Shree Warana Vibhag Shikshan Mandal's

WARANA UNIVERSITY,
WARANANAGAR

(A State Public University established under Section 3 (6) of MPUA, 2016)

।। विद्या सर्वस्य भूषणम् ।।

Warana University

Established:2025

Structure &SyllabusFor
First Year Master ofTechnology (F.Y. M.Tech)
in
Electronics & Telecommunication Engineering

UNDER

Facultyof Science & Technology

(As Per National Education Policy – 2020)

With Effect fromAcademicYear2025-26Onwards

Shree Warana Vibhag Shikshan Mandal's

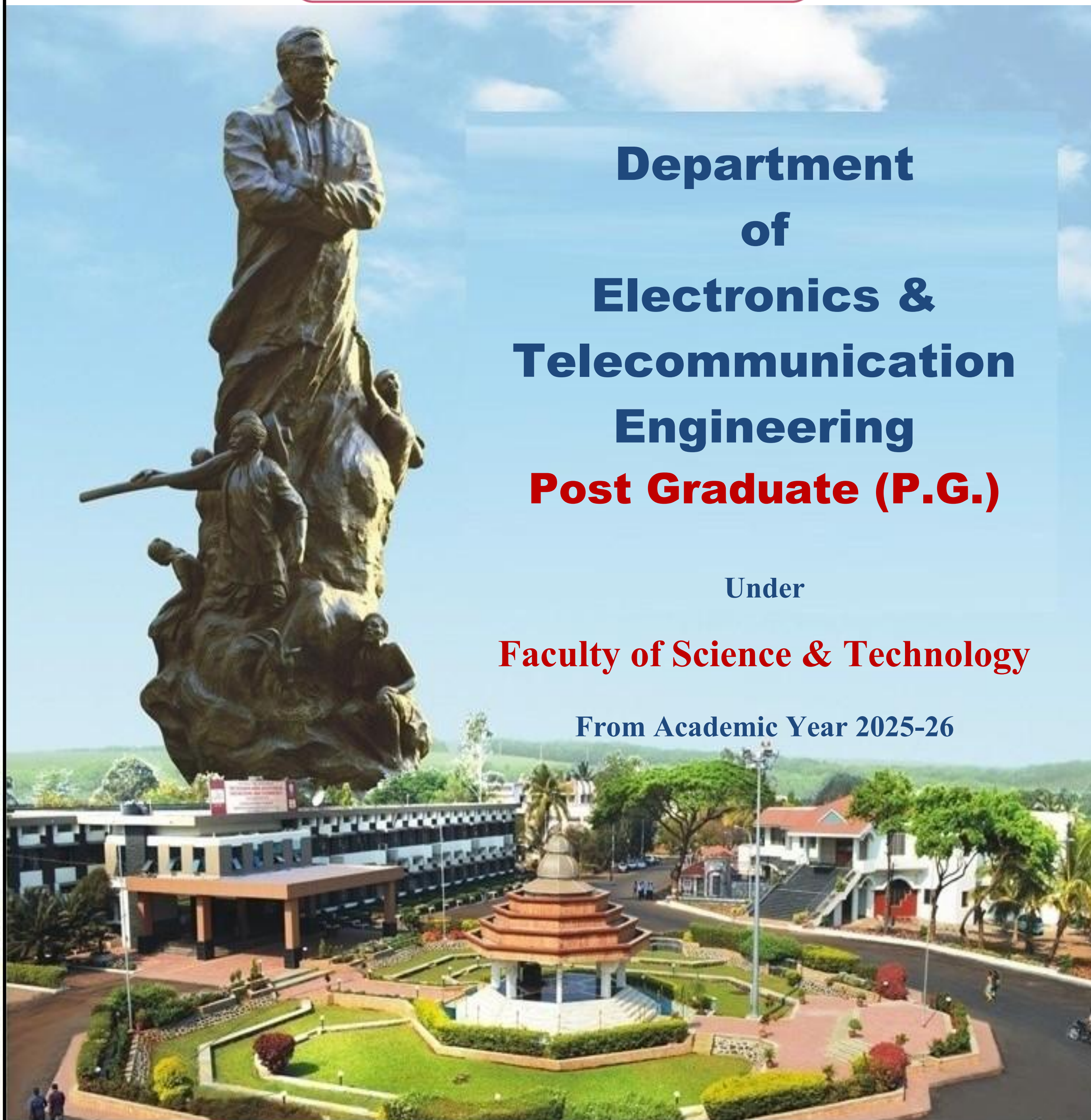
TATYASAHEB KORE INSTITUTE OF ENGINEERING AND TECHNOLOGY (AUTONOMOUS), WARANANAGAR, KOLHAPUR

TKIET Estd. 1983

Lead Institute of

WARANA UNIVERSITY, WARANANAGAR

(A State Public University)



Department of Electronics & Telecommunication Engineering

Post Graduate (P.G.)

Under

Faculty of Science & Technology

From Academic Year 2025-26

M.Tech.inElectronics &Telecommunication Engineering

StructureandSyllabusunderAutonomyasperNEPPolicy2020

Contents

Preface 1
Program Outcomes 2
Duration 3
Eligibility 3
Medium of Instruction 3
Abbreviations 4
Examination& Evaluation Pattern 5
Grading System 9
Curriculum Structure& Evaluation Scheme forSemester-I 10
List of Program Electives for Semester-I 11
Curriculum Structure& Evaluation Scheme for Semester-II 12
List of Program Electives for Semester-II 13
List of Open Electives Offered by All Programs 14
Course Code: 2501PETCPCC101 Course Name: Advanced Embedded System 15
Course Code: 2501PETCPCC101T Course Name: Advanced Embedded System Tutorial 17
Course Code: 2501PETCPCC102 Course Name: Error Control Coding Techniques 19
Course Code: 2501PETCPCC102T Course Name: Error Control Coding Techniques Tutorial 22
Course Code: 2501PETCPE1031 Course Name: Advanced Wireless Communication 24
Course Code: 2501PETCPE1032 Course Name: Optimization Techniques 26
Course Code: 2501PETCPE1033 Course Name: Internet Traffic Engineering 28
Course Code: 2501PETCPE1041 Course Name: Random Process 30
Course Code: 2501PETCPE1042 Course Name: Digital Data Compression 32
Course Code: 2501PETCPE1043 Course Name: Advanced Biomedical Signal Processing 34
Course Code: 2501PETCPE1051 Course Name: Mobile Computing 37
Course Code: 2501PETCPE1052 Course Name: Design of VLSI Systems 39
Course Code: 2501PETCPE1053 Course Name: Advanced Antenna Theory 41
Course Code: 2501PETCLC106P Course Name: Lab Course 44
Course Code: 2501PETCSW107T Course Name: Seminar-I 46
Course Code:2501PETCPCC201 Course Name: Computer Vision 48
Course Code: 2501PETCPCC201T Course Name: Computer Vision Tutorial 50
Course Code: 2501PETCPCC202 Course Name: Adhoc & wireless Sensor networks 52
Course Code: 2501PETCPCC202T Course Name: Adhoc & wireless Sensor networks Tutorial 54
Course Code: 2501PETCPE2031 Course Name: Cryptography and Network Security 56
Course Code: 2501PETCPE2032 Course Name: Multi Rate System 59
Course Code: 2501PETCPE2033 Course Name: Advanced Light Wave Communication 62

Course Code: 2501PETCPE2041 Course Name: Advanced Microwave circuit Design........................ 64
Course Code: 2501PETCPE2042Course Name: SDR & Cognitive Radio Technology 66
Course Code: 2501PETCPE2043 Course Name: Industry Automation & Process Control................... 68
Course Code: 2501PETCOE2051 Course Name: Advanced Operating Systems 71
Course Code: 2501PETCOE2052 Course Name: Cyber Security.. 73
Course Code: 2501PETCOE2053Course Name: Artificial Intelligence and Machine Learning 75
Course Code: 2501PETCLC206TCourse Name: Laboratory Course... 77
Course Code: 2501PETCSW207T Course Name: Seminar II.. 79
Course Code: 2501PETCCV208P Course Name: Comprehensive Viva... 81

Preface

The National Education Policy (NEP) 2020 has introduced significant reforms in India's higher education landscape with a strong focus on multidisciplinary education, flexibility in learning, research orientation, skill development, and industry relevance. In alignment with these progressive reforms, Tatyasaheb Kore Institute of Engineering & Technology (TKIET), Warana University, Waranangar, is committed to implementing the vision of NEP 2020 to cultivate competent, innovative, and ethically responsible professionals capable of addressing emerging technological challenges.

The Department of Electronics & Telecommunication Engineering is pleased to present the Structure and Syllabus of the M.TechProgramme in Electronics & Telecommunication Engineering. The curriculum has been carefully designed to provide students with advanced knowledge and research capabilities in core areas of electronics and communication engineering. The programme includes advanced courses such as Embedded Systems, Error Control Coding Techniques, Computer Vision, Adhoc and Wireless Sensor Networks, along with specialized electives in areas such as wireless communication, VLSI design, antenna theory, mobile computing, signal processing, and communication technologies.

This syllabus provides comprehensive information regarding the course structure, credit framework, learning outcomes, evaluation mechanisms, and academic guidelines to ensure effective implementation of the programme. The Department sincerely acknowledges the valuable contributions of the Board of Studies members, faculty experts, and industry professionals whose insights and expertise have been instrumental in shaping this curriculum.

We are confident that the M. Tech Programme in Electronics & Telecommunication Engineering, designed in accordance with NEP 2020, will equip students with advanced technical knowledge, research capabilities, and lifelong learning skills. The programme aims to prepare future-ready professionals who will contribute significantly to technological innovation, industry growth, and the digital transformation of society.

