MOOC course should be exclusive to courses undertaken by students. **(Repetition of Course undertaken in any semester is not allowed.)**
5. A student wishing to enroll for a MOOC course, in an upcoming academic term should give an application through ERP, to the Head of the Department, all the relevant details of the MOOC course, that he / she wants to enroll for, at least one month prior to the commencement of the upcoming academic term.
6. The details of the MOOC that need to be submitted are:
   (i) Name and Number of the course on the NPTEL/SWAYAM Platform,
   (ii) Name of the instructor,
   (iii) Details of the syllabus,
   (iv) Duration of the course,
   (v) Number of contact hours,
   (vi)Assessment methodology being adopted for the MOOC
7. Weekly assignment needs to be regularly completed as per requirement of course, which will be considered for internal assessment of course.
8. Students should submit progress report of assignment to MOOC Coordinator during the reviews.
9. At the end of the Course a detailed report on MOOC in hardcopy is mandatory.
10. There will be a MOOC coordinator to monitor the overall progress and evaluation of the given course.

Evaluation Guidelines and Rubrics:

1.Continuous Internal Evaluation (Formative Assessment) twice a semester (25 Marks each):

a) Timely completion of online assignment
b) Progress of assignment ,Best /average of the given assignments
c) Appeared for examination
d) Final Examination Certificate: **Certification is optional (MOOC Coordinator can decide minimal credit to certification 10% maximum)**

2. The overall rubrics can be proposed by Course Coordinator and course faculty in their meeting at the start of semester and get approved from academic coordinators/HoD.The rubrics should be shared to registered students at the start of semester.

Course Syllabus

Programme Elective Courses

Semester-VII and VIII

Program:	B.Tech.(E&TC)	Semester	VII/VIII
Course :	Physical Design of VLSI Circuits	Code :	BET27PE01/ BET28PE01

Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
02	02	-	-	10	10	30	50

Prior knowledge of
a. Basics of semiconductor Physics
b. Basic Electronics Engineering
is essential.

Course Objectives:
This course aims at enabling students,

1. To understand the various stages and methodologies involved in the VLSI design process, including full custom and semi-custom design techniques.
2. To Analyze partitioning strategies and optimization algorithms such as the Kernighan-Lin and Fiduccia-Mattheyses algorithms in the VLSI design process.
3. To Explore the concepts of floor planning, placement, and routing in VLSI design, and apply optimization techniques for better circuit performance.
4. Investigate the principles and tools used in physical verification, such as Design Rule Checking (DRC), Layout Versus Schematic (LVS), and Design for Manufacturability (DFM) to ensure correctness and manufacturability of the design.

Course Outcomes:
At the end of the course, the students will be able to
1. Describe the various VLSI design styles (full custom, semi-custom) and identify their applications in real-world designs.
2. Evaluate and implement the Kernighan-Lin (K-L) and Fiduccia-Mattheyses (F-M) algorithms for system partitioning to achieve optimal design results.
3. Create efficient floor plans, perform global and detailed placements, and apply optimization techniques such as simulated annealing and power planning.
4. Conduct physical verification tasks using DRC, LVS, and DFM principles to ensure the design adheres to manufacturability standards.

Detailed Syllabus:

Unit	Description	Duration [Hrs]
1	Introduction- VLSI Design Flow, VLSI Design Styles- Full custom ,semi custom design, Overview of Physical design – RTL, OASIS, GDS standards, RTL to GDS flow System Partitioning, Kernighan-Lin (K-L) Algorithm,Fiduccia-Mattheyses (F-M) Algorithm.	08
2	Floor planning – Optimization goals in floor planning, wirelength estimation, slicing and non- slicing floor plan, Design Constraints: Aspect Ratio, Pin Assignment, Macro Placement, Power Planning (Power Grids and Rings),	08
3	Placement-Global and detailed placement, Simulated annealing algorithm ,Timing and congestion considerations. Clock Tree Synthesis, clock distribution techniques- H-Tree, Buffering, Static Timing analysis-Timing closure, setup time, hold time, clock skew, clock jitter, impact of skew and jitter on performance	07

4	Routing-Global and Detailed Routing Physical Cells- Tap Cells, End Cap Cells, Filler Cells, De-cap cells Physical Verification: Introduction, DRC, LVS, Antenna violations and remedy, IR drop analysis, basics of DFM	07
	Total	30

Text Books:

1. M.J.S. Smith, "Application Specific Integrated Circuits", Pearson, 2003.
2. SudeepPasricha and NikilDutt, "On-Chip Communication Architectures System on Chip Interconnect", Elsevier, 2008.
1. S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley (India), 2006.
2. N.A.Sherwani, "Algorithms for VLSI Physical Design Automation",3rd edition, Kluwer, 2012.
Jan M. RabaeyDigitalIntergrated Circuits- A Design Perspective

Reference Books:

1. H.Gerez, "Algorithms for VLSI Design Automation", John Wiley, 1999.
2. Sarrafzadeh, M. and Wong, C.K., "An Introduction to VLSI Physical Design", 4 th Ed., McGraw-Hill.1996.
3. Andrew B. Kahng and Jens Lienig "VLSI Physical Design: From Graph Partitioning to Timing Closure", Springer, 2011.
4. Wolf, W., "Modern VLSI Design System on Silicon", 2 nd Ed., Pearson Education.2000
5. Jan.M.Rabaey et al, "Digital Integrated Circuit Design Perspective", 2nd Edition, PHI 2003.
6. Sait, S.M. and Youssef, H., "VLSI Physical Design Automation: Theory and Practice", World Scientific.1999

Program: B. Tech. (E&TC)							Semester: VII/VIII
Course: Physical Design of VLSI Circuits Lab							Code: BET27PE02/ BET28PE02
Teaching Scheme Hrs/Week				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	TW	OR	PR	Total
01	-	02	-	50	-		50

Prior knowledge of
a. Digital VLSI Design
b. A basic understanding of digital hardware design
is essential.

Course Objectives:
The objective of this laboratory is to provide the student with:
1. To give students the skills to apply VLSI design tools to simulate and optimize CMOS circuits, including performing power analysis, floor planning, placement, routing, and clock tree synthesis.
2. To train students to analyze and evaluate the trade-offs involved in VLSI design, such as timing violations, routing congestion, and power consumption, and to optimize the design for better performance and efficiency.

Course Outcomes:
After completing the course, the students should be able to:
1. Apply floor planning, placement, power planning, and routing techniques to design a small VLSI circuit, and perform tasks like static and dynamic power analysis, clock tree synthesis, and routing congestion optimization using VLSI design tools.
2. Design and optimize a complete VLSI layout, implementing clock tree synthesis, global and detailed routing, and performing static timing analysis

General Guidelines: Any Eight Experiments is to be performed to meet the above outcomes.

Detailed Syllabus:

Expt. No.	List of Experiments
1	Demonstrate Floor planning of synthesized RTL design and Evaluate Design Trade-offs
2	Design a basic floor plan for a small VLSI circuit, focusing on basic layout, aspect ratio, and pin assignment.
3	Apply the Kernighan-Lin (K-L) algorithm to partition a small circuit design into two blocks.
4	Implement the Power-planning and A. Perform Placement and B. Analyze Impact on Timing and Congestion C. Perform IR drop analysis
5	Simulate the power consumption of a basic CMOS inverter or gate using a VLSI simulation tool, and analyze both static and dynamic power.
6	Design an optimized clock tree using techniques like H-Tree and buffering to minimize clock skew and jitter in the circuit.
7	Demonstrate Clock Tree Synthesis (CTS)and Optimize Clock Skew
8	Demonstrate A) Global Routing for a Digital Design B) Analyze Routing Congestion and Implement Optimization Techniques
9	Implement detailed routing for a small design and complete the interconnections between the cells.
10	Perform Static Timing Analysis (STA) and Identify Timing Violations
11	Perform a basic Design Rule Check (DRC) on a small design to ensure that the layout follows standard manufacturing rules.

12	Perform a basic Layout vs. Schematic (LVS) check to ensure that the layout matches the intended circuit schematic.

References:

1. Neil H. E. Weste, David Harris, CMOS VLSI Design: A Circuits and Systems Perspective4th Edition,2011.
2. N.A.Sherwani, "Algorithms for VLSI Physical Design Automation",3rd edition, Kluwer, 2012.
3. Andrew B. Kahng and Jens Lienig "VLSI Physical Design: From Graph Partitioning to Timing Closure", Springer, 2011.
4. Jan M. Rabaey, AnanthChandrakasan, Borivoje Nikolic, Digital Integrated Circuits: A Design Perspective, 2nd Edition, 2003

MOOC course list:

1. **https://www.udemy.com/course/vlsi-academy-physical-design-flow**
2. **https://www.udemy.com/course/synthesis-and-static-timing-analysissta-demo-with-tools**

Program :	B. Tech. (E&TC)	Semester: VII/VIII	
Course:	Microwave Engineering	Code:	BET27PE03/ BET28PE03

Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
02	02	-	-	10	10	30	50

Prior knowledge of
Electromagnetics **is essential.**

Course Objectives:

This course aims at enabling students,

1. Develop students' understanding of microwaves and the advantages of waveguides over conventional transmission lines for microwave applications.
2. Enhance knowledge of active and passive components used in microwave systems and their corresponding theories to understand their functionality better.
3. Develop proficiency in applying microwave measurement techniques by thoroughly understanding measuring devices and set-ups.

Course Outcomes:

After learning the course, the students should be able to:

1. Compare waveguides with conventional transmission lines for microwave frequency applications in terms of efficiency, loss, and mode of propagation.
2. Design scattering matrices for passive microwave components and compare the performance of active microwave devices.
3. Classify active microwave components and devices based on their working principles, efficiency, and applications.
4. Propose an appropriate microwave measurement mechanism for evaluating key microwave parameters such as frequency, power, attenuation, and VSWR.

Detailed Syllabus

Unit	Description	Duration [Hrs]
1	**INTRODUCTION TO MICROWAVES AND WAVEGUIDES** Introduction to microwave and microwave communication systems, advantages, disadvantages, microwave hazards and ISM applications, Waveguides, comparison of waveguides with conventional transmission lines, Types of waveguides, Propagation of TEM, TE and TM mode in the rectangular waveguide and relevant mathematical analysis, Cavity resonators, microstrip lines.	09
2	**MICROWAVE PASSIVE COMPONENTS** Scattering matrices and their applications in microwave engineering, Microwave Tees, Directional couplers, Ferrite devices.	06
3	**MICROWAVE ACTIVE COMPONENTS** Microwave diodes: Gunn diode, IMPATT diodes, Schottky Diode, PIN Diode, Varactor Diode and step recovery diode Microwave tubes: Limitation of conventional tubes, O type and M type tubes, Klystron, two cavity Klystron amplifier analysis, reflex Klystron, TWTs, Magnetrons.	09
4	**MICROWAVE MEASUREMENT** Introduction to microwave measurement set-up and its components, Measurement devices and instrumentation used in microwave testing, measurement of frequency, power, attenuation, Phase shift, VSWR, Impedance, insertion loss, Noise factor and Quality factor, AI-Powered Virtual Microwave Test Benches.	06
	Total	30

Text Books:

1. S. Y. Liao, Microwave Devices and Circuits, 3rd ed. Pearson, 2003.
2. A. Das and S. K. Das, Microwave Engineering, 2nd ed. New Delhi, India: Tata McGraw-Hill, 2014.
3. M. L. Sisodia, Microwave Techniques and Laboratory Manual, 3rd ed. Hoboken, NJ, USA: Wiley, 2009.
4. M. Kulkarni, Microwave and Radar Engineering, 3rd ed. Umesh Publication, 2008.

Reference Books:

1. A. B. Smolders, H. J. Visser, and U. Johannsen, Modern Antennas and Microwave Circuits -- A Complete Master-Level Course, 2019.
2. J. C. Rautio, Handbook of Microwave Component Measurements: with Advanced VNA Techniques, Hoboken, NJ, USA: Wiley, 2013.
3. F. Gustrau, RF and Microwave Engineering: Fundamentals of Wireless Communications, Hoboken, NJ, USA: Wiley, 2012.
4. R. J. Collier and A. D. Skinner, Microwave Measurements, 3rd ed. London, UK: The Institution of Engineering and Technology, 2007.
5. R. V. Snyder, Introduction to RF and Microwave Passive Components, Norwood, MA, USA: Artech House, 2020.
6. D. M. Pozar, Microwave Engineering, 4th ed. Hoboken, NJ, USA: Wiley, 2011.

NPTEL Courses Link:

1. **https://nptel.ac.in/courses/108/103/108103141**
2. **https://nptel.ac.in/courses/108101112**

Program: B. Tech. (E&TC)						Semester: VII/VIII	
Course: Microwave Engineering Lab						Code: BET27PE04/ BET28PE04	
Teaching Scheme Hrs/Week				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	TW	OR	PR	Total
01	-	02	-	50	-	-	50

Prior knowledge of :

1. Electromagnetics **is essential.**

Course Objectives:

The objective of this laboratory is to provide the student with:

1. Understanding the characteristics and working principles of various microwave components and measurement techniques.
2. Developing practical skills in measuring and analyzing microwave parameters using a microwave test bench and related equipment.

Course Outcomes:

After completing the course, the students should be able to:

1. Analyze microwave components' characteristics and port behaviour, such as tees, directional couplers, isolators, and circulators.
2. Measure key microwave parameters, including wavelength, SWR, dielectric constant, phase shift, attenuation, and S-parameters, using a microwave test bench.
3. Verify theoretical concepts of microwave transmission and propagation through practical experiments and data interpretation.

Guidelines: Any Eight Experiments is to be performed to meet the above outcomes.

Detailed Syllabus

Expt. No.	List of Experiments
1	Study different types of microwave components and their applications.
2	Measure the radiation pattern and gain of a horn or parabolic antenna at microwave frequency.
3	Measure and plot mode characteristics of a Reflex Klystron.
4	Measure the V-I characteristics of a Gunn Diode and study the operation of a PIN modulator.
5	Measure and verify port characteristics of microwave tees (E-plane, H-plane, and Magic Tee).
6	Measure and verify port characteristics of a directional coupler and calculate coupling factor, insertion loss, and directivity.
7	Measure and verify port characteristics of an isolator and circulator and calculate insertion loss and isolation in dB.
8	Measure the wavelength of microwaves using a microwave test bench and verify it with theoretical calculations.
9	Plot the standing wave pattern and measure SWR for open, short, and matched terminations at microwave frequency using a slotted section with a probe carriage.
10	S-parameter measurements using a network analyzer.
11	Measure the dielectric constant of a given material using a microwave test bench.
12	Measure phase shift and attenuation using a microwave phase shifter and attenuator.

References:

1. M. L. Sisodia, Microwave Techniques and Laboratory Manual, 3rd ed. Hoboken, NJ: Wiley, 2009
2. D. M. Pozar, Microwave Engineering, 4th ed. Hoboken, NJ: Wiley, 2011.
3. M. Kulkarni, Microwave and Radar Engineering, 3rd ed. New Delhi, India: Umesh Publications, 2008.

Virtual Lab:

1. Virtual Electromagnetics Lab, IIT Bombay. Available: https://www.ee.iitb.ac.in/course/~vel/
2. RF and Microwave Characterization Lab, IIT Kanpur. Available: http://www.iitk.ac.in/mimt_lab/vlab/index.php

Program :	B. Tech. (E&TC)	Semester : VII/VIII	
Course :	Audio and Speech Processing	Code :	BET27PE05/ BET28PE05

Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
2	2	-	-	10	10	30	50

Prior Knowledge of:
1. Signal and Systems
2. Digital Signal Processing is essential

Course Objectives:
This course aims at enabling students,
1. To familiarize students the basic mechanism of speech production, different speech sounds and parameters.
2. To formulate speech and audio processing methods in time and frequency domain.

Course Outcomes:
After completion of this course, students will be able to,
1. Understand basic concepts of speech production and Categorize different types speech sounds different pitch and formants of speech.
2. Employ time domain speech analysis.
3. Employ frequency domain analysis.
4. Develop and analyse system for different applications of speech processing.