Program Outcomes

Program Outcomes (POs) are clear, measurable statements that describe what students are expected to know, understand, and be able to do by the time they complete an academic program.They define the competencies, skills, and professional abilities that graduates should possess at the end of the program.In India, POs for Engineering Programs are formally prescribed and monitored by the National Board of Accreditation (NBA).NBA has defined the following three POs for a graduate of PG Engineering Program:

PO1:	An ability to independently carry out research /investigation and development work to solve practical problems.
PO2:	An ability to write and present a substantial technical Report/document.
PO3:	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Duration

- The full time M.Tech Program is a 2 yearspost graduate program.
- The program is divided into 4 semesters.

Eligibility

1. The Candidate should be an Indian National.

2. Passed Bachelor's Degree in the relevant field of Engineering& Technology from AICTE or Central or State Government approved institutions or equivalent, with at least 50% marks (at least 45% marks in case of candidates of Backward Class categories, EWS and PWD).

3. Obtained Qualified score or non-qualified score in GATE conducted by the IIT for the current academic year.

OR

3. For sponsored candidates (Proforma P and Q), a minimum of two years of full-time work experience in a registered firm/ company/ industry/ educational and/ or research institute/ any Government Department or Government Autonomous Organization in the relevant field in which admission is being required.

Medium of Instruction

- The medium of instruction, examinations, assignments, and project reports is English.

Abbreviations

Acronym	Full Form
ISE	In-SemesterExamination
ISE-I	In-SemesterExaminationI
ISE-II	In-SemesterExaminationII
ESE	EndSemester Examination
ISA	In Semester Assessment
POE	Practical Oral Examination
L	TheoryLecture
T	Tutorial
P	Practical
C	Number of Credits
CH	Contact Hours
PCC	Program Core Course
PE	Program Elective Course
LC	Lab Course
OE	Open Elective Course
SW	Seminar Work
CV	Comprehensive Viva

Examination& Evaluation Pattern

Evaluation toolsused for the evaluation of a student for each course is as follows:

For Theory Courses	In-Semester Examination (ISE) And End Semester Examination (ESE)
For Lab/Tutorial Courses	In-Semester Assessment (ISA) And/Or Practical and Oral Examination (POE)

Refer course structure for specific evaluation tools used for each course.

In-Semester Examination (ISE)

The In-Semester Examination (ISE) will be conducted at the departmental level. There will be two tests in each semester for every theory course: ISE-I and ISE-II.

- Each test will be of 40 marks.
- The duration of each test will be 1 hour and 30 minutes.

The total ISE marks will be calculated as the average of ISE-I and ISE-II. These rules may be modified from time to time as per the guidelines of the concerned regulatory authorities.

- ISE-I will cover Unit I and Unit II.
- ISE-II will cover Unit III and Unit IV.

  - **Minimum Passing Criteria**

    Students must score a minimum of 40% marks in the ISE. If a student fails to secure the minimum required marks, he/she must appear for a Make-up Examination.

    The Make-up Examination will be conducted in the same semester for:

    - Students who fail to secure minimum passing marks.
    - Students who were absent due to valid reasons such as medical issues, natural calamities, or participation in NSS, NCC, or similar activities (subject to verification of absence and recommendation from the Head of Department).

- **Special Provision**

  If a failed student appears for three tests (including the Make-up test) and scores more than 16 marks when calculating the average of the best two out of the three tests, the student will be awarded the minimum passing marks of 16 only.

  For students absent with valid reasons:

  - If absent in one test, the average of the attempted test and the Make-up test will be considered.
  - If absent in two tests, the decision will be taken after reviewing the reasons and based on the recommendation of the Head of Department.

End Semester Examination (ESE):

The End Semester Examination (ESE) will be conducted for 60 marks and will be based on the entire syllabus. The duration of each examination will be 2 hours.

Weightage of Units

The weightage of units in the ESE question paper will be as follows:

a) Units that are not covered in ISE-I or ISE-II will carry 30% weightage each.

b) Units that are covered in ISE-I and ISE-II will carry 10% weightage each.

Backlog Examination

Students who fail in the End Semester Examination (ESE) of either the odd or even semester within an academic year will be allowed to appear for the Backlog Examination, which will be conducted along with the regular ESE of the respective semester.

- **Re-Examination of ESE**

  A Re-Examination (Make-up Examination) for all courses (UG and PG), including both theory and laboratory courses, will be conducted once a year before the commencement of the odd semester of the next academic year.

  - A one-grade penalty will be applied to students appearing for the Make-up/Re-Examination.
  - However, no grade penalty will be applied if a student secures a ‘P’ grade in the Make-up/Re-Examination.
  - Grace marks will not be awarded for the Make-up/Re-Examination.
  - Exception: Grace marks may be considered if the student is appearing for the ESE for the first time.

- **Eligibility Criteria for ESE**

  To be eligible for the End Semester Examination (ESE), a student must:

  - Secure at least 40% marks in ISE and ISA of the concerned course.
  - Fulfil the attendance requirements as per the norms of Warana University, Warananagar.

  If a student does not meet these requirements, he/she will not be eligible to appear for the ESE.

Nature of Question Paper for ESE

Q. No.			Marks	BL	CO
1	**Attempt the following.**		24		
	a	Unit -1		II	1
	b	Unit -2		III	2
	c	Unit -3		IV	1
	d	Unit -4		I	1
2	**Attempt any Two of the following.**		18		
	a	Unit -5		VI	2
	b	Unit -5		II	3
	c	Unit -5		IV	3
3	**Attempt any Two of the following.**		18		
	a	Unit -6		IV	4
	b	Unit -6		III	4
	c	Unit -6		III	4

In Semester Assessment (ISA):

ISA for laboratory courses will be conducted as a continuous assessment throughout the semester.The assessment will be based on the following:

1. Performance in laboratory work.
2. Submission of experiments in the form of a properly maintained journal or report.
3. Timely completion of assigned experiments.
4. Attendance in laboratory sessions.

5. Understanding of the experiments conducted, evaluated through methods such as quizzes, oral examinations, case studies, field work, surveys, open-book tests, model preparation, programming, projects, or any other criteria specified by the course teacher.

Practical Oral Examination (POE):

POE for laboratory courses will be conducted immediately after the end of the semester. The duration of the practical examination will be as specified in the curriculum structure.The POE will be conducted jointly by an Internal Examiner and an External Examiner.

The examination may be conducted in any one of the following ways:

1. **Oral Examination Only**

   Both the Internal and External Examiners will ask questions based on the practical content of the course to assess the student's practical knowledge.

2. **Practical Examination Only**

   Students will be required to perform a given experiment, complete a workshop task, prepare a drawing, or develop a computer program, as applicable.In this case, the student's performance will be evaluated by the External Examiner only.

3. **Practical and Oral Examination**

   Students will first perform a given practical task. This will be followed by an oral examination (viva voce) based on the practical content of the course.The student's performance will be evaluated jointly by both the Internal and External Examiners.

Grading System

The University follows a **10-Point Grading System** to evaluate student performance.

- **Conversion of Marks into Grades**
  In every semester, the marks you get in each subject (out of 100) are converted into **grade points** as per the table below. You need at least **40% marks** to pass a subject.

Marks Obtained (Out of 100)	Grade Point	Letter Grade	Meaning
Absent	0	AB	Absent
0 – 39	0	F	Fail
40 – 44	4	P	Pass
45 – 49	5	C	Average
50 – 59	6	B	Above Average
60 – 69	7	B+	Good
70 – 79	8	A	Very Good
80 – 89	9	A+	Excellent
90 – 100	10	O	Outstanding

Note:

1. If decimal marks are 0.5 or more, they will be rounded off to the next higher number. (Example: 59.5 will become 60)
2. For courses of 50 marks or 200 marks, marks will be converted proportionally to 100 marks before assigning grade points.

- **Calculation of Semester Grade Point Average (SGPA)**
  SGPA is calculated at the end of each semester.It shows your average performance in one semester.

$$SGPA = \frac{\sum(Credit \times Grade\ Point)\ for\ each\ course\ of\ a\ Semester}{\sum(Credits)\ for\ a\ Semester}$$

- **Calculation of Cumulative Grade Point Average (CGPA)**
  CGPA is calculated after completing multiple semesters.CGPA reflects the overall academic performance of the student in the program.

$$CGPA = \frac{\sum(Total\ Credits\ of\ a\ Semester \times SGPA\ of\ Respective\ Sememster)\ of\ all\ semesters}{\sum(Course\ Credits)\ of\ all\ Semesters}$$

Note:

1. TheSGPA&CGPAshallberounded offto2decimal points.

F.Y. M. Tech Electronics & Telecommunication Engineering

Curriculum Structure& Evaluation Scheme forSemester-I

Course Category	Course Code	Course Title	Teaching and Credit Scheme					Examination and Evaluation Scheme			
			L	T	P	C	CH	Component	Marks	Min for Passing	
PCC	2501PETC PCC101	Advanced Embedded System	3	-	-	3	3	ESE	60	24	40
								ISE	40	16	
	2501PETC PCC101T	Advanced Embedded System Tutorial	-	1	-	1	1	ISA	25	10	10
	2501PETC PCC102	Error control Coding Techniques	3	-	-	3	3	ESE	60	24	40
								ISE	40	16	
	2501PETC PCC102T	Error control Coding Techniques Tutorial	-	1	-	1	1	ISA	25	10	10
PE	2501PETC PE103X	Program Elective-I	3	-	-	3	3	ESE	60	24	40
								ISE	40	16	
	2501PETC PE104X	Program Elective-II	3	-	-	3	3	ESE	60	24	40
								ISE	40	16	
	2501PETC PE105X	Program Elective-III	3	-	-	3	3	ESE	60	24	40
								ISE	40	16	
LC	2501PETC LC106P	Lab Course	-	-	4	2	4	POE	25	10	20
								ISA	25	10	
SW	2501PETC SW107T	Seminar-I	-	-	2	1	2	ISA	50	20	20
Total			15	2	6	20	23		650	260	260

Note : 'X' indicates the sequence number of PE/OE offered by the respective department.

F.Y. M. Tech Electronics & Telecommunication Engineering

List of Program Electives for Semester-I

	Course Code	Course Title
Program Elective-I	2501PETCPE1031	Advanced Wireless Communication
	2501PETCPE1032	Optimization Techniques
	2501PETCPE1033	Internet Traffic Engineering
Program Elective-II	2501PETCPE1041	Random Process
	2501PETCPE1042	Digital Data Compression
	2501PETCPE1043	Advanced Biomedical Signal Processing
Program Elective-III	2501PETCPE1051	Mobile Computing
	2501PETCPE1052	Design of VLSI Systems
	2501PETCPE1053	Advanced Antenna Theory

F.Y. M. Tech Electronics & Telecommunication Engineering

Curriculum Structure& Evaluation Scheme for Semester-II

Course Category	Course Code	Course Title	Teaching and Credit Scheme					Examination and Evaluation Scheme			
			L	T	P	C	CH	Component	Marks	Min for Passing	
PCC	2501PETCPC C201	Computer Vision	3	--	--	3	3	ESE	60	24	40
								ISE	40	16	
	2501PETCPC C201T	Computer Vision Tutorial	--	1	--	1	1	ISA	25	10	10
	2501PETCPC C202	Adhoc & wireless Sensor networks	3	--	--	3	3	ESE	60	24	40
								ISE	40	16	
	2501PETCPC C202T	Adhoc & wireless Sensor networks Tutorial	--	1	---	1	1	ISA	25	10	10
PE	2501PETCPE 203X	Program Elective-IV	3	--	--	3	3	ESE	60	24	40
								ISE	40	16	
	2501PETCPE 204X	Program Elective-V	3	--	--	3	3	ESE	60	24	40
								ISE	40	16	
OE	2501PETCOE 205X	Open Elective Course	3	--	--	3	3	ESE	60	24	40
								ISE	40	16	
LC	2501PETCLC 206T	Laboratory Practice	--	--	2	1	2	ISA	25	10	10
SW	2501PETCSW 207T	Seminar-II	--	--	2	1	2	ISA	50	20	20
CV	2501PETC CV208P	Comprehensive Viva	--	--	2	1	2	POE	25	10	10
Total			**15**	**2**	**6**	**20**	**23**	**--**	**650**	**260**	**260**

Note:

- 'X' indicates the sequence number of Program Elective (PE) offered by Computer Science and Engineering Program.
- Students should opt for the Open Elective (OE) course from other departments. The list of OE courses offered by other departments is available in the structure. Although the OE course code is defined by the respective program in the structure, the actual opted OE course will appear on the mark card.

F.Y. M. Tech Electronics & Telecommunication Engineering

List of Program Electives for Semester-II

	Course Code	Course Title
Program Elective-IV	2501PETCPE2031	Cryptography and Network Security
	2501PETCPE2032	Multi Rate System
	2501PETCPE2033	Advanced Light Wave Communication
Program Elective-V	2501PETCPE2041	Advanced Microwave circuit Design
	2501PETCPE2042	SDR & Cognitive Radio Technology
	2501PETCPE2043	Industry Automation & Process Control

F.Y. M. Tech Electronics & Telecommunication Engineering

List of Open Electives Offered by All Programs

Sr. No.	OE Offered by Program	Course Code	Open Elective Course
1	Chemical Engineering	2501PCHEOE2051	Project Management
2		2501PCHEOE2052	Operations Research
3		2501PCHEOE2053	Energy Technology
4	Electronics& Telecommunication Engineering	2501PETCOE2051	Advanced Operating Systems
5		2501PETCOE2052	Cyber Security
6		2501PETCOE2053	Artificial Intelligence and Machine Learning
7	Construction Management (Civil Engineering)	2501PCCMOE2051	Water Power Engineering
8		2501PCCMOE2052	Waste to Energy
9		2501PCCMOE2053	Contracts & Tenders
10	Mechanical Design (Mechanical Engineering)	2501PMDEOE2051	Cryogenics
11		2501PMDEOE2052	Design for Manufacture & Assembly
12		2501PMDEOE2053	Enterprise Resource Planning
13	Structural Engineering (Civil Engineering)	2501PCSTOE2051	Cost Management of Engineering Projects
14		2501PCSTOE2052	Optimization Techniques in Civil Engineering
15		2501PCSTOE2053	Industrial Safety
16	Computer Science and Engineering	2501PCSEOE2051	Ethical AI & Explainability
17		2501PCSEOE2052	Computer Vision
18		2501PCSEOE2053	High Performance Computing for Multidisciplinary Research

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering				
Course Code: 2501PETCPCC101 Course Name: Advanced Embedded System				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites:

Students should have basic knowledge of microprocessors/microcontrollers, C programming for embedded systems, and computer organization. Familiarity with digital electronics and operating system fundamentals will help in understanding ARM architecture and RTOS concepts.

Course Objectives:

1	Understand the architecture of ARM family.
2	Understand On chip peripherals of ARM controller.
3	Understand basic concepts of RTOS and µCOS.

Course Outcomes:

COs	At the end of the successful completion of the course, the students will be able to
CO1	Explain the ARM9 architecture, memory organization, programmer's model, instruction set, and develop basic ARM assembly programs.
CO2	Analyze and configure ARM cache architecture, MPU, and MMU, including cache policies, page tables, TLB, and Coprocessor-15 operations for efficient memory management.
CO3	Develop and debug Embedded C programs to interface and control ARM on-chip peripherals such as GPIO, timers, UART, I2C, CAN, and interrupts using LPC29xx series controllers.
CO4	Describe and apply RTOS concepts including task management, scheduling algorithms, synchronization mechanisms, inter-task communication, and interrupt handling.
CO5	Implement and manage µC/OS-II kernel services, including task creation, scheduling, context switching, and system initialization in real-time embedded applications.
CO6	Apply time management and event control mechanisms in µC/OS-II to design reliable real-time systems using delays, event control blocks, message queues, and inter-task communication.

Course Description:

This course provides an in-depth understanding of ARM9 microprocessor architecture, memory organization, and assembly-level programming, enabling students to develop efficient embedded applications. Students will learn about ARM caches, Memory Protection Unit (MPU), and Memory Management Unit (MMU), including cache policies, virtual memory, and system-level configuration using Coprocessor15. The course covers on-chip peripherals such as GPIO, timers, UART, I2C, CAN, and LIN, along with practical embedded C programming on LPC29xx series microcontrollers. An introduction to Real-Time Operating Systems (RTOS) is included, focusing on multitasking, task management, context switching, semaphores, message queues, and event handling. The course also emphasizes the µC/OS-II kernel structure, task scheduling, time management, event control blocks,

and inter-task communication, preparing students to design and implement real-time embedded systems efficiently.		
Course Contents		
Unit-1	**ARM9 Architecture & programming**	**6 Hours**
ARM9 architecture, Memory organization, Programmers model, instructions and assembly programming.		
Unit-2	**ARM caches MPU and MMU**	**8 Hours**
Cache architecture, Cache policy, Coprocessor15 and caches, protected region, Initializing MPUs, caches and write buffer, virtual memory, ARM MMU, page tables, TLB, Coprocessor15 and MMU Configuration.		
Unit-3	**ARM Peripherals and Programming**	**8 Hours**
On chip peripherals, GPIO, Event router, Interrupts, vectored interrupt controller (VIC), timers, RTC, Watchdog, UART, I2C, CAN, LIN. programming of GPIO using Embedded "C" (LPC 29xx series Example 2921/23/25).		
Unit-4	**Introduction to RTOS**	**5 Hours**
RTOS basics, RTOS architecture, share data problem, critical section, shared resources, Task states multitasking, context switching, Kernels, pre-emptive & non-pre-emptive schedulers, mutual exclusion,semaphores,Interrupt Latency, pipes & mails boxes. Message queues, timer functions, events.		
Unit-5	**µCOS**	**6 Hours**
Kernel Structure: Tasks, Task State, Task Level Context Switching, Locking and unlocking of scheduler, Idle Task, Statistics Task, Interrupts, Clock Tick, Initialization, Starting the OS, Task Management: Creating/deleting and suspending/Resuming Task, Task Stacks and checking, Changing Task's.		
Unit-6	**Time Management and Event Control Blocks**	**3 Hours**
Time Management: Delaying/Resuming Task, System Time, Event Control Blocks: Initialization of ECB, Placing/Removing Task from ECB waitlist, Finding Highest Priority Task, List of Free ECB, Task State Management. Communication in µCOS-II.		
Learning Resources:		
Reference Books:		
1	ARM System Developers Guide , Designing & Optimizing System Software, Andrew sloss, Dominic symes, Chris Wright, 1stEdition 2004.	
2	Micro C/OSII the Real Time Kernel, Jean Labarosse, CMP Books, PIC C Manual, CCS Inc, 2ndEdition.	
3	Embedded software primer, David Simon, Pearson Education, 1stEdition 2005.	
4	ARM LPC 29xx series data sheet, ARM Datasheet	

Tatyasaheb Kore Institute of Engineering and Technology
F.Y. M. Tech Electronics & Telecommunication Engineering

Course Code: 2501PETCPCC101T Course Name: Advanced Embedded System Tutorial

Teaching Scheme	Credit	Evaluation Scheme
Tutorial/Practical: 02 Hours/Week	**01**	**ISA: 25 Marks**

Prerequisites, if any: Students should have basic knowledge of digital electronics and microprocessor/microcontroller fundamentals. They should be familiar with C programming, including pointers and bitwise operations. Introductory understanding of assembly language concepts and memory organization is expected. Basic awareness of operating system concepts such as interrupts and multitasking will be helpful.