Detailed Syllabus:

Unit	Description	Duration [Hrs]
1.	**Fundamentals of Human speech Production :** Anatomy of the Human Speech Production System, Mechanisms of speech production, Properties of speech, Acoustic Phonetics, Articulatory Phonetics, The Acoustic Theory of Speech Production, Speech Production Variability and Disorders.	07
2.	**Speech Analysis**: Time-domain Analysis-Introduction to short-time speech analysis, short-time energy and average magnitude, short-time Zero Crossing Rate (ZCR), short-time autocorrelation function, Frequency domain analysis- Short-Time Fourier Transform (STFT), Spectrogram, Cepstral Analysis and Pitch Estimation, MFCC	09
3.	**Linear Predictive Analysis:** Basic principles of Linear predictive analysis, autocorrelation method and covariance method, computation of gain for the model, prediction error signal, frequency domain interpretation of LP analysis, applications of LPC parameters.	08
4.	**Speech and audio processing Applications**: speech enhancement, speech recognition, Text-to-Speech system and Speaker recognition systems, Acoustic Scene Classification, Fingerprinting	06
	Total	30

Text Books:
1. Douglas O'Shaughnessy, Speech Communications: Human & Machine, IEEE Press, Hardcover 2/e, 1999; ISBN: 0780334493.
2. Nelson Morgan and Ben Gold, Speech and Audio Signal Processing: Processing and Perception Speech and Music, , John Wiley & Sons, ISBN: 0471351547, July 1999
3. T.F. Quartieri, Discrete-Time Speech Signal Processing: Principles and Practice, Prentice Hall,2008

Reference Books:
1. Rabiner and Juang, Fundamentals of Speech Recognition, Prentice Hall, 1994.
2. Rabiner and Schafer, Digital Processing of Speech Signals, Prentice Hall, 1978

Online Course:
NPTEL Course Digital Speech Processing https://onlinecourses.nptel.ac.in/noc22_ee117/preview

Program: B. Tech. (E&TC)					Semester : VII/VIII		
Course : Audio and Speech Processing Lab					Code : BET27PE06/ BET28PE06		
Teaching Scheme: Hrs./Week				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	TW	OR	PR	Total
01	-	02	-	50	-	-	50

Prior knowledge of:
1. signals and systems,
2. MATLAB/Python
is essential.

Course Objectives:
The objective of this laboratory is to provide the student with:
1. To familiarize student's various domain representations of audio and speech signals.
2. To introduce students about various applications of audio and speech signals.

Course Outcomes:
After completion of this course, students will be able to,
1. Comprehend time and frequency domain representation of audio and speech signal processing.
2. Characterize various speech parameters for representation of audio and speech signals.
3. Design, implement and analyze application of speech and audio processing.

General Guidelines: Any Eight Experiments is to be performed.

Detailed Syllabus

Expt. No.	List of Experiments
1	Analysis and Synthesis of audio and speech signals
2	Identification of voiced speech, unvoiced speech, silence
3	Short time domain analysis of audio and speech Signals
4	Frequency domain analysis of audio and speech Signals
5	Linear Predictive analysis of Speech
6	Pitch Estimation
7	Formant Estimation
8	Enhancement of audio and speech signal
9	Speech Recognition
10	Speaker Recognition
11	Design and Implementation of audio or speech processing based case study.

Reference Books:

1. T. Dutoit, F. Marqués, L.R. Rabiner, Applied signal processing: a MATLAB-based Proof of Concept, Springer 2010
2. Ian Vince Mcloughlin. Speech and Audio Processing: A MATLAB-based Approach, Cambridge University Press 2016

Program :	B. Tech. (E&TC)					Semester: VII/VIII	
Course :	Advanced C++ for Embedded Programming					Code :	BET27PE07/ BET28PE07
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
02	02	-	-	10	10	30	50

Prior knowledge of
C++ for Embedded Programming
is essential.

Course Objectives:

This course aims at enabling students,

1. understanding of operator overloading and object relationships in C++, enabling them to design efficient and reusable object-oriented programs.
2. understanding of inheritance and virtual functions, template-based programs in C++

Course Outcomes:

After learning the course, the students should be able to:

1. Implement operator overloading techniques and model object relationships (composition, aggregation, and association) to create robust and maintainable C++ applications.
2. Apply inheritance and virtual functions to create flexible and maintainable C++ programs that support polymorphism and dynamic behavior.
3. Implement template-based programs and effectively utilize STL containers, iterators, and algorithms for optimized software development.
4. Implement multi-threading, synchronization, and IPC techniques in C++

Detailed Syllabus:

Unit	Description	Duration [Hrs]
1	**Operator Overloading and Object Relationships** Introduction to operator overloading - Overloading the arithmetic operators using friend functions - Overloading operators using normal functions - Overloading the I/O operators - Overloading operators using member functions - Overloading unary operators +, -, and ! - Overloading the comparison operators - Overloading the increment and decrement operators - Overloading the subscript operator - Overloading the parenthesis operator - Overloading typecasts - The copy constructor - Copy initialization -Converting constructors, explicit, and delete - Overloading the assignment operator - Shallow vs. deep copying - Overloading operators and function templates – Object relationships - Composition - Aggregation - Association - Dependencies - Container classes.	08
2	**Inheritance and Virtual Functions** Introduction to inheritance - Basic inheritance in C++ - Order of construction of derived classes - Constructors and initialization of derived classes - Inheritance and access specifiers - Adding new functionality to a derived class - Calling inherited functions and overriding behavior - Hiding inherited functionality - Multiple inheritance – Pointers and references to the base class of derived objects - Virtual functions and polymorphism - The override and final specifiers, and covariant return types - Virtual destructors, virtual assignment, and overriding virtualization - Early binding and late binding - The virtual table - Pure virtual functions, abstract base classes, and interface classes - Virtual base classes - Object slicing - Dynamic casting	08
3	**Templates and Standard Template Libraries** Template classes - Template non-type parameters - Function template specialization - Class template specialization - Partial template specialization - Partial template specialization for pointers - The Standard Library - STL containers overview - STL iterators overview - STL algorithms overview	07

4	**Multi-threading and Inter Process Communication** Thread creation – Thread operations- Thread Synchronization Mechanism- Basic Inter Process communications - Advanced Inter Process communication. **Embedded System development** Linux Basics – Make files – Coding in C++ for controlling Rasberry Pi components - Control the GPIO Pins	07
	Total	30

Text Books:

1. "Embedded Systems with C++" – Maya Posch, Apress, 2017.

Reference Books:

1. "C++ Templates: The Complete Guide" – David Vandevoorde, Nicolai M. Josuttis, Douglas Gregor, Addison-Wesley, 2017.
2. "The C++ Programming Language" – Bjarne Stroustrup, Addison-Wesley, 4th Edition, 2013.
3. "Modern C++ Programming Cookbook" – Marius Bancila, Packt Publishing, 2nd Edition, 2020.
4. "Professional C++" – Marc Gregoire, Wiley, 5th Edition, 2021.
5. "Linux System Programming: Talking Directly to the Kernel and C Library" – Robert Love, O'Reilly Media, 2nd Edition, 2013.
6. "Mastering the Raspberry Pi" – Warren Gay, Apress, 2018.

Links to learn:
10 Things Every Linux Beginner Should Know | Codementor
Getting Started with C++ on Raspberry Pi (Guide & examples) – RaspberryTips
Makefile Tutorial By Example

Program: B. Tech. (E&TC)						Semester : VII/VIII	
Course : Advanced C++ for Embedded Programming Integrated Lab						Code : BET27PE08/ BET28PE08	
Teaching Scheme Hrs/Week				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	TW	OR	PR	Total
01	-	02	-	50	-	-	50

Prior knowledge of:

a. **C++ FOR EMBEDDED PROGRAMMING is essential**

Course Objectives:

The objective of this laboratory is to provide the student with:

1. To develop expertise in Advanced C++ programming for embedded systems, focusing on multithreading, synchronization, memory management, and GPIO interfacing.
2. To provide hands-on experience in real-time embedded programming using Raspberry Pi, exploring thread scheduling, shared memory, and debugging techniques.

Course Outcomes:

After completing the course, the students should be able to:

1. Implement and manage concurrent execution in embedded systems using pthreads, mutex locks, spin locks, and thread synchronization techniques.
2. Demonstrate the ability to interface hardware components with Raspberry Pi, apply bitwise operations, and develop efficient debugging and logging mechanisms for embedded applications.

Guidelines: Any eight Experiments is to be performed to meet the above outcomes.

Detailed Syllabus:

PART:A

Expt. No.	List of Experiments
1	Write a program in CPP a. to create multiple threads and compile the program with lpthread library. b. to pass any data type in thread callback
2	Write a CPP program to simulate decimal number representation with LEDs interfaced with Eight GPIO pins on Raspberry Pi. Example: - 2(10) →0010(2)→Blink LED connected to Raspberry Pi (GPIOs) **GPIO PINS** 4 (GPIO-3) 4 (GPIO-3) 4 (GPIO-3) 4 (GPIO-3) 3 (GPIO-2) 3 (GPIO-2) 3 (GPIO-2) 3 (GPIO-2)
3	Write a CPP program to demonstrate mutex lock.
4	Write a program to create spin locks in user space.
5	Write a CPP program to create a shared memory and synchronize the threads access.
6	Write a CPP program to schedule thread execution in specific order.
7	Write a CPP program to a. simulate buffer overflow b. identify the buffer overflow
8	Write a program to Bit Set/Reset/Complement/Test/Shifting using LEDs interfaced with GIPO pins on Raspberry Pi.
9	Write CPP program using extern modifier (This needs at least two programs); Use simple Makefile to compile them.
10	Write a CPP program to handle its own debugging print levels as below Debug Information: Level INFO: 0 ALERT: 1 WARNING: 2

ERROR	3

Example: - If we pass input to the program as “0”, it should print INFO print statements alone.
If we pass input to the program as “3”, it should print ERROR statements from the program.

TextBook

1. S. Meyers, Effective Modern C++: 42 Specific Ways to Improve Your Use of C++11 and C++14, 1st ed. Sebastopol, CA, USA: O'Reilly Media, 2014.
2. M. Samek, Practical UML Statecharts in C/C++: Event-Driven Programming for Embedded Systems, 2nd ed. Newton, MA, USA: Newnes, 2008.

References:

1. S. Prata, C++ Primer Plus, 6th ed. Upper Saddle River, NJ, USA: Addison-Wesley Professional, 2011.
2. B. Stroustrup, The C++ Programming Language, 4th ed. Boston, MA, USA: Addison-Wesley, 2013.

Program :	B. Tech. (E&TC)					Semester: VII/VIII	
Course :	Connected, Autonomous & Electric Vehicle -II					Code :	BET27PE09/ BET28PE09
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
2	2			10	10	30	50

Prior knowledge of
Fundamentals of Electric, autonomous and connected vehicles technology

Course Objectives:

1. Understand the design, architecture, safety considerations, and troubleshooting of electric vehicle (EV) powertrain.
2. Develop a foundational understanding of computer vision and image processing techniques for Autonomous vehicles
3. Understand the integration of wireless networking with on-board vehicle networks to enhance vehicle connectivity
4. Understand the integration of in-car assistance, multimedia, infotainment systems, data storage, and analysis.

Course Outcomes:
The students will be able to,

1. Analyze EV powertrain systems while ensuring high voltage safety, diagnosing and troubleshooting failures.
2. Apply image processing and computer vision techniques to solve complex visual tasks of Autonomous vehicles
3. Explain the integrated wireless and on-board network systems to improve vehicle connectivity
4. Implement and secure advanced in-car assistance, multimedia, and infotainment systems, connected vehicle platform, stores and analyzes data

Detailed Syllabus:

Unit	Description	Duration [Hrs]
I	Traction System Topology for EV Applications, EV Powertrain Architecture and design, High voltage safety, Onboard charger and Charging Station, Failure mode Analysis and Diagnostic. Maintenance Guidelines and Troubleshooting for EV	**8**
II	Introduction to Computer Vision , Image processing technique, Edge and Line Detection Techniques- CANNY/ HOUGH, Transformation, Projective and Stereo Geometry, 3D Computer Vision Feature Extraction- Image Classification using ANN,CNN, PCA (Principal Component Analysis)	**8**
III	Integration of Wireless Networking and On-Board Vehicle Networks Review of On-Board Networks – Use & Function for CarsConnectivity Fundamentals (Car to Networks and within Car)Navigation and Other Applications. Vehicle-to-Vehicle Technology and Applications - V2VVehicle-to-Roadside and Vehicle-to-Infrastructure Applications - V2XWireless Security Overview and How it impacts Connected cars	**7**
IV	In Car Assistance, Multimedia and Infotainment, Android Auto/ Apple Car play, Car as a Platform, Fastag, GPS, Introduction to Automotive Cybersecurity. Building a connected Vehicle Platform connecting vehicles, storing and analyzing data and building consumer application as a Case Study	**7**
	Total	**30**
	Reference books: 1. Jiajia Liu, Abderrahim Benslimane- Intelligent and Connected Vehicle Security,River Publishers Series, 2021. 2. Zakir, Abdul Hamid ,Fadi Al-Turjman-Towards Connected and Autonomous Vehicle Highways, Technical, Security and Social Challenges, Springer, 2021 3. Sean Bennett-Electric Vehicles: A Systems Approach, G-W publishers, 2024 4. Sumit Ranjan, Dr. S. Senthamilarasu-Applied Deep Learning and Computer Vision for self driving cars, Packt publication, 2020 E-sources:	

	1. Fundamentals of Electric vehicles: Technology & Economics: https://nptel.ac.in/courses/108106170 2. Electric Vehicles - Part 1: https://onlinecourses.nptel.ac.in/noc22_ee53/preview 3. EV - Vehicle Dynamics and Electric Motor Drives: https://onlinecourses.nptel.ac.in/noc24_ee30/preview	

Program:	B. Tech. (E&TC)			Semester: VII/VIII			
Course:	Connected, Autonomous & Electric Vehicle Lab-II			Code: BET27PE10/ BET28PE10			
Credits	Teaching Scheme (Hrs. /Week)			Evaluation Scheme and Marks			
	Theory	Practical	Tutorial	TW	OR	PR	Total
1	-	2	-	50	-	-	50

Prior knowledge of

1. The basics of MATLAB/Simulink are essential.

Course Objectives:

1. Comprehend optimal traction system selection for various EV models.
2. Analyze and model EV power train components.
3. To make them aware of safety protocols and charger design.
4. To get familiar with the role of in-car networks.

Course Outcomes:

After completion of this course, the students will be able to,

1. Utilize MATLAB/Simulink to simulate and analyze traction system performance
2. Design and analyze an EV power train.
3. Explain in-vehicle networking for IoT-enabled vehicles.

Guidelines: any six from part A and Part B is compulsory

Detailed Syllabus

Expt.No.	Suggested List of Experiments
	Part A
1	Analysis and Simulation of Traction System Topologies for Electric Vehicles.
3	Modelling and Performance Analysis of EV Power train Components.
4	Simulate a functional model for smart charging systems and its fault diagnostics.
5	Simulate a functional model for smart charging systems and its fault diagnostics.
6	Architecture creation using the Draw.io kind of application for EV powertrain
7	Object classification and detection using a camera for on-road objects or obstacles
8	Create a real time city traffic data set for computer vision in day and night scenarios and identify objects.
9	Introduction to the vehicle network toolbox from MATLAB sw.
10	Simulate a model for V2V and V2G for the smart charging grid for fast DC charging system.
11	Introduction to the Cyber Security Architecture
	Part B
12	Formation of Group, Finalization of Topic
13	Submission of Synopsis
14	Completion of Simulation/Hardware

References:

1. James Larminie, John Lowry-"Electric Vehicle Technology Explained" ,2nd Edition, 2012
2. Mehrdad Ehsani, Yimin Gao, Ali Emadi-"Modern Electric, Hybrid Electric, and Fuel Cell Vehicles" ,3rd Edition, 2018
3. Iqbal Husain-"Electric and Hybrid Vehicles: Design Fundamentals" ,2nd Edition, 2011
4. Ali Emadi -"Advanced Electric Drive Vehicles",1st Edition, 2014
5. Tom Denton-"Automobile Electrical and Electronic Systems" ,5th Edition, 2017
6. Davide Andrea-"Battery Management Systems for Large Lithium Ion Battery Packs" ,1st Edition, 2010
7. Richard Szelisk- "Computer Vision: Algorithms and Applications" ,2nd Edition, 2022
8. Rafael C. Gonzalez, Richard E.-Woods "Digital Image Processing" ,4th Edition, 2018
9. Rajalingappaa Shanmugamani- "Deep Learning for Computer Vision" ,1st Edition, 2018
10. Bob Metcalfe, Kirsten Matheus, Thomas Königseder- "Automotive Ethernet: The Definitive Guide" ,2nd Edition, 2021
11. Stephan Olariu, Michele C. Weigle-"Vehicular Networks: From Theory to Practice" ,1st Edition, 2009
12. Marko Wolf -"Automotive Cybersecurity: An Introduction to ISO/SAE 21434" ,1st Edition, 2023

Program :	B. Tech. (E&TC)					Semester: VII/VIII	
Course:	Advanced, Low-Power and Emerging CMOS Technologies					Code:	BET27PE11/ BET28PE11
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
02	02	-	-	10	10	30	50

Prior knowledge of:
Basics of CMOS VLSI Design and Digital Logic Design

Course Objectives:
This course aims at enabling students to:
1. To analyze the fundamental principles of semiconductor devices, MOS capacitors, and their impact on CMOS technology.
2. To evaluate low-power design techniques and advanced CMOS technologies for improved device performance and energy efficiency.
3. To assess emerging device architectures such as FinFETs, their scaling challenges, and future trends in CMOS technology.