Course Objectives: The objective of the course is to

1	To understand the architecture, programming model, and instruction set of ARM9 processors for embedded system design.
2	To develop skills in programming ARM on-chip peripherals and interfacing them using Embedded C.
3	To introduce real-time operating system concepts and implement multitasking applications using µC/OS-II.

Course Outcomes: After successful completion of the course, student will be able to

CO1	Explain the ARM9 architecture, memory organization, and programmer's model.
CO2	Write and debug ARM assembly and Embedded C programs for ARM9 processors.
CO3	Configure and use ARM caches, MPU, and MMU for efficient memory management.
CO4	Program on-chip peripherals such as GPIO, timers, UART, I2C, CAN, and interrupts.
CO5	Apply RTOS concepts including task scheduling, synchronization, and inter-task communication.
CO6	Develop and test real-time multitasking applications using µC/OS-II.

Course Description: This course provides an in-depth study of ARM9 processor architecture, programming, and on-chip peripherals. It introduces cache, MPU/MMU concepts and real-time operating system fundamentals. Learners gain hands-on experience in developing multitasking embedded applications using µC/OS-II.

Course Content

Sr. No.	Topic of Practical / Experiment / Tutorial	Assigned Hours
1	Study of ARM9 processor architecture and block diagram	02
2	Study of ARM programmer's model and register organization	02
3	ARM instruction set and addressing modes	02
4	ARM assembly programming for arithmetic operations	02

5	Study of ARM pipeline architecture and performance improvement	02
6	Study of ARM cache architecture and cache policies	02
7	Study of Memory Protection Unit (MPU) and its configuration	02
8	Study of Memory Management Unit (MMU) and virtual memory concept	02
9	Study and programming of ARM peripherals: GPIO	02
10	Interfacing and programming of UART communication	02
11	Study of interrupt handling and Vectored Interrupt Controller (VIC)	02
12	Introduction to Real Time Operating Systems (RTOS) concepts	02
13	Task scheduling, context switching and task management in RTOS	02
14	Study of µC/OS-II kernel architecture and task management	02
15	Study of inter-task communication: semaphores, message queues and mailboxes	02

Learning Resources:

Text Books

1. **Raj Kamal**, *Embedded Systems: Architecture, Programming and Design*, Tata McGraw Hill.
2. **Frank Vahid and Tony Givargis**, *Embedded System Design: A Unified Hardware/Software Introduction*, Wiley.

Reference Books:

1. **Andrew N. Sloss**, *ARM System Developer's Guide*, Morgan Kaufmann.
2. **Jean J. Labrosse**, *MicroC/OS-II: The Real Time Kernel*, CMP Books.

MOOC / NPTEL/YouTube Links:

- NPTEL Course: *Embedded Systems Design* – IIT Kharagpur
- NPTEL Course: *Real Time Operating Systems* – IIT Madras
- ARM Architecture Tutorials (YouTube – NPTEL / ARM Official)

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering				
Course Code: 2501PETCPCC102 Course Name: Error Control Coding Techniques				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites:

Students should have basic knowledge of digital communication systems, probability and random processes, and linear algebra. Familiarity with signals and systems and binary arithmetic is desirable for understanding error control coding techniques.

Course Objective:

1	Understand basic concept & need of Error Control Coding
2	Study of various encoding & decoding techniques through block codes
3	Study of various encoding & decoding techniques through Convolution Codes.

Course Outcomes:

Cos	Explain the need, objectives, and fundamental principles of error control coding, including parameters and distance properties of linear block codes.
CO1	Analyze and design linear block codes such as Hamming, Reed–Muller, product, repetition, and extended/shortened codes for error detection and correction.
CO2	Apply algebraic principles to construct and decode cyclic codes, including CRC, cyclic Hamming, Golay, and quasi-cyclic codes.
CO3	Develop and implement BCH codes using Galois field arithmetic and perform decoding using algebraic decoding algorithms.
CO4	Explain the construction and decoding of Reed–Solomon codes, and apply Euclidean and Berlekamp algorithms for nonbinary error correction.
CO5	Analyze convolutional, Turbo, and LDPC codes, and implement decoding techniques such as Viterbi, MAP, and iterative decoding for modern communication systems.
CO6	Explain the need, objectives, and fundamental principles of error control coding, including parameters and distance properties of linear block codes.

Course Description:

This course introduces the principles and techniques of error control coding, covering both linear block codes and cyclic codes, including Hamming, Reed-Muller, Golay, and Bose-Chaudhuri-Hocquenghem (BCH) codes. Students will learn code construction, encoding and decoding techniques, syndrome computation, distance properties, and error detection and correction capabilities. The course further explores Reed-Solomon codes, convolutional codes, and iterative decoding schemes such as Turbo codes and Low-Density Parity-Check (LDPC) codes, emphasizing algebraic structures, polynomial representations, and practical decoding algorithms including Viterbi, Euclidean, and Berlekamp methods. Through this course, students develop the ability to design, analyze, and implement robust coding schemes for reliable digital communication systems.

Course Content		
Unit-1	**Linear block codes**	**7 Hours**
Need, Objective &Approaches of Error Control Coding, Introduction, Structure, Parameters, Generator& Parity Check Matrix, Encoding circuit for (n-k) Linear Block Code, Syndrome & Error detection,Syndrome circuit, Distance Properties, Error detecting & Correction Capabilities, Standard Array & Syndrome decoding for (n, k) linear Block Code. Hamming Codes, Product codes, Repetition code, Hada mard codes (Wash Code), Dual Code, Shortened and Extended linear Codes, Reed Muller (RM) Codes.		
Unit-2	**Cyclic codes**	**7 Hours**
Algebraic structure, Polynomial representationof codeword, Generator polynomial, Non-systematic & Systematic Cyclic Codes, Generator & Parity Check Matrices, Structure of Cyclic Encoder & Syndrome Calculator, Encoding of cyclic code using (n- k) & K shift register, Syndrome computation and Error detection, Decoding of Cyclic code, Error- Trapping Decoding. Cyclic Redundancy Check Code, Cyclic Hamming Codes, Golay Code, Shortened Cyclic Codes, Cyclic Product Code, Quasi Cyclic Code.		
Unit-3	**Bose Chaudhuri Hocquenghem CODE (BCH)**	**8 Hours**
Groups, Rings & its properties, Fields: Binary Field Arithmetic, Primitiveelement and primitive polynomial, Primitive BCH Code, Construction ofGalois Field GF(2m), Properties of Galois Field GF(2m), Minimal & Generator Polynomial for BCH Code. Decoding of BCH Code, Peterson-Gorenstein- Zierler decoder, Error location and Error Evaluation Polynomials,Implementation Correction of Galois Field Arithmetic, Implementation of Error.		
Unit-4	**Reed-Solomon codes & decoding algorithms**	**7 Hours**
Introduction, Error correction capability of RS code, RS code in Nonsystematic & Systematic form, Syndrome decoding, The Euclidean Algorithm: Error location & Error Evaluation Polynomials, Decoding of RS using the Euclidean Algorithm, Decoding of RS & Nonbinary BCH codes using the Berlekamp Algorithm.		
Unit-5	**Iteratively decoded codes**	**6 Hours**
Introduction, Convolutional Encoder, Generation of Output code sequence using Time domain & Transform domain approach, Convolutional code representation: Code Tree, State diagram & Trellis diagram, Structural & Distance properties of Convolutional codes, Transfer Function of Convolution Code. Optimum decoding of Convolutional Codes: Maximum Likelihood decoding, The Viterbi Algorithm, Suboptimal Decoding: Sequential Decoding, Majority Logic Decoding.		
Unit-6	**Probabilistic Models, Unsupervised Learning & Association Rules**	**7 Hours**
TURBO CODE: Introduction, Basic Turbo Encoding Structure, Decoding Algorithms, The Maximum Posterior Decoding Algorithm. Low Density Parity Check Codes (LDPC): Introduction, Construction, Tanner Graph, Decoding LDPC Code: Hard & Soft decoding, Vertical Step updating, Horizontal Step Updating, Terminating & Initializing the decoder algorithm.		

Learning Resources:	
Reference Books:	
1	Shu Lin, Daniel J. Costello, Jr., “Error Control Coding”, 2nd Edition, Pearson Education
2	Todd K Moon,” Error Correction Coding”, Wiley student, Edition 2006
3	Salvatore Gravano, “Introduction to Error Control Codes”, South Asia Edition, Oxford University Press.
4	Jorge Castineira Moreira, Patrick Guy Farrell,” Essentials of Error Control
5	W. Cary Huffman and Vera Press,” Fundamentals of Error correcting Codes”, First Edition, Cambridge University Press.