Course Outcomes:
After learning the course, the students should be able to:
1. Analyze the impact of carrier transport, recombination mechanisms, and MOS capacitor characteristics on threshold voltage variations.
2. Evaluate various power dissipation mechanisms in CMOS circuits and justify the selection of low-power design techniques for energy-efficient systems.
3. Interpret the advantages and challenges of SOI MOSFETs, high-k dielectricsin next-generation CMOS technology.
4. Analyze the trade-offs between advanced CMOS material-based devices for future CMOS technology.

Detailed Syllabus:

Unit	Description	Duration [Hrs]
1	Fundamentals of Semiconductor Devices & MOS Capacitors: Review of semiconductor physics: Doping, carrier transport, Short Channel Effect and their impact on device scaling.,Surface charge, accumulation, depletion, and inversion in MOS capacitors.Threshold voltage derivation and factors affecting it. Capacitance-voltage (C-V) characteristics under low and high-frequency conditions.	08
2	Low-Power CMOS Design and Techniques: Power dissipation: Static and dynamic components.Leakage currents: Subthreshold, gate, and junction leakage. Low-power techniques: Voltage scaling, transistor sizing, MTCMOS.Clock gating, power gating, and dynamic power reduction.Near-threshold and subthreshold CMOS design.	07
3	Advanced CMOS Technologies: Partially and fully depleted SOI MOSFETs.High-k gate dielectrics, metal gate electrodes, and their impact.Strained silicon for mobility enhancement.High-frequency performance, backgating effects, and limitations.	08
4	Emerging CMOS Devices – FinFETs& Beyond: FinFET basics: Structure and advantages,Bulk-FinFET and SOI-FinFET process flow.quantum effects,Scaling challenges, Introduction of 2D materials,and future CMOS trends.	07
	Total	30

Text Books:
1. Physics of Semiconductor Devices: S. M. Sze, Wiley Eastern, 5th edition, 2020.
2. Semiconductor physics and Devices, Donald Neamen, McGraw-Hill, 3rd edition. 2014
3. Modern Semiconductor Devices for Integrated Circuits, Chenming Hu, Prentice Hall, 2010.

Reference Books:
1. CMOS Circuit Design, Layout and simulation: J. Baker, D.E. Boyce., IEEE press.
2. FinFET Devices for VLSI Circuits and Systems, Samar K. Saha, Taylor and Francis Group, 2020.

MOOC course list:
1. https://archive.nptel.ac.in/courses/108/108/108108122/
2. https://archive.nptel.ac.in/courses/108/106/108106181/

Program: B. Tech. (E&TC)					Semester : VII/VIII		
Course: Advanced, Low-Power and Emerging CMOS Technologies Lab					**Code : BET27PE12/ BET28PE12**		
Teaching Scheme Hrs/Week				**Evaluation Scheme and Marks**			
Credit	**Lecture**	**Practical**	**Tutorial**	**TW**	**OR**	**PR**	**Total**
01	-	02	-	50	-	-	50

Prior knowledge of

Course Objectives:

The objective of this laboratory is to provide the student with:

1. **To analyze** the characteristics of MOS capacitors, MOSFETs, and FinFETs through circuit simulations.
2. **To evaluate** low-power techniques in CMOS logic circuits, memory cells, and flip-flops using open-source tools.
3. **To compare** the performance of conventional CMOS, SOI MOSFETs, and FinFET-based circuits in terms of power, speed, and leakage.

Course Outcomes:

After completing the course, the students should be able to:

1. **Analyze** MOS capacitor C-V characteristics, MOSFET I-V curves, and short-channel effects using circuit simulation.
2. **Evaluate** power dissipation and performance improvements in low-power CMOS circuits such as inverters, NAND gates, and current mirrors.
3. **Compare** the impact of high-k dielectrics, SOI MOSFETs, and FinFETs on the performance of SRAM cells and flip-flops.
4. **Design** optimized FinFET-based circuits, such as sense amplifiers and flip-flops, to improve power efficiency and speed in memory applications.

Detailed Syllabus:

Expt. No.	List of Experiments
1	Design and simulate a **MOS capacitor circuit** to analyze accumulation, depletion, and inversion regions
2	Simulate a **MOSFET biasing circuit** to obtain its **transfer and output characteristics** and study short-channel effects
3	Design a **CMOS inverter** and analyze **static and dynamic power dissipation**
4	Implement **clock gating in a CMOS NAND gate** and observe power savings
5	Simulate a **current mirror circuit** using SOI MOSFETs and compare its performance with a conventional MOSFET-based current mirror
6	Design and simulate a **6T SRAM cell** and analyze leakage current and stability
7	Design and simulate a **D Flip-Flop circuit using FinFETs** and compare its performance with a conventional CMOS-based Flip-Flop
8	Simulate and compare **FinFET and CMOS-based sense amplifier circuits** for SRAM, analyzing speed and power consumption

References:

1. S. M. Sze and Kwok K. Ng, *Physics of Semiconductor Devices*, 3rd Edition, Wiley, 2006.
2. Yannis Tsividis and Colin McAndrew, *Operation and Modeling of the MOS Transistor*, 3rd Edition, Oxford University Press, 2011.
3. Kang, Sung-Mo, and Yusuf Leblebici, *CMOS Digital Integrated Circuits: Analysis and Design*, 4th Edition, McGraw-Hill, 2014.
4. Behzad Razavi, *Design of Analog CMOS Integrated Circuits*, 2nd Edition, McGraw-Hill, 2016.
5. Sorin Voinigescu, *High-Frequency Integrated Circuits*, 1st Edition, Cambridge University Press, 2013.

MOOC course list:

1. https://onlinecourses.nptel.ac.in/noc24_ee77/preview?utm_source=chatgpt.com
2. https://archive.nptel.ac.in/courses/117/101/117101004/?utm_source=chatgpt.com

Program :	B. Tech. (E&TC)					Semester: VII/VIII	
Course :	5G and Beyond Wireless Networks					Code :	BET27PE13/ BET28PE13
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
2	2	-	-	10	10	30	50

Prior knowledge of
wireless communication, networking, and digital communication **is essential.**

Course Objectives:

This course aims at enabling students,

1. To build an understanding among students about the advanced concepts of 5G and beyond networks.
2. To make students aware of 5G enabling technology.
3. To Educate students about security issues and trends after 5G.

Course Outcomes:

After learning the course, the students should be able to:

1. Understand the fundamentals of 5G architecture, network components, and key enabling technologies.
2. Analyze the role of massive MIMO, beamforming, and mmWave communications in 5G.
3. Evaluate the impact of network slicing, AI/ML in 5G, and edge computing on future wireless networks.
4. Explore 6G and beyond technologies, including THz communication, AI-driven wireless systems, and quantum networks.

Detailed Syllabus:

Unit	Description	Duration [Hrs]
1	**Unit 1: Introduction to 5G Network** Evolution from 1G to 5G,5G architecture and components,Key performance metrics (latency, throughput, reliability),Use Cases: Enhanced Mobile Broadband (eMBB), Ultra-Reliable Low Latency Communication (URLLC), Massive Machine-Type Communication (mMTC),5G spectrum allocation and frequency bands,Standardization (3GPP, ITU) and regulatory aspects	07
2	**Unit 2: 5G Enabling Technologies** OFDM and waveforms used in 5G (CP-OFDM, DFT-s-OFDM),Massive MIMO and Beamforming,mmWave Communication: Challenges and solutions,5G Core Network and Cloud-Native Architecture,gNB, ng-eNBNetwork Slicing for flexible service provisioning, Edge Computing (MEC) and its role in 5G	08
3	**Unit 3: Security, AI, and Future 5G Applications** 5G Security: Threats and mitigation strategies,AI/ML applications in 5G optimization Energy Efficiency and Green Communication,V2X Communication for autonomous vehicles,Private 5G networks and Industrial IoT, Integration of satellite communication with 5G	08
4	**Unit 4: Beyond 5G (6G and Future Wireless Technologies)** 6G Vision and requirements, THz Communication: Potential and challenges, AI-driven wireless networks and cognitive radio, Quantum Communication and secure 6G networks,Integration of 6G with IoT, AI, and blockchain,Future trends in wireless communication and standards. Case studies. i. Network Slicing in Enterprise Applications ii. mMTC: Smart Agriculture	07
	Total	30

Text Books:

1. H. Sun, R. Q. Hu, and Y. Qian, “5G and Beyond Wireless Communication Networks”. Hoboken, NJ, USA: Wiley-IEEE Press, 2023.
2. Manish Mandloi, Devendra Gurjar, Prabina Pattanayak, Ha Nguyen, "5G and Beyond Wireless Systems: PHY Layer Perspective",Springer Singapore,2020.

Reference Books:

1. X. Huang and J. A. Zhang, "5G Mobile Communications: Concepts and Technologies," CRC Press, 2020.
2. M. Shafi, A. F. Molisch, P. J. Smith, T. Haustein, P. Zhu, and P. De Silva, "5G: A Tutorial Overview of Standards, Trials, Challenges, Deployment, and Practice," IEEE Press, 2019.
3. F. Hu, "5G Development and Applications," Springer, 2021.

NPTEL links: *https://nptel.ac.in/courses/117104115*

Program: B. Tech. (E&TC)				Semester : VII/VIII			
Course : 5G and beyond Wireless Networks Lab				Code : BET27PE14/ BET28PE14			
Teaching Scheme Hrs/Week				Evaluation Scheme and Marks			
Credit	**Lecture**	**Practical**	**Tutorial**	**TW**	**OR**	**PR**	**Total**
01	-	02	-	50	-	-	50

Prior knowledge of:
basics of communication systems is essential.

Course Objectives:
The objective of this laboratory is :
1. To expose students the trending 5G PHY design.
2. To introduce to 6G and related research in the domain.

Course Outcomes:
After completing the course, the students should be able to:
1. Apply the principles of advanced modulation, multiple access, and channel coding techniques in 5G and beyond wireless systems.
2. Design practical PHY layer solutions, including Massive MIMO, beamforming, and mmWave communication, for 5G and beyond networks.

Guidelines: Any Ten Experiments is to be performed to meet the above outcomes.

Detailed Syllabus

Expt. No.	List of Experiments
1	Simulate an OFDM system and analyze its performance in terms of BER (Bit Error Rate) and PAPR (Peak-to-Average Power Ratio) under different channel conditions.
2	Implement and compare the performance of FBMC and OFDM waveforms in terms of spectral efficiency and out-of-band emissions.
3	Simulate a NOMA system with multiple users and evaluate its performance in terms of user throughput and fairness.
4	Implement LDPC and Polar channel codes and compare their error correction performance under different SNR (Signal-to-Noise Ratio) conditions.
5	Simulate a Massive MIMO system with beamforming and analyze its impact on signal strength and interference reduction.
6	Simulate channel estimation techniques in a Massive MIMO environment and evaluate their accuracy.
7	Simulate mmWave propagation and analyze path loss variations with distance and frequency.
8	Simulate mmWave beam steering and evaluate the impact of beam alignment on signal reception.
9	Simulate a MIMO system, and vary the number of antennas at the base station and user equipment, and observe the change in system capacity.
10	Simulate a channel with a RIS present, and show how the RIS can improve the signal strength at the receiver.
11	Research paper presentation on recent trends
12	Field visit and technical report submission.

References:

1. Manish Mandloi, Devendra Gurjar, Prabina Pattanayak, Ha Nguyen, "5G and Beyond Wireless Systems: PHY Layer Perspective",Springer Singapore,2020.
2. https://www.mathworks.com/solutions/wireless-communications/5g.html
3. https://www.mathworks.com/campaigns/offers/5g-technology-ebook.html

Program :	B. Tech. (E&TC)			Semester: VII/VIII			
Course :	Biomedical Signal Processing			Code :		BET27PE15/ BET28PE15	
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
02	02	-	-	10	10	30	50

Prior knowledge of
a. Digital signal processing
b. Basic Electronics Engineering
is essential.

Course Objectives:
This course aims at enabling students,
1. To describe the use of analog and digital signal processing for several biomedical applications.
2. To explore the process of estimation, detection and filtering on biomedical signals.

Course Outcomes:
After completion of this course students will be able to
1. Understand physiological signals and its behavior.
2. Choose appropriate filtering and artifact removal methods in biomedical signal processing.
3. Analyze heart behavior using ECG signal processing and parameter extraction.
4. Apply knowledge of EEG signal processing to analyze brain behavior.

Detailed Syllabus:

Unit	Description	Duration [Hrs]
1.	Introduction to biomedical signals: ECG, EEG, EMG, Electro-oculogram (EOG), Vibrarthographic (VAG), Biomedical signal acquisition and processing, Difficulties in signal acquisition, Signal Conversion, Signal Averaging	6
2.	Adaptive Noise Filtering: Principle noise canceller model, 60-Hz adaptive canceling using a sine wave model, other applications of adaptive filtering. Band pass filtering techniques Signal Artifact Removing Methods: PCA,ICA, EEGLAB Toolbox	8
3.	Cardio-logical signal processing: Basic Electrocardiography, ECG data acquisition, ECG lead system, ECG signal characteristics (parameters and their estimation), Power spectrum of the ECG, A QRS detection algorithm, ECG interpretation, ST segment analyzer, Portable arrhythmia monitor.	8
4.	Neurological signal processing: The brain and its potentials, the electrophysiological origin of brain waves, The EEG signal and its characteristics (EEG rhythms, waves, and transients), Correlation. Analysis of EEG channels: Detection of EEG rhythms, Analysis of sleep EEG	8
	Total	30

Text Books:
1. Rangaraj M Rangayyan “Biomedical Signal Analysis – A case study approach” IEEE press series in biomedical engineering, First Edition, 2002.

Reference Books:
1. Eugene N. Bruce, Biomedical Signal Processing and Signal Modeling, First Edition, John Wiley & Sons, 2001
2. Biomedical Digital Signal Processing- Willis J. Tompkins, Second Edition, Prentice-Hall, 2006Bajaj, V., Sinha, G.R., & Chakraborty, C. (Eds.). (2021).
3. Biomedical Signal Processing for Healthcare Applications (1st ed.). CRC Press.
4. Biomedical Signal Processing Principles and Techniques- D C Reddy, Third Edition, McGrawHill publications 2007

MOOC course:–
Biomedical Signal Processing course https://onlinecourses.nptel.ac.in/noc20_ee41/preview

Program: B. Tech. (E&TC)				Semester : VII/VIII			
Course : Biomedical Signal Processing Lab				Code : BET27PE16/ BET28PE16			
Teaching Scheme Hrs/Week				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	TW	OR	PR	Total
01	-	02	-	50	-	-	50

Prior knowledge of:
1. Basic of signal transforms
2. Basic programming skills

is essential.

Objectives:
1. To describe the physiological biomedical signals.
2. To explore importance of biomedical signals in real time applications.

Outcomes:
After completion of this course students will be able to,
1. Sketch/ Interpret various physiological biomedical signals.
2. Apply various types of filtering operation to remove artifacts from the biomedical signals in time, frequency, or time-frequency domains.
3. Discriminate the important features of the biomedical signals.

Guidelines: Any Six Experiments is to be performed to meet the above outcomes.
Practical:
1. Practical for 25 Marks.
2. Practical Assessment will be based on PART A

Term work:
1. Term Work for 25 Marks
2. For Term Work assessment only Mini Project is mandatory.

Detailed Syllabus:

PART:A

Expt. No.	List of Experiments
1	To create real-time database for EEG/ECG.
2	To remove the artifacts from real-time captured signal using various types of filtering operations.
3	To analyze time and frequency domain characteristics of ECG using suitable tool.
4	To remove the artifacts from ECG signal using various types of filtering operations.
5	To detect the QRS component from the given ECG data.
6	To detect the arrhythmia using heart rate variability (HRV)analysis.
7	To analyze time and frequency domain characteristics of EEG using suitable tool.
8	To remove the artifacts from EEG signals using EEGLAB Toolbox
9	To extract statistical features of EEG signals.
10	To analyze sleep disorder using EEG signal.

11	To analyze the muscle activity using EMG.
12	Frequency-domain Analysis of Biomedical Signals using DWT or EMD.
PART B : Mini Project	
1	Formation of Group, Finalization of Topic
2	Submission of Synopsis
3	Completion of Simulation
4	Completion of Hardware
5	Completion of Hardware

Reference Books:

1. R M Rangayyan “Biomedical Signal Analysis: A case Based Approach”, IEEE Press, John Wiley & Sons. Inc, 2002
2. D C Reddy “Biomedical Signal Processing: Principles and Techniques”, Tata McGraw-Hill Publishing Co. Ltd, 2005
3. Willis J. Tompkins “Biomedical Digital Signal Processing”, EEE, PHI, 2004

Program :	B. Tech. (E&TC)					Semester: VII/VIII	
Course :	Product Development Process					Code :	BET27PE17/ BET28PE17
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
02	02	-	-	10	10	30	50

Prior knowledge of….Nil

Course Objectives:

This course aims at enabling students,

1. To provide an in-depth understanding of the product development process, from ideation to final product launch, covering market research, competitor analysis, and requirements gathering.
2. To equip students with knowledge of product design, development, verification, and validation, incorporating Agile methodologies, prototyping, testing, and industry-standard tools.

Course Outcomes:

After learning the course, the students should be able to:

1. Analyze and define product requirements, develop scope and requirement documents, and apply brainstorming techniques for ideation.
2. Demonstrate the ability to design and prototype products, incorporating architecture design, coding standards, and database integration.
3. Gain proficiency in verification and validation techniques, performing unit, integration, functional, and user acceptance testing using industry-standard tools.
4. Understand Agile development (Scrum) methodologies, including sprint planning, backlog management, Scrum roles, and using tools like JIRA and Confluence for project tracking.

Detailed Syllabus:

Unit	Description	Duration [Hrs]
1	**Product definition** Types of products – generic and customized – product development process- Ideation – brainstorming techniques - marketing research – competitor analysis - product definition – scope document– requirements document	08
2	**Product design and development** Prototyping – PoC – Architecture - Design concept - Design document - Unified Models – Design Patterns - coding standards – database design and integration	08
3	**Product verification and validation** Unit testing – Integration testing – Functional testing- non-functional testing - User Acceptance testing – regression testing – debugging and testing tools	07
4	**Agile Development (Scrum)** Scrum – Sprints – Sprints planning – Ceremonies – Backlogs – Sprint Review – Standups – Scrum master – Retrospectives – Distributed Scrums – roles – Scrum of Scrums - Agile Scrum artifacts – Scrum metrics – JIRA- Confluence Scrum	07
	Total	30

Self Learning

Development and Deployment tools and Platforms

IDEs – Static and Dynamic Code analysis tools- SCM - CI/CD Pipelines – DevOps – Cloud Solutions (Azure, AWS, GCP) – Cloud Deployment (Host as VM, PaaS, Saas, Cloud Native)

Text Books:

1. C. Larman, Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development, 3rd ed. Upper Saddle River, NJ, USA: Prentice Hall, 2004.
2. K. Ulrich and S. Eppinger, Product Design and Development, 7th ed. New York, NY, USA: McGraw-Hill, 2020.

Reference Books:

1. J. Highsmith, Agile Project Management: Creating Innovative Products, 2nd ed. Boston, MA, USA: Addison-Wesley, 2009.
2. E. Ries, The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, 1st ed. New York, NY, USA: Crown Business, 2011.
3. M. Cohn, Succeeding with Agile: Software Development Using Scrum, 1st ed. Boston, MA, USA: Addison-Wesley, 2009.
4. K. Beck et al., Manifesto for Agile Software Development, 1st ed. Agile Alliance, 2001.
5. S. Thomke, Experimentation Matters: Unlocking the Potential of New Technologies for Innovation, Boston, MA, USA: Harvard Business School Press, 2003.

Links to learn:

1. What is Product Development? The 6 Stage Process [2023] • Asana
2. 7 Steps of Product Development Process: A Comprehensive Guide | OFFEO
3. 7 Definitions of Concept - Simplicable
4. Design Patterns in C++ (refactoring.guru)
5. Scrum Sprints: Everything You Need to Know | Atlassian
6. The Step-by-step Product Development Process Guide | ClickUp
7. Roger Pressman – Software Engineering - 7th edition

Program: B. Tech. (E&TC)					Semester : VII/VIII		
Course : Product Development Process Lab					Code : BET27PE18/ BET28PE18		
Teaching Scheme Hrs/Week				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	TW	OR	PR	Total
01	-	02	-	50	-	-	50

Prior knowledge of:
Nil **is essential**

Course Objectives:

The objective of this laboratory is to provide the student with:

1. To provide hands-on experience in the end-to-end product development process, including ideation, prototyping, design, testing, and validation.
2. To implement Agile and Scrum methodologies for efficient product development, team collaboration, and iterative design improvements.

Course Outcomes:

After completing the course, the students should be able to:

1. Demonstrate the ability to define product requirements through market research, competitor analysis, and brainstorming techniques.
2. Develop and validate a working prototype, implementing software and hardware design principles, testing strategies, and debugging tools.

Guidelines: Any eight Experiments is to be performed to meet the above outcomes.

Detailed Syllabus:

PART:A

Expt. No.	List of Experiments
1	Conduct a brainstorming session to generate product ideas and document findings
2	Perform market research on a selected product, including competitor analysis.
3	Develop a Product Scope Document based on business and technical requirements.
4	Develop a Proof of Concept (PoC) for a selected product idea using prototyping tools.
5	Design a System Architecture Diagram and create a high-level design document.
6	Use UML modeling tools to represent workflows (Use Case Diagrams, Sequence Diagrams).
7	Perform unit testing on software modules using an automated testing framework.
8	Conduct integration testing to verify interactions between different components.
9	Create and manage a Scrum backlog using JIRA or an equivalent tool
10	Plan and execute a Sprint cycle, including backlog grooming, sprint planning, and retrospectives.

References:

1. Ulrich, K. T., & Eppinger, S. D. (2019). Product Design and Development (6th ed.). McGraw-Hill Education.
2. Pahl, G., Beitz, W., Feldhusen, J., & Grote, K. H. (2007). Engineering Design: A Systematic Approach (3rd ed.). Springer.
3. Gamma, E., Helm, R., Johnson, R., & Vlissides, J. (1994). Design Patterns: Elements of Reusable Object-Oriented Software. Addison-Wesley. 4. Sommerville, I. (2015). Software Engineering (10th ed.). Pearson.
4. Myers, G. J., Sandler, C., & Badgett, T. (2011). The Art of Software Testing (3rd ed.). John Wiley & Sons. 6. Perry, W. E. (2007). Effective Methods for Software Testing (3rd ed.). John Wiley & Sons.
5. Schwaber, K., & Sutherland, J. (2020). The Scrum Guide: The Definitive Guide to Scrum: The Rules of the Game. Scrum.org. 8. Rubin, K. S. (2012). Essential Scrum: A Practical Guide to the Most Popular Agile Process. Addison-Wesley

Program :	B. Tech. (E&TC)	Semester: VII/VII	
Course :	Automotive Cyber Security	Code :	BET27PE19/BET28PE19

Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
02	02	-	-	10	10	30	50

Prior knowledge of

Basic knowledge of computer networks, cybersecurity concepts, embedded systems, and programming (C, Python, or embedded C).is essential.

Course Objectives:

This course aims at enabling students,

1. To provide students with a foundational knowledge of automotive cybersecurity, including communication protocols, attack surfaces, and security standards.
2. To provide students with the ability to identify and analyze cybersecurity threats, vulnerabilities, and attack scenarios in modern automotive systems.

Course Outcomes:

After learning the **course**, the students should be able to:

1. **Understand automotive cybersecurity fundamentals,** including communication protocols, attack surfaces, and regulations.
2. **Identify and assess threats and vulnerabilities in** ECUs, telematics, and V2X communication.
3. **Apply cybersecurity defense mechanisms** like cryptography, secure development, and intrusion detection.
4. **Analyze emerging trends and compliance** in AI-driven security, V2X, and autonomous vehicle protection.

Detailed Syllabus:

Unit	Description	Duration [Hrs]
1	**Introduction to Cyber Security:** Overview of Automotive Cybersecurity, Evolution of Automotive Security Challenges, Vehicle Communication Protocols (CAN, LIN, FlexRay, MOST, Automotive Ethernet), Attack Surfaces in Modern Vehicles, Cybersecurity Standards and Regulations (ISO/SAE 21434, UNECE WP.29, NHTSA Guidelines)	08
2	**Threats,** Attacks**, and Vulnerabilities in Automotive Systems** Types of Cyber Threats, Vulnerabilities in ECUs, Telematics, and V2X Communication Attack Scenarios (Keyless Entry Hacks, GPS Spoofing, OBD-II Exploits, Remote Hacking), Case Studies: Real-World Automotive Cyber Attacks (Jeep Hack, Tesla Security Flaws, etc.). Risk Assessment and Threat Modelling for Vehicles	08
3	**Cybersecurity Measures and** Defense **Mechanisms** Secure Automotive Software Development Lifecycle (SDLC), Cryptographic Techniques in Automotive Security (Encryption, Authentication, Secure Boot), Intrusion Detection and Prevention Systems (IDPS) for Vehicles, Secure Over-the-Air (OTA) Updates and Firmware Security, In-Vehicle Security Monitoring and Threat Intelligence	07
4	**Future Trends and Compliance in Automotive Cybersecurity** Role of Artificial Intelligence and Machine Learning in Automotive Security, Secure V2X and Connected Vehicle Ecosystem (5G Security, Cloud Security in Automotive), Cybersecurity Challenges in Autonomous Vehicles, Automotive Penetration Testing and Ethical Hacking Approaches	07
	Total	30

Text Books:

1. "Automotive Cybersecurity: An Introduction to ISO/SAE 21434" – Mark McLain and Jason Smith, 1st Edition, SAE International, 2021.
2. "Automotive Embedded Systems Handbook" – Nicolas Navet and Francoise Simonot-Lion, 2nd Edition, CRC Press, 2017.

Reference Books:

1. "Vehicle Security: Security Vulnerabilities and Solutions in Smart Vehicles" – Yeswanth Rao and B Balamurugan, 1st Edition, Springer, 2021.
2. "Cybersecurity for Connected Vehicles: Fundamentals, Security Techniques, and Applications" – Shingo Yamaguchi, 1st Edition, Springer, 2020.

MOOC Courses:

1. https://www.mooc-list.com/course/automotive-cyber-security-introduction-futurelearn?utm_source=chatgpt.com
2. https://www.coursera.org/learn/introduction-to-automotive-cybersecurity-vehicle-networks?utm_source=chatgpt.com
3. https://www.sae.org/learn/content/c2105/?utm_source=chatgpt.com

Program: B. Tech. (E&TC)					Semester : VII/VIII		
Course : Automotive Cyber Security Lab					**Code :** BET27PE20/BET28PE20		
Teaching Scheme Hrs/Week				**Evaluation Scheme and Marks**			
Credit	**Lecture**	**Practical**	**Tutorial**	**TW**	**OR**	**PR**	**Total**
01	-	02	-	50	-		50

Prior knowledge of:

1. Basics of Microcontroller and Microprocessors
2. Basics of Computer Networks and security.

Course Objectives:

The objective of this laboratory is to provide the student with:

1. To provide basic foundation of automotive cybersecurity concepts.
2. To make students aware about various automotive protocol implementations.
3. To identify the malicious activity in the vehicular network.

Course Outcomes:

After completing the course, the students should be able to:

1. Develop secure automotive systems by monitoring and analyzing vehicle communication networks, detecting anomalies, and applying security measures.
2. Analyze CAN bus communication and evaluate message injection attacks using ICSim, CANToolz, and Wireshark.
3. Design and implement an Intrusion Detection System (IDS) on Raspberry Pi to prevent DoS and DDoS attacks in automotive networks

Guidelines: Any Eight Experiments is to be performed to meet the above outcomes.

Detailed Syllabus:

Expt. No.	List of Experiments
1	To monitor and log OBD-II (On-Board Diagnostics) data using Python.
2	To write a Python script to create a basic firewall for CAN bus traffic.
3	To develop a Python script to monitor ECU response time and detect delays.
4	To implement a secure keyless entry system using Arduino and RFID.
5	To simulate and analyze Controller Area Network (CAN) bus communication between multiple Electronic Control Units (ECUs) using ICSim or CANoe tool
6	To perform a message injection attack on a virtual CAN bus environment using ICSim and CANToolz to manipulate vehicle functions
7	To capture and monitor CAN network traffic to detect malicious messages and abnormal behavior using Wireshark with CAN protocol filters
8	To Demonstrate the DoS attack using Raspberry pi and analyze it using Wireshark tool.
9	To Demonstrate the DDoS attack using Raspberry Pi and analyze it using Wireshark tool.
10	To develop and implement a basic Intrusion Detection System (IDS) on Raspberry Pi to detect malicious messages and prevent unauthorized access to vehicle functions

Reference Books:

1. T. M. Monk, "OBD-II: Functions, Monitors and Diagnostic Techniques", 2nd ed. SAE International, 2016.
2. K. Koscher, A. Czeskis, F. Roesner, S. Patel, T. Kohno, and S. Checkoway, "Experimental Security Analysis of a Modern Automobile," *IEEE Symposium on Security and Privacy*, pp. 447-462, 2010.
3. C. Miller and C. Valasek, *"Car Hacker's Handbook: A Guide for the Penetration Tester"*, No Starch Press, 2016.
4. R. A. Miller, *"CAN System Engineering: From Theory to Practical Applications"*, SAE International, 2012.
5. P. Schreiner, *"Raspberry Pi for Cyber Security Experts: Perform DoS and DDoS Attacks and Implement an IDS System"*, Packt Publishing, 2021.

MOOC Courses:

1. https://www.coursera.org/learn/introduction-to-automotive-cybersecurity-vehicle-networks
2. https://www.futurelearn.com/courses/basics-of-automotive-cyber-security

Program:	B. Tech. (E&TC)	Semester: VIII/VII	
Course:	Research Methodology (MOOC)	Code:	BET28EL01/ BET27EL01

Credits	Teaching Scheme (Hrs./Week)				Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	Other	FA		SA	Total
					FA1	FA2		
02	02	-	-	-	25	25	-	50

Prior knowledge of:

Mini-project work and seminar presentation **is essential**

Course Objectives:

This course aims at enabling students to:

1. **Identify** research problems and formulate hypotheses.
2. **Analyze** engineering data using descriptive and inferential statistical methods.
3. **Develop** and analyze mathematical and simulation-based models for engineering systems.
4. **Write** research reports, **prepare** publications, and **understand** the fundamentals of Intellectual Property Rights.

Course Outcomes:

After learning the course, the students should be able to:

1. **Define** a research problem and develop a suitable hypothesis
2. **Apply** statistical tests and interpret results to support engineering conclusions
3. **Construct** and validate system models and predict performance using appropriate analytical or simulation methods.
4. **Structure** research reports, **format** publications correctly, and **identify** patentable engineering innovations.

Guidelines:

1. Individual student should register for MOOC course of their interest provided in the **NPTEL/SWAYAM links given in the syllabus.(See links on next page)**
2. The course contents should cover given syllabus contents (at least 75 % match).
3. Student should submit the registration details with documentary proof to Course Coordinator/Course Faculty.
4. Course selected should be Minimum of 30-45 hours or 8-12 weeks contact hours.
5. Weekly assignment needs to be regularly completed as per the requirement of course, which will be considered for formative assessment of the course.
6. Students should submit progress report of assignment to course coordinator during the regular reviews/interactions.
7. At the end of the Course a detailed report on MOOC in hardcopy is mandatory.
8. Course coordinators will decide the evaluation rubrics for FA1 and FA2.
9. Certification of MOOC will be optional but carry 10% credit in overall evaluation
10. Course coordinator/Faculty will ensure the overall evaluation as per rubrics set in their course meetings.