Tatyasaheb Kore Institute of Engineering and Technology F.Y.M. Tech Electronics & Telecommunication Engineering		
Course Code: 2501PETCPCC102T Course Name: Error Control Coding Techniques Tutorial		
Teaching Scheme	**Credit**	**Evaluation Scheme**
Tutorial/Practical: 02 Hours/Week	**01**	**ISA: 25 Marks**

Prerequisites, if any: Students should have a basic understanding of **digital communication systems**, **binary number systems**, and **probability concepts** related to noise and errors in communication channels. Familiarity with **Boolean algebra**, **matrix operations**, and **polynomial arithmetic** is essential for understanding linear block and cyclic codes. Prior exposure to **digital logic design** and **discrete mathematics** will help in grasping concepts such as syndrome decoding, Galois fields, and advanced error control coding techniques.

Course Objectives: The objective of the course is to

1. To understand the **fundamental principles and necessity of error control coding** in digital communication systems.
2. To analyze and apply **linear block codes, cyclic codes, and convolutional codes** for error detection and correction.
3. To develop the ability to **encode and decode advanced error control codes** such as BCH, Reed–Solomon, Turbo, and LDPC codes for reliable data transmission.

Course Outcomes: After successful completion of the course, student will be able to

CO1	**Explain the need, objectives, and classification of error control coding** techniques used in digital communication systems.
CO2	**Construct generator and parity check matrices** for linear block codes and perform encoding and syndrome calculations.
CO3	**Apply syndrome decoding and standard array methods** for error detection and correction, including Hamming codes.
CO4	**Analyze and implement cyclic codes**, including CRC, using polynomial representation and shift-register–based encoding.
CO1	**Use Galois field arithmetic to encode and decode BCH and Reed–Solomon codes**, including error location techniques.
CO2	**Design and analyze convolutional codes and decoding algorithms**, including trellis representation, Viterbi algorithm, and an introduction to Turbo and LDPC codes.

Course Description: This course provides a comprehensive understanding of error control coding techniques **used to ensure reliable digital communication. It covers** linear block codes, cyclic codes, BCH, Reed–Solomon, and convolutional codes **with practical encoding and decoding methods. Advanced topics such as** Viterbi algorithm, Turbo codes, and LDPC codes **are introduced to address high-performance communication systems. The course emphasizes both** theoretical foundations and practical implementation aspects **relevant to modern communication technologies.**

Course Content

Sr. No.	**Topic of Practical / Experiment / Tutorial**	**Assigned Hours**

1	Introduction to Error Control Coding: Need, objectives, types of errors and coding approaches	02
2	Parameters of Linear Block Codes, Generator Matrix & Parity Check Matrix construction	02
3	Encoding and Syndrome calculation for Linear Block Codes	02
4	Error detection & correction using Syndrome decoding and Standard Array	02
5	Hamming Codes: Construction, encoding and error correction	02
6	Advanced Linear Codes: Repetition, Hadamard, Product Codes, Dual Codes	02
7	Cyclic Codes: Polynomial representation and Generator Polynomial	02
8	Encoding of Cyclic Codes using shift registers (Systematic & Non-systematic)	02
9	Syndrome computation, CRC codes and Error-Trapping decoding	02
10	Introduction to Galois Fields GF(2^m), Field construction and arithmetic	02
11	BCH Codes: Generator polynomial and encoding procedure	02
12	Decoding of BCH Codes: Error location using Peterson Algorithm	02
13	Reed-Solomon Codes: Encoding and Syndrome decoding	02
14	Convolutional Codes: Encoder design, state diagram & Trellis representation	02
15	Viterbi Algorithm, Turbo Codes & Introduction to LDPC decoding	02

Learning Resources:

Text Books

1. Shu Lin, Daniel J. Costello, Jr., *Error Control Coding*, Pearson
2. Todd K. Moon, *Error Correction Coding*, Wiley

Reference Books:

1. Salvatore Gravano, *Introduction to Error Control Codes*, Oxford
2. Jorge Castineira Moreira, Patrick Guy Farrell, *Essentials of Error Control Coding*
3. W. Cary Huffman, Vera Pless, *Fundamentals of Error-Correcting Codes*, Cambridge

MOOC / NPTEL/YouTube Links:
https://nptel.ac.in/courses/117104121

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering					
Course Code: 2501PETCPE1031 Course Name: Advanced Wireless Communication					
Teaching Scheme		**Credit**	**Evaluation Scheme**		
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**	
			ESE:	**60 Marks**	

Prerequisites:

Students should have prior knowledge of signals and systems, probability and random processes, and basic digital communication concepts. Familiarity with linear algebra and electromagnetic wave propagation is desirable for understanding wireless channel and MIMO systems.

Course Objectives:

1	Acquire fundamental knowledge of Wireless Communications
2	Study the wireless channel capacities and different channel models
3	Understand the basic concepts of OFDM

Course Outcomes:

COs	**At the end of the successful completion of the course, the students will be able to**
CO1	Explain the physical and statistical modelling of wireless channels, including time- and frequency-domain characteristics.
CO2	Analyse point-to-point wireless communication over fading channels and evaluate the impact of time, frequency, and antenna diversity.
CO3	Describe and analyse OFDM-based multicarrier modulation, including orthogonality principles, system design, and parameter selection.
CO4	Evaluate the capacity of wireless channels, including AWGN, LTI Gaussian, and fading channels under different resource constraints.
CO5	Analyse MIMO systems for capacity enhancement and diversity gain, including space–time modulation and coding techniques.
CO6	Explain and compare multiuser MIMO uplink and downlink communication, focusing on multiple-antenna transmission and reception strategies.

Course Description:

This course provides a comprehensive study of wireless communication systems, covering the physical modelling of wireless channels, statistical channel behaviour, and input/output channel models. Students will explore point-to-point communication in fading environments, including diversity techniques and channel uncertainty impacts, as well as wideband modulation schemes such as OFDM and multicarrier systems. The course also focuses on channel capacity analysis for AWGN and fading channels, and advanced MIMO techniques, including space-time coding, MIMO diversity, and multiuser communication for both uplink and downlink scenarios, enabling students to design and analyse high-performance wireless systems.

Course Content		
Unit-1	**Wireless channel**	**7 Hours**
Physical modelling for wireless channels, input/output model of wireless channel, time and frequency response, statistical models.		
Unit-2	**Point to point communication**	**7 Hours**
Detection in rayleigh fading channel, time diversity, Antenna diversity, frequency diversity, impact of channel uncertainty.		
Unit-3	**Wideband Modulation Techniques: OFDM (Multicarrier Modulation)**	**6 Hours**
Basic Principles of orthogonality, single vs multicarrier systems, OFDM block diagram and ITS Explanation, OFDM signal mathematical representation, selection parameters for modulation.		
Unit-4	**Capacity of wireless channels**	**7 Hours**
AWGN channel capacity, resources of AWGN channel, Linear time invariant gaussian channels, capacity of fading channels.		
Unit-5	**MIMO and multicarrier modulation**	**6 Hours**
Narrowband MIMO model-parallel decomposition of MIMO channel-MIMO channel capacity-MIMO diversity gain Space-Time modulation and coding, Smart.		
Unit-6	**MIMO IV –multiuser communication**	**7 Hours**
Uplink with multiple receive antennas, MIMO uplink, Downlink with multiple receive antennas, MIMO downlink.		

Learning Resources:

Reference Book	
1	Fundamentals of wireless communication, David Tse, P. Viswanath, Cambridge, 5thEdition 2005
2	Andreas Molisch, Andreas Molisch, Wiley, 2nd Edition 2012
3	Wireless communications, Principles and Practice, Theodore S. Rappaport, Pearson, 2nd Edition 2010
4	Wireless communication, Upen Dalal, Oxford, 1stEdition, 2009
5	Wireless communications, Mark Ciampa, Jorge Olenwa, Cengage, 3rd Edition, 2013

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering				
Course Code: 2501PETCPE1032 Course Name: Optimization Techniques				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites:

Students should have basic knowledge of engineering mathematics, including calculus, linear algebra, and probability. Familiarity with numerical methods and fundamentals of operations research will be helpful for understanding optimization techniques.

Course Objectives:

1	Students should understand the concept of Optimization Techniques.
2	Students should understand the concept of linear programming, Nonlinear programming, Geometric programming, Dynamic programming.
3	Studentsshould understand the method for formulation of problem and assignment of models

Course Outcomes:

COs	**At the end of the successful completion of the course, the students will be able to**
CO1	Explain the fundamental concepts of optimization, including problem formulation, classification, and multivariable optimization with and without constraints.
CO2	Formulate and solve linear programming problems using graphical, simplex, revised simplex, and duality methods, including transportation models.
CO3	Apply nonlinear programming techniques for single- and multi-variable optimization using analytical and numerical search methods.
CO4	Analyse and solve convex optimization problems using geometric programming and Kuhn–Tucker optimality conditions.
CO5	Apply dynamic programming and assignment models to solve multistage decision-making and resource allocation problems.
CO6	Explain and implement genetic algorithms for solving complex engineering optimization problems and analyze their performance.

Course Description:

This course introduces the principles and methods of optimization in engineering problems, starting from the historical development and classification of optimization problems to multivariable optimization with and without constraints. Students will learn linear programming including formulation, graphical and simplex solutions, duality, and transportation problems, as well as nonlinear programming techniques such as unidimensional search methods, steepest descent, and Kuhn-Tucker conditions. The course further explores geometric and dynamic programming, assignment models, and genetic algorithms, emphasizing both theoretical concepts and practical applications through case studies and computational procedures.