Detailed Syllabus:

Unit	Description	Duration (Hrs.)

1	**Research Problem and Research Design** *Research:* Meaning & importance, Types of research (Basic, Applied, Experimental in Engineering), Difference: Research Methods vs Methodology, Characteristics of good research, Definition, identification & feasibility of research problem *Hypothesis:* meaning, types, and role in decision making, Selecting research problems from Communication, VLSI, Signal Processing, AI-IOT, Embedded Systems.	**6**
2	**Applied Statistics** *Measures of Variability:* Standard Deviation, variance, Quartiles, Interquartile Range *Inferential Statistics:* Statistical Significance (p values), Pearson 's test, t- test, Chi square test, ANOVA (Analysis of variance), Signal-to-Noise Ratio (SNR) vs filter performance	**7**
3	**Mathematical Modelling & System Performance Prediction** *Mathematical model*: concept and need of model systems for engineers, *Types of models:* Analytical, Simulation-based, Empirical, Steps to build a simulation model, Validation & sensitivity analysis, Linear & Nonlinear Filters (FIR/IIR), DSP Model example: Convolution system response prediction.	**8**
4	**Research Report Writing, Publication & IPR** *Report Writing***:** Research report structure, Steps for writing literature review, Referencing styles (IEEE format), Use of Turnitin / Grammarly / Plagiarism checkers. *Research Publication:* Difference: Conference paper vs Journal paper, Impact factor, Scopus, SCI indexing, Peer review and publication workflow, IEEE Xplore search & IEEE Conference Paper formatting. *Intellectual Property Rights (IPR):* Definition of IPR, Need of Filing Patents for engineers, Patentable vs non-patentable electronics inventions, Case Study of Patent and Copyright.	**9**
	Total	**30**

Textbooks:

1. C. R. Kothari and G. Garg, *Research Methodology: Methods and Techniques*, 4th Edition, New Age International Publishers, 2019.
2. Ranjit Kumar, *Research Methodology: A Step-by-Step Guide for Beginners*, 4th Edition, Sage Publications, 2024.
3. Ramakrishna B and Anil Kumar H S., *Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers*, Notion Press, 2017.

Reference Books:

1. Virendra Kumar Ahuja, *IPR in India*, LexisNexis Butterworths Wadhwa Nagpur, 2017.
2. Stuart Melville and Wayne Goddard, *Research methodology: An Introduction for Science & Engineering students*, Juta Education, 1996.

NPTEL/ SWAYAM Online Courses / MOOCs:

1. **Research Methodology:https://onlinecourses.nptel.ac.in/noc23_ge36/preview**
2. **Research Methodology and Statistical Analysis:** https://onlinecourses.swayam2.ac.in/nou25_cm15/preview
3. **Research Methodology & IPR:https://onlinecourses.swayam2.ac.in/ntr24_ed08/preview**

Program: B. Tech. (E&TC)					Semester: VIII/ VII			
Course: Research Methodology Lab					Code: BET28EL02/ BET27EL02			
Teaching Scheme Hrs/Week					Evaluation Scheme and Marks			
Credit	**Lecture**	**Practical**	**Tutorial**	**Other**	**TW**	**OR**	**PR**	**Total**
2	-	4	-	-	100	-	-	100

Prior knowledge of:

Mini-project work and seminar presentation **is essential**

Course Objectives:

The objective of this laboratory is to provide the student with:

1.The ability to **identify and define** research problems through literature review and problem analysis.
2. The skills to **organize and manage** references using standard citation and reference management tools.
3. The competency to **analyze** engineering data using descriptive and inferential statistical techniques.
4.The capability to **develop** basic mathematical models and prepare research reports in standard technical formats.

Course Outcomes:

After completing the course, the students should be able to:

1. **Identify** a research problem and prepare a well-defined problem statement.
2. **Use** reference management tools to organize literature and citations effectively.
3. **Apply** statistical techniques to analyze engineering data and interpret results.
4. **Prepare** research reports and presentations in standard technical and IEEE formats.

Guidelines:

- Perform any *Six* experiments from Part A
- Part B experiments are *Compulsory*
- Students must prepare a lab journal with screenshots, results & reflection notes
- Use tools like Google Scholar, IEEE Xplore, Mendeley, Zotero, Excel, MATLAB, Python (NumPy/SciPy), Word/LaTeX

Term Work: 100 Marks

1. Continuous assessment of Practical Work (Part A): 60 Marks
    - Each experiment in Part A is assessed out of 100 marks and scaled down to 10 marks.
    - Total marks for Part A practical performance = 60 Marks.

Part B (Research Paper & Report): 50 Marks

- Research Paper Preparation: 20 Marks
- Research Report Preparation:20 Marks
- Plagiarism Check (≤ 10%) – 10 Marks

The final Term Work marks will be based on overall performance, documentation, and viva.

Detailed Syllabus:

Part A

Expt. No.	List of Experiments
1	Identification of a Research Problem and Preparation of Problem Statement
2	Literature Survey and Preparation of Literature Review Matrix
3	Reference Management using Citation Tools: Mendeley / Zotero
4	Research Report Formatting using MS Word/LaTeX
5	Data Acquisition and Basic Statistical Analysis
6	Hypothesis Testing on Sample Engineering Data (t-test / Chi-square / ANOVA)
7	Developing a Mathematical Model and Performance Prediction

Part B	
1	Research Paper Formatting (IEEE Conference Template)
2	Plagiarism Check and Research Ethics Awareness

Textbooks:

1. C. R. Kothari and G. Garg, *Research Methodology: Methods and Techniques*, 4th Edition, New Age International Publishers, 2019.
2. Ranjit Kumar, *Research Methodology: A Step-by-Step Guide for Beginners*, 4th Edition, Sage Publications, 2024.
3. Ramakrishna B and Anil Kumar H S., *Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers*, Notion Press, 2017.

Reference Books:

1. Virendra Kumar Ahuja, *IPR in India*, LexisNexis Butterworths Wadhwa Nagpur, 2017.
2. Stuart Melville and Wayne Goddard, *Research methodology: An Introduction for Science & Engineering students*, Juta Education, 1996.

Program: B. Tech. (E&TC)					Semester: VIII/ VII			
Course: Internship					Code: BET28EL04/ BET27EL04			
Teaching Scheme Hrs/Week					Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	Other	TW	OR	PR	Total
12	-	40	-	-	300	150	-	450

Prior knowledge of:

Mini-project work and seminar presentation **is essential**

Course Objectives:

The objective of the internship is to provide the student with:

1. To expose students to real-world industrial/research environments.
2. To bridge the gap between academic curriculum and industry practices.
3. To develop skills in communication, teamwork, problem-solving, and project management.
4. To encourage innovation, critical thinking, and a multidisciplinary approach.
5. To help students build a professional network and enhance employability.

Course Outcomes:

After completing the internship, the students should be able to:

1. Apply theoretical knowledge to practical problems.
2. Understand workplace dynamics and organizational structure.
3. Develop hands-on skills in software/hardware tools.
4. Document and present technical work systematically.
5. Gain clarity on career path—industry, higher studies, or entrepreneurship.

General Guidelines:

1. All internships must be pre-approved by the Department Internship Coordinator.
2. Students must maintain a weekly log and get it signed by the industry mentor.
3. A plagiarism-free internship report is mandatory.
4. Minimum attendance of 90% during the internship period is expected.
5. Faculty mentors will be assigned to each student for monitoring and guidance.
6. **As per the respective schemes, students are required to opt for an Project scheme as follows:**
   - **Scheme A:** Students must opt for the internship in the **VIII semester**.
   - **Scheme B:** Students must opt for the internship in the **VII semester**.
   - Students can avail the internships of minimum 8 weeks to maximum 12 weeks.
   - Review 1 will be conducted at the commencement of the internship (as per the Scheme selected), and Review 2 will be conducted at the end of the VIII semester.
7. Internship completion will be considered only after submission of valid documents at the end of internship like Synopsis Report, Completion certificate, Report and presentation of work done etc. and after TW completion.

Plan of implementation

Year	Credits	Duration	Marks TW	Oral	Suggested Weeks
SY	2	Short-term	50	--	2–3 weeks
TY	4	Mid-term	100	50	4–6 weeks
B.Tech	6	Long-term / Capstone	150	100	8+ weeks

Internship Guidelines Year wise

SY (2 Credits – 50 Marks)

- Types: Introductory internships, shadowing, NGO/social innovation projects, skill-based training (AICTE virtual internships, coding platforms, etc.)
- Examples: Atal Tinkering Labs, MSMEs, NGO tech support, online simulations, basic project-based learning.

TY (4 Credits – 100 Marks)

- Types: Industry-assigned mini projects, product prototype development, government/academic lab internships, virtual internships with deliverables.
- Examples: Smart India Hackathon follow-ups, IoT, Embedded System prototyping, open-source contributions.

B.Tech (6 Credits – 150 Marks)

- **T**ypes: Industry R&D, Capstone projects, startup internships, research internships at premier institutes (IITs, IISc, IISER), or government bodies (DRDO, ISRO).
- Examples: Design and development projects, Verilog/VLSI research, product validation, publication-driven internships.

Please visit Department Webpage for detailed Internship Guidelines
https://entc.pccoepune.com/syllabi.php

Program: B. Tech. (E&TC)							Semester : VII/VIII
Course : Project							Code : BET28EL03/ BET27EL03
Teaching Scheme Hrs/Week				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	TW	OR	PR	Total
04	-	08	-	100	50		150

Prior knowledge of:
Research Methodology is essential.

Course Objectives:
The objective of the project is:

1. To enable students to identify, analyze, and solve real-life engineering problems using E&TC concepts, modern tools, and systematic project development approaches.
2. To develop the ability to design, implement, test, and document an engineering solution while applying appropriate standards and constraints.
3. To cultivate teamwork, project management, ethical responsibility, and effective technical communication skills.

Course Outcomes:
After completing the project :

1. Students will be able to define a problem statement, conduct literature review, and formulate project requirements with justified methodologies.
2. Students will design and develop a functional prototype/system using relevant E&TC hardware/software tools and evaluate its performance against set objectives.
3. Students will prepare professional documentation, demonstrate the project effectively, and exhibit teamwork, ethical practices, and project management skills.

Detailed Project Guidelines are given in Annexure -A

ANNEXURE-A
Project Guidelines
B.Tech. E&TC Engineering
(Sem-VII and VIII)

B.Tech. Project

Approach of the Project work is to develop a **teaching method in** which students gain knowledge and skills by **working for an extended period of time** to investigate and respond to an authentic,engaging, and complex question, problem, or challenge.

SCHEME A

			Credit Scheme				Teaching Scheme(Hours/Week)				Evaluation scheme and Marks					
Course Code	Course Type	Course Name	L	P	T	Total	L	P	T	Total	FA1	FA2	TW	PR	OR	Total
BET28EL03	PRJ	Project		4		4		8		8			100		50	150
Total			**2**	**18**	**0**	**20**	**2**	**52**	**0**	**54**	**25**	**25**	**500**	**0**	**200**	**750**

SCHEME B

			Credit Scheme				Teaching Scheme(Hours/Week)				Evaluation scheme and Marks					
Course Code	Course Type	Course Name	L	P	T	Total	L	P	T	Total	FA1	FA2	TW	PR	OR	Total
BET27EL03	PRJ	Project		4		4		8		8			100		50	150
Total			**2**	**18**	**0**	**20**	**2**	**52**	**0**	**54**	**25**	**25**	**500**	**0**	**200**	**750**

Project Evaluation Guidelines: Scheme A & B

- **B.Tech. Project Evaluation: Scheme A & B (Two Reviews per semester)**

Sr. No.	Agenda	Assessment	Review Assessment Weightage
1	Project Synopsis Evaluation (Review1)	Rubric R1	25
2	Progress Review (Review2)	Rubric R2	50
3	Evaluation by Project Guide	Rubric R3	25
4	End Semester Project Evaluation by Guide & External	Rubric R4	50
	Total		**150**

Framework of Project:

1. **Project Group shall have minimum 2 students & maximum 4 students from any department (interdisciplinary Projects). But all the Project group members must choose any one of schemes as mentioned above.**

2. Types of projects: Projects may be in-house, Sponsored or Multidisciplinary. Projects can be carried out inside or outside the institute, in any relevant industry or research institution.

- Self-sponsored Project
- Institute sponsored Project
- Industrial Project - Private, Public, LLP or Start-up company
- Government Research organization - IIT's, NIT's, IITM, IISR, DIAT, ISRO, TIFR etc.
- Research lab - NCL, CSIR, CME, CPR, HEMRL, DRDO, Police Research Centre etc.

3.Identification of Project: Student shall identify the area or topics in recent trends and developments in consultation with institute guide or industry or any research organization.

4.Project should solve real time problems of Thrust Areas as below:

- Health & Hygiene
- Agriculture: Crop, food and water
- Energy
- Transportation
- Quality Education & Effective Governance
- Communication & Networking (Cyber security etc)
- Indian Knowledge System
- Any Other(specify)

5. All project should be associated to the SIG (Special Interest Group) for new opportunities and explorations:

- ❑ VLEB (VLSI and Embedded System)
- ❑ SP (Signal Processing)
- ❑ COMM (Communication)
- ❑ ATMN (Automation)

Evaluation will be carried out by Programme Head/ Cell In-charge / Project Head / faculty mentor or Industry Supervisor

1. **Review –** Every Project should give 02 reviews per semester to the internal guide and assessment team.
    a. This evaluation is based on an overview of Goals, objectives of Project. Reviews should be done on literature review, software and hardware implementation results.
    b. Every student is obliged to keep a written record of his or her activities, such assimulation results, analysis, hardware models etc.
    c. All should complete and maintain workbook, which is assessed during the reviews.

2. **Project Presentation** - The student will give a seminar presentation based on the project experience, before an expert committee constituted by the department based on overall learning and achievements during internship. The evaluation will be based on the following criteria:
    a. Depth of knowledge and skills
    b. Communication & presentation Skills
    c. Team work and creativity
    d. Planning & organizational skills
    e. Simulation Results
    f. Hardware implementations
    g. Societal understanding and Ethics
    h. Regularity and punctuality
    i. Attendance record and Log book
    j. Ability to transfer work to society

3. **Report –** After completing the Project, all groups must submit a report to the guide and department thatincludes project work.

    Report Should contain completion certificate, company certificate of sponsorship, Scope and object of the study, personal observation, Problem statement/objectives, Motivation/Scope and rationale of the study,Methodological details, Results / Analysis /inferences and conclusion, Suggestions / Recommendations for improvement to industry, if any, List of reference (Library books, magazines and other sources)

4. **Project Deliverables:**

    - Publications: Publications in the peer reviewed journals / International Conferences willbe an added advantage/ Participation in Project competitions /Hackathon etc.

    - IPR / Product develop

General Guidelines

Table of Contents

1. What is B. Tech Project?

The B. Tech Project (BTP) is a year-long project taken by B. Tech students in their fourth year. It is a compulsory component of their BTP course curriculum in the final year. The project work shall be based on the knowledge acquired by the student during the four year graduation programme in Engineering and preferably it should meet and contribute towards the needs of the society. The BTP is broadly classified as experimental, numerical simulation or product development. The project aims to provide an opportunity of designing and building complete systems or subsystems based on area where the student likes to acquire specialized skills.

2. What can be the B. Tech Project?

Project work shall be based on any of the following:

1) Formulation of the new algorithm/method that has significance in many applications or that improvises the performance of the existing methods.
2) Implementation and experimental analysis of recent research paper published in quality journal/conference in order to discover the possibility of improvement.
3) Customizing the known methods/algorithms to the newer applications by value addition into it.
4) Fabrication of product/ testing setup of an experimentation unit/ apparatus/ small equipment, in a group.
5) Experimental verification of principles used in Engineering Applications.
6) Projects having a valid database, data flow, algorithm, and output reports, preferably software based.

The possible problem statements for the project can be availed from

a) Industries

b) Research labs or organization

c) In-house research projects

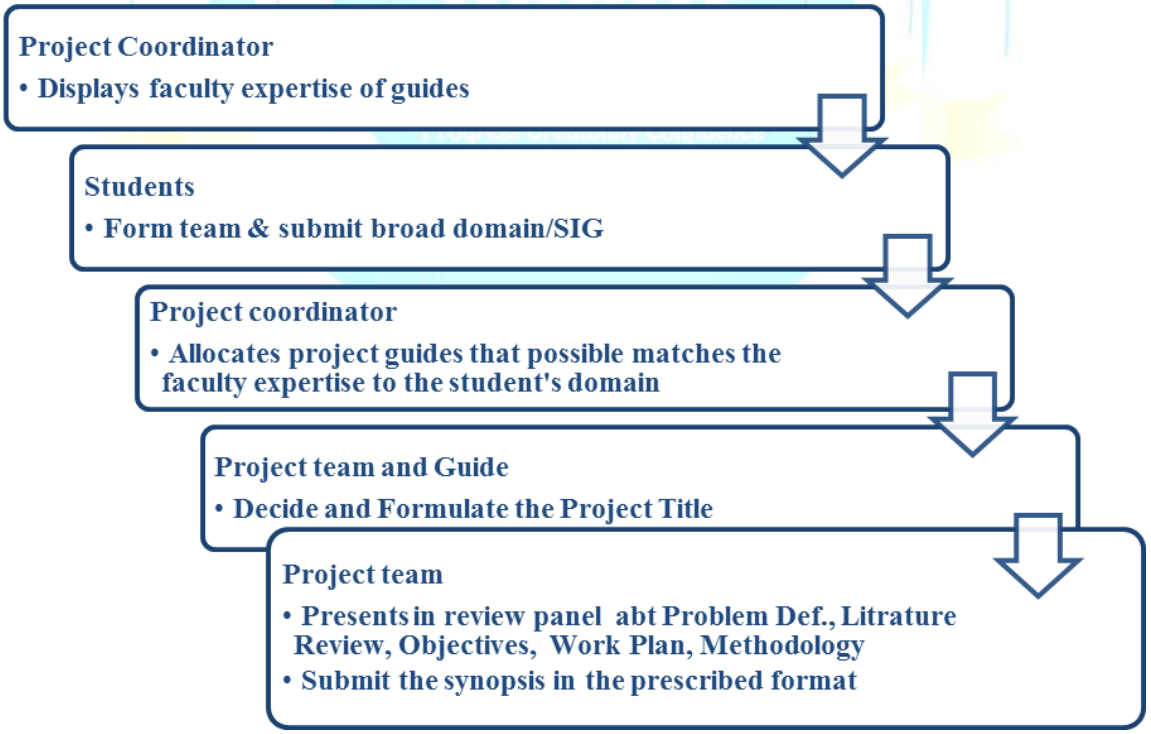
d) Collegiate clubs

3. Why B. Tech Project?

BTP provides an opportunity for students-

- To demonstrate sound academic fundamentals to formulate and analyze engineering problems.
- To apply creative/innovative solutions for engineering problems.
- To learn about cutting-edge technologies and modern tools
- To design systems, products and processes.
    - To communicate effectively with written, oral, and visual means in a technical presentations / discussions.
    - To learn and apply organizational and collaborative skills essential for successfully carrying out project goals
    - To demonstrate skills for lifelong learning.
    - To recognize environmental constraints and safety issues in engineering.
    - To use modern modeling and simulation techniques, and computing tools.

4. Project Guide Allocation



5. Project Team

The BTP can be taken by a team of students consisting of 3 to 4 students. Each students of the team has to work collaboratively and contribute significantly for the project development.

6. Project Guide

- Each project activity must be supervised by a faculty member of the concerned department. These faculty members are termed as Project Guide.
- In case of the interdisciplinary project, there can be two supervisors; out of which at least one shall be from the parent Department and the other from the other Department.
- Project guide shall help students to finalize (or identify) the project definition/statement and suggest the objectives / methodology through brainstorming. The project team is required to regularly appraise the project guide about the progress and seek his/her guidance.
- Project guides must monitor the weekly progress being carried out by the project groups.
- In case of industry sponsored projects, guides are expected to visit the industry on a regular basis along with students.
- The project guide shall ensure the completion of all the project related activities as per the requirement of review.
- Project guide shall motivate and facilitate the students to write patent, copyright, research funding proposal and paper publications for the overall development of the student.

7. Project Activities

Students are expected to perform the following activities:

i. Review of Recent Literature and Gap Identification
ii. Requirement Analysis and Feasibility Study
iii. Defining the Problem Statement and Objectives
iv. Identifying the Project Implementation Requirements
v. Formulation of Methodology and Mathematical Modelling
vi. Project Implementation
vii. Testing and Deployment
viii. Observations & Results

ix. Results Analysis and Validation

x. Conclusions

xi. Research Paper Publication/IPR Filing if any

xii. Report Writing

Above listed project activities are carried out during Semester 7/8.

8. Project Synopsis

The group should submit the synopsis in the following form.

1. Title of Project
2. Names of Students
3. Name of Guide
4. Background
5. Literature Review
6. Problem Definition
7. Objectives
8. Brief Methodology
9. Hardware/Software Requirements
10. References

The synopsis shall be signed by the each student in the group, approved by the guide (along with external guide in case of sponsored projects) and endorsed by the Head of the Department

9. Project Monitoring and Reviews

- In order to ensure the quality and progress of BTP, Project Synopsis Evaluation, Progress Review, End Semester Project Evaluation and Evaluation by Guide are scheduled by the Project coordinator.
- Assessment criteria for each review in the form of Rubrics will be notified to the students in advance by the project coordinator. Students have to read these carefully and accordingly to be prepared for reviews.
- During project reviews, project team has to present in front of the review panel consisting of the faculty working in the same SIG or similar cluster group.
- During reviews, students are required to demonstrate the progress done after the last review.
- The suggestions or corrections given by the review panel committee shall be recorded (on the review form attached), incorporated and demonstrated in the consecutive reviews.

10. Project Rubrics

- Rubrics is an assessment tool wherein the different assessment parameters and their weightages are documented.
- It normalizes the subjectivity of the assessor by bringing the transparency in the assessment.
- It helps the students to understand the expectations from each review and prepare accordingly.
- It helps the assessor to assess against different parameters and give the marks accordingly.

11. Project Report

- Project Report should begin with cover pages (Front Page, Certificate, Vision/Mission/PEOs, Abstract Table of Contents, List of Figures, List of tables) as given in Annexure I.
- This project report should be presented in a number of chapters, starting with Introduction and ending with Summary and Conclusions.
- Each of the other chapters will have a precise title reflecting the contents of the chapter.
- A chapter can be subdivided into sections, subsections and sub subsection so as to present the content discretely and with due emphasis.
- Following Chapter should be included in the report-

1. **Introduction**- It should be the **Chapter 1** and it should highlight the problem posed, define the topic and explain the aim and scope of the work presented in the project report. It may also highlight the significant contributions from the investigation.
2. **Literature Review**- It should be the **Chapter 2** and this Chapter should present a critical appraisal of the previous work published in the literature pertaining to the topic of the investigation. This chapter highlights the identified research gaps. It is recommended to review the recent literature published in reputed journals/conferences.
3. **Chapter on proposed work**- The proposed work should be presented in one or more chapters with appropriate chapter titles**.**
    a. Due importance should be given to experimental setups, procedures adopted, techniques developed, methodologies, algorithms developed and adopted.
    b. While important derivations/formulae should normally be presented in the text of these chapters.
    c. Detailed results in tabular and graphical forms included in appropriate

d. Figures and tables should be presented immediately following their first mention in the text.

e. Equations should form separate lines with appropriate paragraph separation above and below the equation line, with equation numbers flushed to the right.

4. **Results and Discussions-** This Chapter should include a thorough evaluation of the investigation carried out and bring out the contributions from the study. Quantitative results should be presented in tabular or graphical form. Interpretations of every table and graph should be given in the text. The discussion shall logically lead to inferences and conclusions as well as scope for possible further future work.
5. **Summary and Conclusions**- This will be the final chapter of the project report. A brief report of the work carried out shall form the first part of the Chapter. Conclusions derived from the logical analysis presented in the Results and Discussions Chapter shall be presented in this chapter. Scope for future work should be stated lucidly in the last part of the chapter.

12. Plagiarism

A student has to ensure that the Synopsis, Project Report and Research Publications are checked for plagiarism by using iThenticate/Turnitin software. The maximum similarity allowed is 10%. The undertaking regarding the same and plagiarism verification report must be attached in the project report.

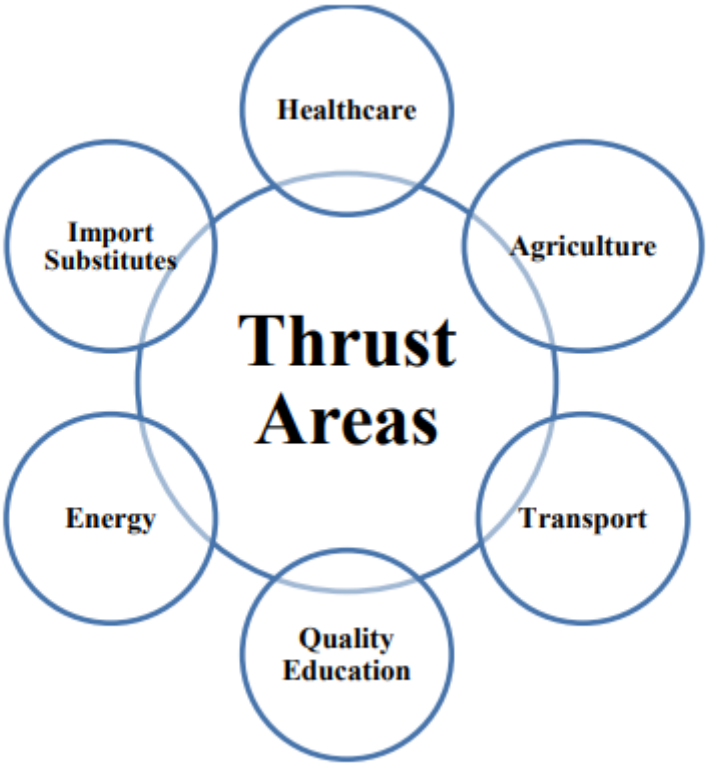
13. Research Outcomes

Based on the project results and conclusions, students are recommended to generate the research outcomes in terms of Research Publication, Patents, and Copyrights. This has to be done in consultation with project guides. Guides will decide the appropriateness of the results and converting those into research outcomes.

14. Technology Domains

E&TC Engineering	
1	VLSI & Embedded Systems
2	Communication and Signal Processing
3	Power Systems
4	Microelectronics and nanoelectronics
5	Quality Education & Effective Governance
6	Communication & Networking (Cyber security etc)
7	Robotics
8	Reliability and Maintainability
9	Home Automation
10	Industrial Automation
11	Advanced Driver Assistance System
12	Vehicle to Vehicle Communication
13	Autonomous Vehicle Navigation
14	Patient Health Monitoring System
15	Pollution monitoring and control
16	Indian Knowledge System

15. Thrust Areas for Research



16. Agriculture and Rural Development

1. Mobile App for plant/crop diseases identification and prediction using Machine Learning Techniques
2. Stored grain insect identification: Mobile App for grain sack analysis/scanning for identification of bugs.
3. Women friendly improved farm tools for small operations.
4. Colour Sorter: Image Processing based affordable grain colour sorting system.
5. Micro-climate identification and prediction of local climate of a usually small site or habitat.
6. Soil Moisture Monitoring: Wireless system for alerting farmers on the smart phone about how much, when, and where to water their plants or crops.
7. Soil nutrients Analyzer Automated Soil micro/ macro-nutrient analyzer
8. Food Grain Analysis: Automated system for classification and quality analysis of food grains.
9. Cotton picking Automated system for intelligent cotton harvesting machine.
10. Seed Sowing Robot Automatic seeding sowing and ploughing machine.

11. Automatic weeders for row crops
12. Post-harvest trash management system (eg. Sugarcane, Maize) (Rural)
13. Application for Agro Product & services
14. Application for management & Marketing of agro foods & artifacts (rural)
15. Replacement to traditional fuel by biodegradable fuel (rural)
16. Technique for early detection of pest in cotton
17. Perishable crop wastage, storage management
18. Application for farming as a service (rural)
19. Affordable drone technology for spraying in Indian scenario
20. Affordable solution for food processing in Indian Scenario(rural)
21. Supply chain management for agro product and services in Indian scenario(rural)
22. Telemedicine for rural health care management
23. Build an online system for monitoring water quality, leaks, contamination, and managing pipeline networks.
24. Smart Garbage systems
25. Smart education system
26. Development of Low Cost Solar Dryer for Hygienic drying.
27. Design and Development of Integrated curing and storage structure for onions.
28. Cold Storage Facility for Post-harvest Preservation of Fruits and Vegetables using Solar and Bio methane Heat Based Refrigeration.
29. Enhancement of Shelf-life of Perishable Agro Produce using Evaporative Cooling Technology.
30. Cost effective mechanism to treat waste water in small villages
31. Artificial intelligence enabled robotic trash boat to drive& harvest floating trash from urban drain.
32. Priority Road List for Maintenance
33. Automatic Assessment of Pavement condition based on road photographs

Healthcare Engineering

Medical Imaging

- Computed tomography (CT)
- Diagnostic radiology
- Fluoroscopy
- Magnetic resonance imaging (MRI)
- Mammography
- Medical imaging
- Positron emission tomography (PET)
- Ultrasound
- X-ray

Artificial Organs

- 3D printing of organs
- Artificial organs
- Bionics
- Bone tissue engineering
- Cartilage tissue engineering
- Prostheses
- Regenerative medicine
- Tissue engineering

Biomaterials

- Biomaterial surface characterization
- Biomaterial surface modification
- Biomaterials for spine
- Breast implants
- Cardiovascular materials
- Cell therapies
- Composite resin fillings
- Craniofacial materials
- Dental amalgam
- Dental materials
- Denture adhesives
- Dermal fillers
- Drug delivery materials
- Hydrogel for healthcare
- Hydrogel for bone
- Implant materials
- Medical ceramics
- Medical metals
- Nanotechnology
- Ophthalmic materials
- Organ therapy
- Orthopedic materials
- Medical polymers
- Protein and cells at interfaces
- Stem cells
- Tissue engineering

- Hydrogel for drug delivery

AI based Disease Diagnosis

Alzheimer's disease/ anesthesiology/ arthritis/ asthma/ attention deficit / hyperactivity disorder (ADHD)/ autism/ brain diseases/ cancer/ cardiovascular medicine/ Chronic Fatigue / chronic obstructive pulmonary disease (COPD)/ tuberculosis/ coronary artery disease/ dementia/ dentistry/ diabetes/ diagnosis Ebola/ epilepsy/ flu/ gastroenterology/ healthcare/ heart disease/ hematology/ hepatitis/ kidney disease / obesity/ ophthalmology/ orthopaedic/ osteoporosis/ pathology/ precision medicine/ stroke/ women's health/ aging

Healthcare Systems

Digital health/E-Health/Electronic health record/Healthcare cybersecurity/Lean healthcare/M-Health/Rural health/Telehealth/Telemedicine

Internet of Things (IoT) for Healthcare

IoT for patient monitoring/IoT for surgery/Medical IoT data security/Medical IoT device integration/Elderly care/Biomedical Device Manufacturing/Wearable Devices

Surgery & Robots

- 3D printing for surgery
- Computer-Assisted (Robotic) Surgery
- Engineering for neurosurgery
- Image-guided surgery
- Minimally invasive surgery
- Minimally invasive surgery devices
- Robot for heart surgery
- Surgical robot
- Surgical robot for cardiac surgery

Transports and Safety

- Intelligent Transportation System
- Alternate Fuel Based Transportation
- Advanced Powertrain Technologies
- Affordable Energy Storage And Infrastructure For Fast Charging
- Active Aerodynamics
- Heat Recovery Systems
- Intelligent Roads
- Long Life, Low Maintenance Roads And
- Active And Passive Safety Technology
- Magnetic Levitation Technology
- Tilting Train Technology
- Autonomous Vehicles
- Novel Modes Of Transport

(e.g.: Evacuated Tube Transport, Hyperloop)

- Amphibian And Flying Vehicles
- Biomimetics Design For Ship

Structures

- Self Healing Roads
- Fog Vision System For Road And Rail

Quality Education, Livelihood and Creative Opportunities

- Massively Online Open Courseware (Moocs)
- Gaming/Gamification
- Interactive Remotely Controlled Laboratories
- Personalised Virtual Teachers
- 4g And 5g Communication
- Immersive Virtual Reality
- Brain Computer Interface And
- Machine Augmented Cognition
- Wearable Devices
- Digital Identity And Learning Analytics
- Automated Evaluation And Assessment Systems
- Digital Holography, 3d Imaging And Volumetric/3d Display
- 3d Printing
- Real Time Translation For Indian Languages

Energy

- Solar PV
- Algal Energy
- Nuclear Fusion
- Fusion Fission Hybrid Reactor
- Fast Breeder Reactors For Thorium
- Supercritical Coal
- Advanced Coal Cycles
- Advanced Fossil Fuels Extraction Technologies
- Shale Gas
- Tight Gas
- Gas Hydrate
- Hybrid Storage
- Fuel Cell
- Microbial Fuel Cell
- Dc Grids
- Smart Grids
- ICT Based Smart Monitoring Systems
- Wireless Power Transmission
- Green And Net Zero Energy Buildings
- Smart Windows
- Zero Energy Artificial Lighting (E.G. Bioluminescence)
- Micro-Gasifier Cookstove

- Hydrogen Energy
- Biorefineries
- Brushless Dc (BLDC) Motors

16. Import Substitutes

Following list 45 items is provided by the Director General of Commercial Intelligence and Statistics (DGCIS), Govt. of India to encourage the MSME to manufacture indigenously under AtmaNirbhar Bharat Abhiyaan.