Course Content		
Unit-1	**Introduction**	**5 Hours**
Historical development, Application to Engineering Problems, Statement Of Optimization problems, Classification of Optimization, Multivariable optimization with and without constraints.		
Unit-2	**Linear Programming**	**7 Hours**
Formulation, Geometry, Graphical solution, standard and matrix form of linear programming problems, Simplex programming and its flow chart, revised simplex algorithm, Two-phase Simplex method, Degeneracy. Duality in linear programming: Definition of Dual Problem, General Rules for converting any Primal into its Dual Simplex method and its flow chart. Decomposition principle, Transportation problem.		
Unit-3	**Nonlinear Programming**	**6 Hours**
Unimodal functions, single dimensional minimization methods, Exhaustive search, Fibonnacimethod, Golden section, Comparison of Elimination method, Quadrature interpolation, Cubic interpolation, Direct root method, Randomsearch method, Steepest decent method, Fletcher-Reeves method, David-Fletcher- Powell Method, Convex sets and convex functions, Kuhn-Tucker conditions.		
Unit-4	**Geometric programming**	**6 Hours**
Problems with coefficients up to one degree of difficulty, Generalized for the positive and negative coefficients dynamic programming: Discrete & continuous dynamic programming (simple illustrations). Multistage decision problems, computation procedure and case studies.		
Unit-5	**Assignment Models**	**6 Hours**
Formulation of problem, Hungarian Method for Assignment Problem, Unbalanced Assignment Problems.		
Unit-6	**Genetic Algorithms**	**6 Hours**
Network optimization, Resource allocation and scheduling problems, Multiobjective optimization basics (Pareto optimality, trade-offs).		
Learning Resources:		

Reference Book

1	Linear Programming and Network Flows- Mokhtar S. Bazaraa, John J. Jarvis,
2	Chong, E. P. & Zak S. H. An introduction to optimization, John Wiley
3	Peressimi A.L., Sullivan F.E., Vhi, J.J.Mathematics of Non-linear Programming, Springer–Verlag
4	Optimization: Theory and Practices, S.S Rao, New Age Int. P Ltd. Publishers, New Delhi
5	Optimization concepts & application in Engg. -A. D. Belegundu, Tirupati R. Chandrupatla Pearson Edn.

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering				
Course Code: 2501PETCPE1033 Course Name: Internet Traffic Engineering				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites:

Students should have prior knowledge of computer networks, including IP addressing, routing protocols, and TCP/IP architecture. Familiarity with data communication concepts and basic algorithms will help in understanding traffic engineering and QoS routing.

Course Objectives:

1	Determine link weights for IP traffic engineering for an interior gateway protocol (IGP) such as OSPF or IS-IS.
2	To discuss traffic engineering for intra domain networks.
3	Develop the platform for understanding the basics of routers and types of routers, and as the background material to understand more details about a router's critical functions, such as address lookup and packet class classification.

Course Outcomes:

COs	At the end of the successful completion of the course, the students will be able to
CO1	Explain the evolution, architecture, and performance metrics of IP traffic engineering, including traffic models and link weight determination.
CO2	Analyse Internet routing principles and router architectures, including policy-based routing, routing instability, and packet processing mechanisms.
CO3	Evaluate and implement IP address lookup algorithms, focusing on longest prefix matching and triebased techniques for high-speed networks.
CO4	Analyse IP packet filtering and classification algorithms, including multidimensional and hardware-based approaches for high-performance routing.
CO5	Design and evaluate Quality of Service (QoS) routing mechanisms, including source-based routing, QoS-aware protocols, and routing under dynamic network conditions.
CO6	Apply MPLS-based traffic engineering techniques for IP and VPN networks, including constrained shortest path and network flow modelling approaches.

Course Description:

This course covers the principles and practices of IP traffic engineering and advanced routing techniques in modern networks. It begins with the evolution, taxonomy, performance measures, and architectural framework of Internet traffic engineering, including link weight determination and MCNF problem duality. Students will study Internet routing and router architectures, IP address lookup algorithms, and packet filtering/classification techniques. The course further explores Quality of Service (QoS) routing and MPLS-based traffic engineering, including VPN traffic management, constrained path determination, and network flow modelling, emphasizing both theoretical foundations and practical design considerations for high-performance networks.

Course Content

Unit-1	IP traffic engineering	5 Hours
Evolution of Traffic engineering in internet domain, Taxonomy and recommendation for internet traffic engineering, Performance Measures and characteristics, applications view and traffic models, Architectural frame work, link weight determination, Duality of the MCNF Problem.		
Unit-2	**Internet Routing and Router Architectures**	**7 Hours**
Architectural View of the Internet, Allocation of IP Prefixes and AS Number, Policy-Based Routing, Point of Presence, Traffic Engineering Implications, Internet Routing Instability. Router Architectures: Functions, Types, Elements of a Router, Packet Flow, Packet Processing: Fast Path versus Slow Path, Router Architectures.		
Unit-3	**Analysis of IP address lookup Algorithms**	**5 Hours**
Network Bottleneck, Network Algorithmics, Strawman solutions, Thinking Algorithmically, Refining the Algorithm, Cleaning up, Characteristics of Network Algorithms. IP Address Lookup Algorithms: Impact, Address Aggregation, Longest Prefix Matching, Naïve Algorithms, Binary, Multibit and Compressing Multibit Tries.		
Unit-4	**IP Packet Filtering and Classification**	**6 Hours**
Search by Length Algorithms, Search by Value Approaches, Hardware Algorithms, Comparing Different Approaches IP Packet Filtering and Classification: Classification, Classification Algorithms, Naïve Solutions, Two-Dimensional Solutions, Approaches for d Dimensions.		
Unit-5	**Quality of Service Routing**	**6 Hours**
QoS Attributes, Adapting Routing: A Basic Framework. Update Frequency, Information Inaccuracy, and Impact on Routing, Dynamic Call Routing in the PSTN, Heterogeneous Service, Single Link Case, A General Framework for Source-Based QoS Routing with Path Caching, Routing Protocols for QoS Routing, QOSPF: Extension to OSPF for QoS Routing, ATM PNNI.		
Unit-6	**Semantic Web Software Tools**	**8 Hours**
Traffic Engineering of IP/MPLS Networks, VPN Traffic Engineering, Problem Illustration: Layer 3 VPN, LSP Path Determination: Constrained Shortest Path Approach, LSP Path Determination: Network Flow Modelling Approach, Layer2 VPN Traffic Engineering, Observations.		
Learning Resources:		
Reference Book		

1	Network Routing: Algorithms, Protocols, and Architectures
2	Network Algorithmic: An Interdisciplinary Approach to Designing Fast Networked Devices George Varghese (Morgan Kaufmann Series in Networking
3	Network Analysis, Architecture, and Design, James D. McCabe, Morgan Kaufmann

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering				
Course Code: 2501PETCPE1041 Course Name: Random Process				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites:

Students should have basic knowledge of engineering mathematics, including calculus and elementary statistics. Familiarity with set theory and basic probability concepts will help in understanding random variables and stochastic processes.

Course Objectives:

1	Develop the logical concepts of probability theory.
2	Understand basic concepts of Random variables & Random Processes.
3	Study concept of Markov Chain and Queuing Theory.

Course Outcomes:

COs	At the end of the successful completion of the course, the students will be able to
CO1	Explain the fundamental concepts of probability, including axioms, conditional probability, Bayes' theorem, and Bernoulli trials.
CO2	Analyse discrete and continuous random variables and compute expectation, moments, and statistical measures.
CO3	Apply concepts of multiple random variables, including joint distributions, correlation, covariance, and the central limit theorem.
CO4	Analyse random processes using autocorrelation, cross-correlation, and spectral density in time and frequency domains.
CO5	Model and analyse Markov chains, including state classification, stability, and limiting probabilities.
CO6	Apply queuing theory models such as M/M/1 and multi-server systems to evaluate system performance using Little's law.

Course Description:

This course provides a comprehensive foundation in probability theory, random variables, and stochastic processes, essential for modelling and analysing engineering systems under uncertainty. It covers the fundamental concepts of probability, conditional probability, Bayes' theorem, and Bernoulli trials, extending to random variables and their statistical properties, including expectation, moments, and distributions. Students will learn multiple random variable analysis, cumulative distribution functions, Gaussian distributions, and the Central Limit Theorem. The course also introduces random processes, including autocorrelation, cross-correlation, spectral density estimation, and coherence analysis, alongside Markov chains and their applications in system modelling. Finally, it covers queuing theory, including Little's formula, M/M/1 queues, and multi-server systems, enabling the design and performance evaluation of service-oriented and communication systems.

Course Content		
Unit-1	**Probability Theory**	**7 Hours**
The concept of Probability; the axioms of Probability; sample space and events; Conditional probability and Baye's theorem, Independence of events, Bernoulli trails.		
Unit-2	**Random variables**	**6 Hours**
Introduction to Random Variables, Discrete Random Variable, Continuous Random Variable, Expectation of Random Variable, Moments of Random Variable (mean, mode variance, skewness, Kurtosis).		
Unit-3	**Multiple Random Variables**	**7 Hours**
Cumulative distribution function and probability density function of single and multiple Random Variables, statistical properties, jointly distributed Gaussian random variables, Conditional probability density, properties of sum of random variables, Central limit heorem, estimate of population means, Expected value and variance and covariance.		
Unit-4	**Random Processes**	**6 Hours**
Classification of Processes; Properties, Auto correlation and cross correlation function; Estimate of auto correlation function. Spectral Density: Definition, Properties, white noise, Estimation of auto-correlation function using frequency domain technique, Estimate of spectral density, cross spectral density and its estimation, coherence.		
Unit-5	**Markov Chains**	**7 Hours**
Chapman Kolmogorov equation, Classification of states, Limiting probabilities, Stability of Markov system, Reducible chains, Markov chains with continuous state space.		
Unit-6	**Queuing Theory**	**7 Hours**
Elements of Queuing System Little's Formula, M/M/1 Queue, Multi server system.		