1. Hand presses 2. Inverter Domestic type upto 5 KVA 3. Film Polythene-Including Wide Width Film 4. Toggle Switches 5. Valves metallic 6. Anklets web Khaki 7. Plaster of paris 8. Stoneware jars 9. Centrifugal Pumps and suction and Delivery 10. Air/ Room cooler manufacturing 11. Domestic House wiring with PVC insulated Aluminium 12. Corrugated Paper Board and Boxes 13. Pressure Die Casting up to 0.75kg 14. Rubber cord 15. Distribution Board up to 15 amps 16. Artistic wooden furniture 17. Squirrel cage Induction Motor 18. Spiked Boots, Skiboots and shoes 19. Steel cross bars, cross arms, clamps, arching horn, brackets 20. Dust Shield leather 21. Domestic electric appliances – Food mixer,	25. Augur (carpenter) 26. Chrome tanned leather 27. Nuts & Bolts or Hand Tools of all Types or Distribution of Board up to 15 amps 28. Office furniture (Wooden chairs/Tables) 29. Naphthalene Balls 30. Pulley wires 31. Paper tapes (Gummed) 32. Insecticides Dust and Sprayers (Manual Only) 33. Street light fittings 34. Windshield wipers (arms and blade only) 35. Transistorized Insulation tester 36. Battery Eliminator, Voltage stabilizer 37. Transformer type welding set confirming to IS 1291[1] 38. Hinges, Hasps and staples 39. Garments (excluding supply from Indian Ordnance Factory 40. Hand tools-Mechanical 41. Cane furniture handloom 42. Sluice valves

wet grinder and food processor 22. M S Tie bars 23. Cotton Wool (Non-Absorbent) 24. Tent poles	43. Wooden boards 44. Teak fabricated round blocks 45. Lubricators

Additional Import Substitutes

- Blood Bags - Manufacturing Plant, Detailed Project Report, Profile, Business Plan, Industry Trends, Market Research, Survey, Manufacturing Process, Machinery, Raw Materials, Feasibility Study, Investment Opportunities, Cost and Revenue, Plant Economics.

  - Liquid Organic Fertilizer (Biofertilizer) Selenium Coated Aluminum Drum Used In Plain Paper Copier - Manufacturing Plant, Detailed Project Report, Profile, Business Plan, Industry Trends, Market Research, Survey, Manufacturing Process, Machinery, Raw Materials, Feasibility Study
  - Soyabean Cultivation and Processing For Soy Nuggets (Nutrela), Paneer and Milk - Manufacturing Plant, Detailed Project Report, Profile, Business Plan, Industry Trends, Market Research, Survey, Manufacturing Process, Machinery, Raw Materials, Plant Layout
  - Natural Food Colour - Manufacturing Plant, Detailed Project Report, Profile, Business Plan, Industry Trends, Market Research, Survey, Manufacturing Process, Machinery, Raw Materials, Feasibility Study, Investment Opportunities, Cost and Revenue.
  - Indian Made Foreign Liquor (IMFL) (WHISKEY, RUM, GIN, VODKA AND BRANDY) - Manufacturing Plant, Detailed Project Report, Profile, Business Plan, Industry Trends, Market Research, Survey, Manufacturing Process, Machinery, Raw Materials, Feasibility Study
  - sanitary Napkins - Manufacturing Plant, Detailed Project Report, Profile, Business Plan, Industry Trends, Market Research, Survey, Manufacturing Process, Machinery, Raw Materials, Feasibility Study, Investment Opportunities, Cost and Revenue, Plant Layout
  - Carbon Composite Fiber - Manufacturing Plant, Detailed Project Report, Profile Business Plan, Industry Trends, Market Research, Survey, Manufacturing Process, Machinery, Raw Materials, Feasibility Study, Investment Opportunities, Cost and Revenue.
  - Photocopier Cleaning Web (Non-Woven) - Manufacturing Plant, Detailed Project Report, Profile, Business Plan, Industry Trends, Market Research, Survey, Manufacturing Process, Machinery, Raw Materials, Feasibility Study, Investment Opportunities.

- Medical Disposables: Disposable Syringes (Self-Destructive) with Needles, Catheters and Mask - Manufacturing Plant, Detailed Project Report, Profile, Business Plan, Industry Trends, Market Research, Survey, Manufacturing Process, Machinery, Raw Materials.

Indian Knowledge System

- Indian Knowledge System (IKS) is an innovative cell under Ministry of Education (MoE) at AICTE, New Delhi. It is established to promote interdisciplinary research on all aspects of IKS, preserve and disseminate IKS for further research and societal applications. It will actively engage for spreading the rich heritage of our country and traditional knowledge in the field of Arts and literature, Agriculture, Basic Sciences, Engineering & Technology, Architecture, Management, Economics, etc

ANNEXURE-I
Sponsorship Structure and Guidelines

Sponsored Project Guidelines:

1. Students can opt for sponsored project after VI semester.
2. With concern to final year project guide student must identify project requirements in industry/Research Labs/Institutes.
3. Students must understand the project scope.
4. Sponsored project duration must be bounded to the opted project scheme.
5. Guide must visit the industry regularly for the assessment of students.
6. Students must submit the permission letter, offer letter, feedback letter and work completion record to opt for the sponsored project.
7. At every review student must give the details of work done and progress to the guide.

Types of Sponsored Project

1. Self-sponsored Project

- Choose a project idea
- Define project goals and scope
- Plan your timeline and resources
- Allocate time and set priorities
- Develop a budget (if necessary)
- Start working and iterate
- Seek feedback and collaborate
- Document and showcase your project

2. Industry /Research Institute sponsored Project

- Identify the project scope and objectives
- Seek sponsorship or collaboration
- Develop a project plan
- Allocate resources
- Assemble the project team
- Execute the project plan
- Collaborate and leverage expertise
- Document and report progress
- Disseminate findings and outcomes

3. Institute sponsored Project

- Identify the project scope and objectives.
- Seek sponsorship or support from the institute.
- Develop a detailed project plan.
- Collaborate and leverage expertise within the institute.
- Document and report progress to the project supervisor or advisor.
- Disseminate findings and outcomes through publications and presentations.
- Adhere to ethical guidelines and institutional policies throughout the project.
- Engage with the research community within the institute.
- Maximize the support and resources available for project success.

	Pimpri Chinchwad Education Trust's **Pimpri Chinchwad College of Engineering** Sector No. 26, Pradhikaran, Nigdi, Pune – 411 044	

Subject – Permission Letter for Sponsored Project

Date:

To,

The Head of the Department

Pimpri Chinchwad college of

Engineering, Nigdi, Pune-44

From,

Student name with Roll no

Subject: Request for Permission for sponsored project. Respected Sir/Madam,

With due respect, my name is <**Student Name**>from Electronics and Telecommunication, having **Roll no._____.** I am writing this letter to request permission for allowing me for the sponsored project. I recently got offer letter from <**Company Name**> for the Project sponsorship**.** This project being a really important and integral part of my learning procedures. I request you to consider my request and grant me permission for the same.

Looking forward to your kind consideration.

Yours

,

Sincer

ely,

Student Name: % Attendance-

Year with roll no:

PTG Remark

Project Guide Remark-

Project Coordinator Remark-

Head of Department Remark-

Pimpri Chinchwad Education Trust's

Pimpri Chinchwad College of Engineering

An Autonomous Institute

(Affiliated to Savitribai Phule Pune University)

Sponsored Project FEEDBACK FORM

Department of Electronics & Telecommunication Engineering

Student/Intern Name:-

Academic Year:- 2023-24	**Student PRN Number:-**	**Student Mail ID :-**
Student Phone Number :-	**Employer Name :-**	

Please Rate your experience for the following parameters on a scale of 1 to 10.

Work quality: An evaluation of the student work performance, including accuracy, attention to detail, and ability to meet deadlines on given project. **Your Score**

Poor **Best**

1	2	3	4	5	6	7	8	9	10

Technical skills: An assessment of the student technical skills and knowledge related to the field they were working in. **Your Score**

Poor **Best**

1	2	3	4	5	6	7	8	9	10

Communication skills: A review of the student communication skills, including their ability to articulate ideas, listen effectively, and collaborate with others **Your Score**

Poor **Best**

1	2	3	4	5	6	7	8	9	10

Initiative and motivation: An assessment of the student level of initiative, drive, and motivation to complete project and contribute to the company. **Your Score**

Poor **Best**

1	2	3	4	5	6	7	8	9	10

Adaptability: A review of the student ability to adapt to new situations, learns quickly, and handles challenges. **Your Score**

Poor **Best**

1	2	3	4	5	6	7	8	9	10

Attitude: An evaluation of the student attitude, including their enthusiasm, professionalism, and overall demeanor. **Your Score**

Poor **Best**

1	2	3	4	5	6	7	8	9	10

Overall impression & Punctuality: Final evaluation of the student overall performance and suitability for future employment opportunities. **Your Score**

Poor **Best**

1	2	3	4	5	6	7	8	9	10

Request for Sponsorship for Project Proposal

[Your Name]
[Your Address]
[City, State, ZIP Code]
[Email Address]
[Phone Number]
[Date]
[Organization Name]
[Organization Address]
[City, State, ZIP Code]

Subject: Request for Sponsorship for Project Proposal

Dear [Organization Name], I hope this letter finds you well. Currently I am studying in Final Year, Electronics and Telecommunication Department, PCET's Pimpri Chinchwad College of Engineering. I am writing to request sponsorship from [Organization Name] for a project proposal that aligns with your organization's mission and goals. As an esteemed organization known for its commitment to [relevant field or cause], I believe our collaboration would yield mutual benefits and contribute to the advancement of [specific area of interest].

The project I propose focuses on [briefly describe the project's scope and objectives]. It aims to [explain the problem or research question to be addressed] and seeks to achieve [specific outcomes or deliverables]. This project is significant because [highlight the potential impact, benefits, or innovations it can bring].

Having reviewed [Organization Name]'s past initiatives and contributions, I am confident that our project aligns well with your areas of expertise and strategic objectives. I firmly believe that with your sponsorship and support, we can successfully execute this project and make a meaningful impact.

I kindly request your sponsorship in the form of [specific details regarding financial support, resources, or expertise]. This support will enable us to secure the required resources, access specialized facilities, and ensure the project's smooth execution. In return, we are open to discussing potential collaboration opportunities, recognition, and the opportunity to disseminate our findings through joint publications or presentations.

I would be honored to discuss this project proposal further and explore how we can establish a mutually beneficial partnership. I am available for a meeting or call at your convenience. I have attached the detailed project proposal for your review, and any feedback or suggestions you may have would be greatly appreciated.

Thank you for considering our request for sponsorship. I truly believe that together we can make a significant contribution to [relevant field or cause]. I look forward to the possibility of collaborating with [Organization Name] and working towards the success of this project.

Thank you for your time and

consideration. Sincerely,

[Your Name]

ANNEXURE-II
Project Report Format

A Project Report
on

DSACTION AND PREDICTION OF ANEMIA USING NON-INVASIVE METHODS

by

Hiral Ameet Bhuptani, Shreya Joshi, Samruddhi Bora
(PRN. 04417454301, PRN. 04417454302, PRN. 04417454303)
Final Year – VIII Semester

Under the guidance of:

Dr. …….

DEPARTMENT OF ELECTRONICS & TELECOMMUNICATION ENGINEERING

Pimpri Chinchwad College of Engineering, Nigdi, Pune -411044

[An Autonomous Institute Affiliated to Savitribai Phule Pune University]

2025-2026

Certificate

Certified that this Project work titled "**Detection and Prediction of Anemia using Non-invasive Methods**" by Hiral Ameet Bhuptani, Shreya Joshi, Samruddhi Bora with PRN. 04417454301, PRN. 04417454302, PRN. 04417454303 respectively from Final Year E&TC, VIII semester,

Academic year 2023-24 is approved for submission by Department of Electronics & Telecommunication Engineering, Pimpri Chinchwad College of Engineering Nigdi, Pune -411044. Further certified that, to the best of my knowledge, the report represents the original work carried out by the student

Date:

Signature and Name of Guide

Signature and seal of Head of the Department

Vision of the Programme

To become the leading online platform for Engineering students to enhance their technical knowledge, practical skills, and professional development, and to inspire a passion for engineering and innovation.

Mission of the Programme

Our mission is to provide comprehensive and high-quality educational resources, including lectures, tutorials, assignments, and projects, to students pursuing their Engineering degree. We aim to foster a collaborative and inclusive learning community that encourages curiosity, critical thinking, and creativity. We strive to prepare our students to excel in their future engineering careers, and to contribute positively to society through their technical expertise and leadership.

Program Educational Objectives

PEO 1	To provide sound foundation in mathematics, basic science and fundamentals of E&TC engineering to the students.
PEO 2	To provide students with good Electronics and Telecommunication Engineering breadth so as to enable them to comprehend, analyze, design, and create novel products and solutions for the real-life problem.
PEO 3	To inculcate effective communication skills, teamwork spirit and professional ethics in students to meet employers need at large and prepare them for higher studies.
PEO 4	To create awareness among students about social commitment and responsibilities.

Title of the Project: Detection and Prediction of Anemia using Non-invasive

Methods Academic Year: 2023-24, Semester – VII / VIII, VII &VIII

Name of the Students: Hiral Ameet Bhuptani, Shreya Joshi, Samruddhi Bora

PO mapping of the Project Topic

PO/PSO*	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
Mapping Strength															

*Description of POs given Overleaf

Sr. No.	Statement of PO/PSO
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 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.
PO 12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO 1	Ability to comprehend and exhibit the competency in the areas of Electronics & Communication Engineering including Signal processing and Communication, VLSI and Embedded System, Computing and programming and Automation.

PSO 2	Ability to design and analyze the systems of Electronics & Telecommunication Engineering using state of the art hardware and software tools to address the needs of industry and society.
PSO 3	Ability to demonstrate proficiency to build research attitude, imbibe ethical values and strengthen/enhance professional competency for holistic development and build problem solving attitude to address the societal, environmental, health & safety issues.

Abstract

A single page 3-paragraph summary of the Project report Project report may not be accepted for submission without abstract

Paragraph 1 –Introduction/ Back ground

Paragraph 2 – Work Done/ Analysis

Paragraph 3 – Result/ Conclusions

/Findings

Table of Contents

- **Project Title/ Cover sheet specifications**

1. Page size: A4
2. Left and right margins: 1.25”
3. Top and Bottom Margin: 1 “
4. Logo of the Institute: Necessary
5. All font: Times new Roman
6. Entire texts center aligned

- **General instructions for Project Report**

1. The Project report should be complete in all respects i.e. signed by the guide and HOD
2. Number of copies submitted: THREE

   [1 each for the candidates + 1 for the guide + 1 for the internal examiner and Departmental Library]
3. Maximum page limit : 100
4. Start numbering the pages from the Table of contents page as page 1
5. Table of Contents should follow - two separate lists of Figure captions and Table titles along with their numbers
6. Pages before table of content should not be numbered
7. Page Size: A4
8. Binding: spiral /coil binding
9. Printing: on both sides of the pages

10.Paper thickness: minimum 85 GSM

Typesetting: MS word, Star Office or Latex, Entire Report must be in point Times New Roman Font, 1” margin from all sides, one and half spacing on all lines

Chapter Title	16pt bold title case
Section Heading	12pt bold title case
Subsection Heading	12pt italic title case
Body Text	12pt normal, justified to both margins
Figure/ Table Captions	12pt normal
Footnote Text	9pt normal

11. Each Chapter must start on new page, center aligned

13. No Abbreviations in the title of the Project

14. Numbering and Title to all the figures is mandatory, title of the figure to be given below the figure

15. Numbering and Title to all the Tables is mandatory, title of the Table to be given above the Table

16. In the body of the report, References should be cited in square brackets for example [MNRE Annual Report,2014]

17. At the end of the report references should be mentioned as follows

- **Book references should be mentioned as follows**

1. Duffie, J.A., Beckman, W.A., *Solar Engineering of Thermal Processes*, John Wiley and Sons, New York,1991.

2. Rabl A., *Active Solar Collectors and their Applications*, Oxford University Press, New York, 1985.

3.