Learning Resources:

Reference Book

1	Introduction to probability Models, Sheldon M. Ross, Academic Press, 9th edition2009
2	Random Signal Processing, Prof. G. V. Kumbhojkar, C. Jamanadas& Company, 2nd edition 2009
3	Probability and Random Processes for Electrical Engg., Alberto Lean, Pearson, 2nd edition 2009
	Probability, Random Variables and Stochastic Processes, Athanasios Papoulis,S. Unnikrishnan Pillai, PHI, 4thb edition 2010

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering				
Course Code: 2501PETCPE1042 Course Name: Digital Data Compression				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites:

Students should have basic knowledge of signals and systems, digital signal processing fundamentals, and probability concepts. Familiarity with digital communication and linear algebra will be helpful for understanding compression techniques.

Course Objectives:

1	Provide students with contemporary knowledge in Data Compression and Coding.
2	Equip students with skills to analyse and evaluate different Data Compression and Coding methods
3	To study and apply image, video, and audio compression techniques using transform based, predictive, and perceptual coding methods for multimedia applications.

Course Outcomes:

COs	**At the end of the successful completion of the course, the students will be able to**
CO1	Explain the fundamental concepts, taxonomy, and applications of data compression, including intuitive and run-length encoding techniques.
CO2	Analyse and implement statistical compression methods based on information theory, including Huffman, adaptive Huffman, and arithmetic coding.
CO3	Apply dictionary-based compression algorithms such as LZ77, LZ78, LZW, and their variants for efficient lossless compression.
CO4	Analyse image compression techniques, including transform-based, vector quantization, wavelet-based, and context-based methods such as JPEG and JPEG-LS.
CO5	Explain the principles and standards of video compression, including MPEG, MPEG-4, and H.261, for digital video applications.
CO6	Describe and evaluate audio and speech compression techniques, including companding, ADPCM, MPEG audio layers, and speech coding methods.

Course Description:

This course introduces the fundamental concepts and techniques of data compression for text, image, audio, and video applications. It begins with an overview of compression principles, including run-length encoding, move-to-front coding, and scalar quantization, and then explores statistical methods such as variable-length codes, Huffman coding, Golomb codes, and arithmetic coding. Students learn dictionary-based compression algorithms, including LZ77, LZ78, LZW, and their variants. The course covers image compression techniques, from transform-based approaches like Discrete Cosine Transform (DCT) and wavelet methods to vector quantization and progressive coding standards like JPEG, JPEG-LS, JBIG, and JBIG2. For multimedia applications, it addresses video compression standards (MPEG, MPEG-4, H.261) and audio compression techniques, including ADPCM, μ-Law/A-Law companding, MLP, and speech coding, with emphasis on the underlying theory, human perception, and practical implementation considerations.

Course Content

Unit-1	Introduction	6 Hours
Definitions, Historical background, Applications, Taxonomy, Intuitive Compression. Run-Length Encoding, RLE Text Compression, RLE Image Compression, Move- to Front Coding, Scalar Quantization.		
Unit-2	**Statistical methods**	**7 Hours**
Information Theory Concepts, Variable-Size Codes, Prefix Codes, Golomb Codes, The Kraft-Mac Millan Inequality, The Counting Argument, Shannon-Fano Coding, Huffman Coding, Adaptive Huffman Coding, MNP5, MNP7, Arithmetic.		
Unit-3	**Dictionary Methods**	**7 Hours**
String Compression, Simple Dictionary Compression, LZ77 (Sliding Window), LZSS, Repetition Times, QIC-122, LZX, File Differencing: VCDIFF, LZ78, LZFG, LZRW1, LZRW 4, LZW, LZMW, LZAP, LZY, LZP.		
Unit-4	**Image Compression Approaches to Image Compression**	**6 Hours**
Image Transforms, Orthogonal Transforms. The Discrete Cosine Transform JPEG, JPEG-LS. Progressive Image Compression, JBIG, JBIG2, Vector Quantization, Adaptive Vector Quantization, Block Matching, Block Truncation Coding, Context- Based Methods, Wavelet Methods.		
Unit-5	**Video Compression**	**6 Hours**
Analog Video, Composite and Components Video, Digital Video, Video Compression, MPEG, MPEG-4, H.261.		
Unit-6	**Audio Compression**	**6 Hours**
Sound, Digital Audio, The Human Auditory System, μ-Law and A-Law Companding, ADPCM Audio Compression, MLP Audio, Speech Compression, Shorten MPEG-1 Audio Layers.		

Learning Resources:

Reference Book

1	The Data Compression- Mark Nelson, Jean-Ioup Gailly, 2nd edition, M&T pub.
2	Introduction to Data Compression-Khalid Sayood, 2nd edition, Academic press ltd.
3	Introduction to Information Theory and Data Compression- Darrel Hankerson, 2nd ed, Chapman and Hall/CRC publications.
4	Handbook of Image and video Processing-Al Bovik Academic press ltd. Publication.
5	Compression Algorithms for Real Programmers- Peter Wayner Academic press ltd.
6	Data compression: the complete reference- David Salomen D, Springer Publication

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering				
Course Code: 2501PETCPE1043 Course Name: Advanced Biomedical Signal Processing				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites:

Students should have basic knowledge of signals and systems, digital signal processing, and probability & random processes. Familiarity with linear algebra and human physiology fundamentals is desirable for understanding biomedical signal analysis.

Course Objectives:

1	Introduce students to the principles of signal processing techniques and its application to biomedical signals.
2	Understanding methods and tools for extracting information from biomedical signals.
3	Understand analysis of biomedical signals.

Course Outcomes:

COs	**At the end of the successful completion of the course, the students will be able to**
CO1	Explain the characteristics and clinical significance of biomedical signals such as ECG, EEG, and EMG, and their role in computer-aided diagnosis.
CO2	Apply linear systems, Fourier, wavelet, and spectral estimation techniques for analysis of deterministic, random, and stochastic biomedical signals.
CO3	Analyse and design adaptive and optimal filtering methods to detect biomedical signals in noise and remove artifacts, including maternal–fetal ECG and muscle interference.
CO4	Process and interpret cardiological signals, including ECG acquisition, parameter estimation, QRS detection, and arrhythmia analysis using multiscale methods.
CO5	Apply data compression and heart rate variability analysis techniques for efficient representation and interaction of physiological signals.
CO6	Model and analyse EEG signals using linear, stochastic, and nonlinear techniques, and evaluate brain connectivity through time–frequency, correlation, and coherence analysis.

Course Description:

This course provides a comprehensive introduction to biomedical signal processing, focusing on signals such as ECG, EEG, and EMG, and their applications in computer-aided diagnosis. Students learn foundational concepts in linear systems, Fourier and wavelet transforms, and processing of random and stochastic signals, including spectral estimation and noise filtering in biomedical instruments. The course explores concurrent, coupled, and correlated processes, with adaptive and optimal filtering, event detection, and artifact removal, supported by case studies on ECG and EEG. Emphasis is placed on cardiological signal processing, including ECG acquisition, QRS detection, arrhythmia analysis, heart rate variability, and both lossless and lossy data compression techniques. In addition, EEG processing and modeling is covered, including linear and nonlinear models, spectral analysis, time-frequency methods, channel correlation, and coherence analysis, with applications in

epilepsy diagnosis, sleep disorder monitoring, and brain-computer interfaces.		
Course Content		
Unit-1	**Introduction To Biomedical Signals**	**7 Hours**
Examples of Biomedical signals - ECG, EEG, EMG etc. - Tasks in Biomedical Signal Processing - Computer Aided Diagnosis. - Review of linear systems- Fourier Transform and Time Frequency Analysis (Wavelet) of biomedical signals- Processing of Random & Stochastic signals – spectral estimation– Properties and effects of noise in biomedical instruments Filtering in.		
Unit-2	**Concurrent, Coupled and Correlated Processes**	**6 Hours**
Illustration with case studies – Adaptive and optimal filtering - Modeling of Biomedical signals - Detection of biomedical signals in noise -removal of artifacts of one signal embedded in another - Maternal-Fetal ECG – Muscle contraction interference. Event detection - case studies with ECG & EEG– Independent component Analysis.		
Unit-3	**Cardio logical Signal Processing and Applications**	**5 Hours**
Basic Electrocardiography (ECG) - Electrical Activity of the heart- ECG data acquisition– ECG Lead System- ECG parameters & their estimation - Use of Multi-Scale analysis for parameters estimation of ECG Waveforms - Noise & Artifacts- ECG Signal Processing: Baseline Wandering, Power line interference, Muscle noise filtering – QRS detection - Arrhythmia analysis.		
Unit-4	**Cloud Platform Architecture over Virtualized Data Centers**	**4 Hours**
Cloud Computing and Service Models, Data-Center Design and Interconnection Networks, Architectural Design of Compute and Storage Clouds, Public Cloud Platforms: GAE, AWS, and Azure, Inter-cloud Resource Management, Cloud Security and Trust Management.		
Unit-5	**Introduction to EEG**	**7 Hours**
The Electroencephalogram - EEG rhythms & waveform-categorization of EEG activity - recording techniques - EEG applications- Epilepsy, sleep disorders, Brain Computer Interface.		
Unit-6	**EEG Modelling**	**7 Hours**
Linear, stochastic models – Nonlinear modelling of EEG - artifacts in EEG& their characteristics and processing – Model based spectral analysis - EEG segmentation -Joint Time-Frequency analysis – correlation analysis of EEG channels - coherence analysis of EEG channels.		
Learning Resources:		
Text Book		

1	Biomedical Signal Processing: Principles and techniques, D. C. Reddy, Tata McGraw-Hill, New Delhi.
2	Biomedical Signal Processing, Willis J Tompkins, ED, Prentice Hall, 1993.
3	Compression Algorithms for Real Programmers- Peter Wayner Academic press ltd.
4	Biomedical Signal Analysis, R. Rangayan, Wiley, 2002.