Journal paper reference should be mentioned as follows

4. Furbo S., Anderson E., Thur A., Shah L. J. and Anderson K.D., Performance Improvement by Discharge from Different Levels in Solar Storage Tanks, *Solar Energy*, 79, 431-439,2005.

5. Kalogirou, S. A., The Potential of Industrial Process Heat Applications, *Applied Energy*, 76, 337– 361,2003.

- **Reports/ Surveys Standards reference should be mentioned as follows**

6. *ISO 9459–3:1997(E),Performance Tests for Solar plus supplementary Systems*, Organization for International Standards, Geneva, Switzerland, 1997.

7. Kedare S.B., Nayak J.K. and Paranjape A.D., Energy Systems Engineering, Indian Institute of Technology, Final Project Report of R & D Project No. 15/9/2002-ST,*Development, Installation and Evaluation of Large Scale Concentrating Solar Collector for Medium Temperature Industrial Thermal Applications*Sponsored byMinistry of New and Renewable Energy (MNRE), Government of India, New Delhi,2006.

8. MNES, Ministry of Non-Conventional Energy Sources, Govt. of India, *MNES Annual Report 2003-04*, p1, 2005.

- **Websites referred should be mentioned as follows**

9. Petroleum Bazaar, *Properties of LPG*, www.petroleumbazar.com, March 20, 2005.

10. RBI, Reserve Bank of India, www.rbi.org.in/home.aspx, March 20,2005.

ANNEXURE-III

Project Evaluation Rubrics

Rubric R1 -Project Synopsis Evaluation (Review 1)

Pimpri Chinchwad College of Engineering

Department of Electronics & Telecommunication

Title of the Project	
Name of the Guide	

1. Problem Identification, Novelty and Relevance –
Detailed and extensive explanation of the purpose and need of the project, Novelty and usage of the project for the society.

2. Literature Survey –

Quality of References searched in order of increasing merit - Internet websites, Text Books, Reference Books, Hand Books, Conference papers (National), Conference papers (International), National Journalpapers, International Journal Papers, Surveys. The total number should not more than 50
effectiveness as a team member, Workability of the project

3. Objectives and Methodology:

All the objectives of the proposed work are well defined. Objectives are measurable and attainable. Methodology consists of recent algorithms/models/techniques.

4. Presentation - Communication and Manners

Manners, wishing, greeting, permission to begin, permission to proceed, Body Language,
Grasp over spoken English, Effectiveness in technical communication of the project topic, clarity of concepts, clarity in thought process, Technical Content, Depth
Listening and comprehension ability, temperament in question answer session

5. Quality of the Synopsis:
Systematic Organization, Syntactical Errors, Technical Content, Depth, apparent efforts put in the preparation of the synopsis.

Performance levels (PL): Five Performance levels are defined in this assessment 1.Excellent,2 Very Good, 3. Good, 4 Average, 5 Weak Divide Maximum Marks by the number of performances levels i.e.,5 to obtain the increment or decrement of marking		1	2	3	4	5	Out of
	Maximum Marks	**3**	**5**	**20**	**15**	**7**	**50**
	Name of the Student						
1							
2							

6							

Signature and Name of the Guide

Signature, Name and of the Examiner

Rubric R2– Project Progress Review Evaluation (Review 2)

Pimpri Chinchwad College of Engineering

Department of Electronics & Telecommunication

Title of the Project	
Name of the Guide	

1. Incorporation of Suggestions of earlier review -

Changes are made as per the suggestion received in the earlier review

2. Demonstration of Concepts and Technical Details -

Technical concepts are well put forth and sound knowledge of engineering fundamentals required for the project

3. Work done and Demonstration –

Apparent quantum of efforts put in the project work, Perseverance, quality and correctness of design, fabrication, analysis, workability of the project, obtaining the results, documentation, success in the outcome.

4. Team work and Presentation:

Involvement of all the team members, effective presentation, answering to the questions, temperament in question answer session, professionalism in presentation.

5. Content of presentation and Result Analysis:

Appropriate slides, content on slides is well organize, results are shown in tabular and graphical formats, interpretation of results is well explained

Performance levels (PL): Five Performance levels are defined in this assessment 1.Excellent,2 Very Good, 3. Good, 4 Average, 5 Weak Divide Maximum Marks by the number of performances levels i.e.,5 to obtain the increment or decrement of marking		1	2	3	4	5	Out of
	Maximum Marks	**6**	**14**	**20**	**30**	**14**	**100**
	Name of the Student						
1							
2							

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4							
5							
6							

Signature and Name of the Guide

Signature, Name and of the Examiner

Rubric R3 – Evaluation by Project Guide

Pimpri Chinchwad College of Engineering

Department of Electronics & Telecommunication

Title of the Project	
Name of the Guide	

1. Self-Motivation and Determination

Self-motivated and determined towards the implementation of the project, takes initiatives and discuss the different approaches of the implementation

2. Technical Knowledge and awareness related project

Extensive knowledge of the project, understanding of different tools and techniques.

3. Working in a Team & Regularity

Collaborates and the communicates effectively in the group, express the opinions, takes others view into the consideration. Reports to the guide regularly discuss the project.

4. Learnability (MOOC course):

Ability to learn the new tools and techniques through different courses and using requirement of the project development.

5. Project Outcome

Project outcomes based on Publication, IPR (Patent & Copyright), Proposal, Project competition etc.

Performance levels (PL): Five Performance levels are defined in this assessment 1.Excellent,2 Very Good, 3. Good, 4 Average, 5 Weak Divide Maximum Marks by the number of performances levels i.e.,5 to obtain the increment or decrement of marking		1	2	3	4	5	Out of
	Maximum Marks	3	5	7	15	20	50
	Name of the Student						
1							
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4							
5							
6							

Signature and Name of the Guide

Signature, Name and of the Examiner

Rubric R4 -End Semester Project Evaluation (Oral Exam)

Pimpri Chinchwad College of Engineering

Department of Electronics & Telecommunication

Title of the Project	
Name of the Guide	

1. Novelty, Innovation and Relevance of the topic - Societal relevance, possible topic leading to patenting,

2. Literature survey - Quality of References searched in order of increasing merit - Internet websites, Text Books, Reference Books, Hand Books, Conference papers (National), Conference papers (International), National Journal papers, International Journal Papers, Surveys. The total number should not more than 50

effectiveness as a team member, Workability of the project

3. Work done – Apparent quantum of efforts put in the project work, Perseverance, quality and correctness of design, fabrication, analysis, workability of the project, obtaining the results, documentation, success in the outcome.

4. Presentation - Communication and Manners

Manners, wishing, greeting, permission to begin, permission to proceed, Body Language,

Grasp over spoken English, Effectiveness in technical communication of the project topic, clarity of concepts, clarity in thought process, Technical Content, Depth

Listening and comprehension ability, temperament in question answer session

5. Quality of the report & Project Outcome

Systematic Organization, Syntactical Errors, Technical Content, Depth, apparent efforts put in the preparation of the report i.e., data collection, expression in own language, application of thought process etc. and Project outcomes based on Publication, IPR (Patent & Copyright), Proposal, Project competition etc. achieved.

Performance levels (PL): Five Performance levels are defined in this assessment 1.Excellent,2 Very Good, 3. Good, 4 Average, 5 Weak Divide Maximum Marks by the number of performances levels i.e.,5 to obtain the increment or decrement of marking		1	2	3	4	5	Out of
	Maximum Marks	**10**	**20**	**40**	**30**	**50**	**150**
	Name of the Student						
1							
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5							
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Signature and Name of the Guide

Signature, Name and of the Examiner

Rubric R5 – Project Progress Review Evaluation (Review 5)

Pimpri Chinchwad College of Engineering

Department of Electronics & Telecommunication

Title of the Project	
Name of the Guide	

1. **Incorporation of Suggestions of earlier review:**

   Changes are made as per the suggestion received in the earlier review

2. **Demonstration of Concepts and Technical Details:**
   Technical concepts are well put forth and sound knowledge of engineering fundamentals required for the project

3. **Work done and Demonstration:**

   Apparent quantum of efforts put in the project work, Perseverance, quality and correctness of design, fabrication, analysis, workability of the project, obtaining the results, documentation, success in the outcome.

4. **Team work and Presentation:**

   Involvement of all the team members, effective presentation, answering to the questions, temperament in question answer session, professionalism in presentation.

5. **Content of presentation and Result Analysis:**

   Appropriate slides, content on slides is well organize, results are shown in tabular and graphical formats, interpretation of results is well explained

Performance levels (PL): Five Performance levels are defined in this assessment 1.Excellent,2 Very Good, 3. Good, 4 Average, 5 Weak Divide Maximum Marks by the number of performances levels i.e.,5 to obtain the increment or decrement of marking		1	2	3	4	5	Out of
	Maximum Marks	**2**	**3**	**10**	**7**	**3**	**25**
	Name of the Student						
1							
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Signature and Name of the Guide

Signature, Name and of the Examiner

Rubric R6 – Evaluation by Project Guide

Pimpri Chinchwad College of Engineering

Department of Electronics & Telecommunication

Title of the Project	
Name of the Guide	

6. Self-Motivation and Determination

Self-motivated and determined towards the implementation of the project, takes initiatives and discuss the different approaches of the implementation

7. Technical Knowledge and awareness related project

Extensive knowledge of the project, understanding of different tools and techniques.

8. Working in a Team & Regularity

Collaborates and the communicates effectively in the group, express the opinions, takes others view into the consideration. Reports to the guide regularly discuss the project.

9. Learnability (MOOC course):

Ability to learn the new tools and techniques through different courses and using requirement of the project development.

10. Project Outcome

Project outcomes based on Publication, IPR (Patent & Copyright), Proposal, Project competition etc.

Performance levels (PL): Five Performance levels are defined in this assessment 1.Excellent,2 Very Good, 3. Good, 4 Average, 5 Weak Divide Maximum Marks by the number of performances levels i.e.,5 to obtain the increment or decrement of marking		1	2	3	4	5	Out of
	Maximum Marks	2	3	3	7	10	25
	Name of the Student						
1							
2							

3							
4							
5							
6							

Signature and Name of the Guide

Signature, Name and of the Examiner

Rubric R7 -End Semester Project Evaluation (Oral Exam)

Pimpri Chinchwad College of Engineering

Department of Electronics & Telecommunication

Title of the Project	
Name of the Guide	

1. Novelty, Innovation and Relevance of the topic - Societal relevance, possible topic leading to patenting,

2. Literature survey - Quality of References searched in order of increasing merit - Internet websites, Text Books, Reference Books, Hand Books, Conference papers (National), Conference papers (International), National Journal papers, International Journal Papers, Surveys. The total number should not more than 50

effectiveness as a team member, Workability of the project

3.Work done – Apparent quantum of efforts put in the project work, Perseverance, quality and correctness of design, fabrication, analysis, workability of the project, obtaining the results, documentation, success in the outcome.

4. Presentation - Communication and Manners

Manners, wishing, greeting, permission to begin, permission to proceed, Body Language,

Grasp over spoken English, Effectiveness in technical communication of the project topic, clarity of concepts, clarity in thought process, Technical Content, Depth

Listening and comprehension ability, temperament in question answer session

5. Quality of the report and Project Outcome

Systematic Organization, Syntactical Errors, Technical Content, Depth, apparent efforts put in the preparation of the report i.e., data collection, expression in own language, application of thought process etc. and Project outcomes based on Publication, IPR (Patent & Copyright), Proposal, Project competition etc. achieved.

Performance levels (PL): Five Performance levels are defined in this assessment 1.Excellent,2 Very Good, 3. Good, 4 Average, 5 Weak Divide Maximum Marks by the number of performances levels i.e.,5 to obtain the increment or decrement of marking		1	2	3	4	5	Out of
	Maximum Marks	**5**	**5**	**15**	**10**	**15**	**50**
	Name of the Student						
1							
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5							
6							

Signature and Name of the Guide

Signature, Name and of the Examiner

Rubric R8 -End Semester Project Evaluation (Oral Exam)

Pimpri Chinchwad College of Engineering

Department of Electronics & Telecommunication

Title of the Project	
Name of the Guide	

1. **Novelty, Innovation and Relevance of the topic** - Societal relevance, possible topic leading to patenting,
2. **Literature survey -** Quality of References searched in order of increasing merit - Internet websites, Text Books, Reference Books, Hand Books, Conference papers (National), Conference papers (International), National Journalpapers, International Journal Papers, Surveys. The total number should not more than 50 effectiveness as a team member, Workability of the project
3. **Work done –** Apparent quantum of efforts put in the project work, Perseverance, quality and correctness of design, fabrication, analysis, workability of the project, obtaining the results, documentation, success in the outcome.
4. **Presentation - Communication and Manners**

   Manners, wishing, greeting, permission to begin, permission to proceed, Body Language,
   Grasp over spoken English, Effectiveness in technical communication of the project topic, clarity of concepts,clarity in thought process, Technical Content, Depth
   Listening and comprehension ability, temperament in question answer session
5. **Quality of the Report and Project Outcome**

Systematic Organization, Syntactical Errors, Technical Content, Depth, apparent efforts put in the preparation of the report i.e., data collection, expression in own language, application of thought process etc. and Project outcomes based on Publication, IPR (Patent & Copyright), Proposal, Project competition etc. achieved.

Performance levels (PL): Five Performance levels are defined in this assessment 1.Excellent,2 Very Good, 3. Good, 4 Average, 5 Weak Divide Maximum Marks by the number of performances levels i.e.,5 to obtain the increment or decrement of marking		1	2	3	4	5	Out of
	Maximum Marks	**5**	**10**	**30**	**25**	**30**	**100**
	Name of the Student						
1							
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4							
5							
6							

Signature and Name of the Guide

Signature, Name and of the Examiner

Vision and Mission of E&TC program

VISION : To be recognized as a distinguished department in the field of electronics and telecommunication transforming students into competent technocrats by providing an Ethical, Sustainable and Value-Added Quality Education.

MISSION :

1. To create competent Electronics and Tele-communication engineers with Knowledge, Skill and Attitude by establishing a conducive learning environment.
2. To nurture technical competency, entrepreneurship skills and promote higher studies through the state-of-art facilities for building successful careers.
3. To facilitate research by engaging in projects of industrial requirement and national importance.
4. To impart Life skills, Ethical and Social values for self-sustainability.

Programme Educational Objectives (PEO's)

1. Establish a strong base in mathematics, basic sciences, and the fundamental principles of Electronics and Telecommunication Engineering for the students.
2. Equip students with a comprehensive understanding of Electronics and Telecommunication Engineering, enabling them to effectively comprehend, analyse, design, and to innovate practical solutions for real-world challenges.
3. Foster the development of effective communication skills, teamwork, and professional ethics among students, in order to meet the demands of employers and prepare them for higher studies and successful careers.
4. Promote social consciousness and a sense of responsibility among students, creating awareness about their commitment and obligations to society.

Program Outcomes (PO's)

Engineering Graduates will be able to:

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

2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics,natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
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 modeling 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 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 thesssse to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

1. **PSO1:** Ability to exhibit the competency to solve the problems related to Electronics & Telecommunications Engineering by applying advanced knowledge in the fields of VLSI, Embedded Systems, Signal Processing, Communication, Computing and Automation.
2. **PSO2:** Ability to design and analyse Electronics & Telecommunications systems using state of the art hardware and software tools to address the needs of the industry and society.
3. **PSO3:** Ability to build research and problem-solving attitude through Project based learning to address the societal, environmental, health and safety issues.