5	Biomedical Signal Processing and Signal Modeling, Eugene N. Bruce, Wiley, 2001.
6	Introduction to Biomedical Engineering, John D. Enderle, Elsevier, 2005.
7	Advanced Bio signal Processing, Amine Nait-Ali, Springer, 2009.

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering				
Course Code: 2501PETCPE1051 Course Name: Mobile Computing				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites:

Students should have basic knowledge of analogue and digital communication systems, signals and systems, and computer networks fundamentals. Familiarity with modulation techniques and TCP/IP concepts will help in understanding wireless communication technologies.

Course Objectives:

1	Define Mobile Computing study its applications and look at current trends
2	Distinguish between different types of Mobility.
3	Analyse the performance of MAC protocols used for wired network and wireless networks.
4	Explore Theory and Research areas related to Mobile Computing

Course Outcomes:

COs	At the end of the successful completion of the course, the students will be able to
CO1	Explain the need, applications, and market evolution of wireless communication systems and wireless data technologies.
CO2	Describe wireless transmission principles, including antennas, signal propagation, modulation, multiplexing, spread spectrum, and cellular concepts.
CO3	Analyse medium access control techniques such as SDMA, FDMA, TDMA, and CDMA for efficient wireless resource sharing.
CO4	Explain the architecture, protocols, and services of GSM and UMTS/IMT-2000 systems, including mobility management and security.
CO5	Analyse wireless LAN and personal area network technologies, including IEEE 802.11 and Bluetooth, and compare infrastructure and ad-hoc networks.
CO6	Explain mobile networking and wireless application protocols, including Mobile IP, TCP over wireless networks, and WAP architecture and services.

Course Description:

This course introduces the principles, technologies, and applications of wireless communication. It covers fundamental concepts of wireless transmission, signal propagation, antennas, multiplexing, modulation, and cellular systems, along with medium access control techniques including SDMA, FDMA, TDMA, and CDMA. Students explore telecommunication systems such as GSM, UMTS, and IMT-2000, including system architecture, protocols, handover, localization, security, and emerging data services. The course also addresses wireless LAN technologies, comparing infrared and radio transmission, infrastructure versus ad-hoc networks, and standards like IEEE 802.11 and Bluetooth. Additionally, it examines mobile network and transport layers, including Mobile IP, DHCP, TCP enhancements over 2.5G/3G networks, and wireless application protocols, WAP

architecture, security, session management, and push/pull services, preparing students to design and analyze modern mobile communication systems.		
Course Content		
Unit-1	**Introduction to wireless communication**	**7 Hours**
Need and Application of wireless communication. Wireless Data Technologies Market for mobile.		
Unit-2	**Wireless transmission and medium access Control**	**6 Hours**
Frequency for radio transmission signal antennas, signal propagation Multiplexing Modulation, Spread and Cellular systems. Medium access control: Specialized MAC, SDMA, FDMA, TDMA &CDMA.		
Unit-3	**Telecommunications systems**	**7 Hours**
GSM: Mobile services, System architecture, Radio interface, Protocols, Localization and calling, Handover, Security, New data services. UMTS and IMT-2000:UMTS releases and standardization, UMTS.		
Unit-4	**Wireless LAN**	**7 Hours**
Introduction, Infrared v/s Radio transmission, Infrastructure and ad-hoc Network, IEEE 802.11, Blue Tooth.		
Unit-5	**Mobile Network Layer and Transport Layer**	**7 Hours**
Mobile IP, DHCP, Mobile ad-hoc networks, Traditional TCP, Classical TCP improvements, TCP over 2.5/3G wireless networks.		
Unit-6	**Wireless Application Protocol**	**6 Hours**
Architecture, Wireless datagram protocol, Wireless transport layer, security Wireless transaction protocol, Wireless session protocol, Wireless application environment, Wireless markup language, WML Script, Mobile communications, Wireless telephony application, Push architecture, Push/pull services, Example stacks with WAP 1.x 429.		
Learning Resources:		
Text Book		

1	Mobile Communications - Jochen Schiller - 2nd edition, Publication-Pearson Education.
2	Introduction to Wireless Telecommunications systems and Networks - Gary J. Mulett. Publications- Cengage Learning India Edition.
3	Mobile Computing – Ashok K Talukdar, Roopa R Yavagal, Publication-TATA MGH.

<table>
<tr><th colspan="6">Tatyasaheb Kore Institute of Engineering and Technology
F.Y. M. Tech Electronics & Telecommunication Engineering</th></tr>
<tr><th colspan="6">Course Code: 2501PETCPE1052 Course Name: Design of VLSI Systems</th></tr>
<tr><td colspan="2">Teaching Scheme</td><td>Credit</td><td colspan="2">Evaluation Scheme</td></tr>
<tr><td>Lectures:</td><td>03 Hours/Week</td><td>03</td><td>ISE:</td><td>40 Marks</td></tr>
<tr><td></td><td></td><td></td><td>ESE:</td><td>60 Marks</td></tr>
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Prerequisites:

Students should have basic knowledge of digital electronics, including logic gates, combinational circuits, and flip-flops. Familiarity with Boolean algebra and introductory hardware description language concepts is desirable.

Course Objectives:

1	Understand the design of logic circuits
2	Provide exposure to ASIC, CPLD & FPGA
3	Provide exposure to VHDL Programming..

Course Outcomes:

COs	At the end of the successful completion of the course, the students will be able to
CO1	Explain the fundamentals of sequential logic design, including FSM concepts, state diagrams, ASM charts, and flip-flop behaviour.
CO2	Analyse and design synchronous finite state machines (Moore, Mealy, and mixed types) using systematic synchronous design procedures.
CO3	Analyse asynchronous sequential circuits, including race conditions, hazards, and race-free state assignment techniques
CO4	Explain the architecture and applications of ASICs, CPLDs, and FPGAs, and select appropriate programmable devices for given design requirements.
CO5	Develop VHDL models using concurrent and sequential constructs, entities, architectures, and component instantiation.
CO6	Perform simulation and synthesis of digital designs, including test bench development, timing analysis, and application of synthesis guidelines.

Course Description:

This course provides a comprehensive understanding of sequential logic design, covering both synchronous and asynchronous circuits. Students learn finite state machines (FSMs), state diagrams, ASM charts, latches, flip-flops, and design procedures, including metastability and timing analysis. The course introduces ASIC, FPGA, and CPLD architectures, device selection, and practical design considerations. It also covers VHDL programming, including entities, architectures, concurrency, sequential statements, processes, loops, and test benches for simulation. Key topics include simulation methodologies, test bench design, and synthesis, enabling students to model, simulate, and implement complex digital systems efficiently.

Course Content		
Unit-1	**Fundamentals of Sequential Logic Design**	**5 Hours**
Definition and characteristics of IoT, Technical Building blocks of IoT, Device, Communication Technologies, Data, Physical design of IoT, IoT enabling technologies, IoT Issues and Challenges: Planning, Costs and Quality, Security and Privacy, Risks.		
Unit-2	**Asynchronous Sequential logic Circuit Design**	**7 Hours**
IoT systems management, IoT Design Methodology: Specifications Integration and Application Development.		
Unit-3	**ASIC, FPGA and CPLD**	**8 Hours**
IoT Protocols: MQTT, CoAP, XMPP and AMQT, IoT communication models, IoT Communication technologies: Bluetooth, LTE-A, DTLS, BLE, Zigbee, Zwave, NFC, RFID, LiFi, Wi-Fi, Interfacing of wifi, RFID, Zigbee, NFC with development board.		
Unit-4	**Introduction to VHDL and Elements of VHDL**	**7 Hours**
Physical device, Raspberry Pi Interfaces: Programming – APIs / Packages, Web services. Intel Galileo Gen2 with Arduino: Interfaces, Arduino IDE, Programming APIs and Hacks, IoT standards, Cloud computing for IoT, Bluetooth Low Energy, beacons.		
Unit-5	**Simulation Issues and Test Benches**	**7 Hours**
Resource-oriented Architecture and Best Practices: Designing RESTful Smart Things – Web enabling, Constrained Devices – The Future Web of Things.		
Unit-6	**Synthesis Issues**	**6 Hours**
Introduction to synthesis, synthesis tools and their features, hardware modeling examples, synthesis guidelines.		

Learning Resources:

Text Book / Reference Books

1	Digital Design- principles and practices J. F. Wakerly PHI 3rd edition
2	Digital Principles and Design, Donald Givone, TMH
3	Digital Logic Design Principles, Bradley Carlson, Wiley
4	Introductory VHDL from Simulation to Synthesis, Sudhakar Yalamanchil, Pearson
5	Digital System Design using VHDL, Charles Roth, TMH

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering				
Course Code: 2501PETCPE1053 Course Name: Advanced Antenna Theory				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites:

Students should have basic knowledge of electromagnetic field theory, antenna fundamentals, and RF/microwave engineering concepts. Familiarity with vector calculus and wireless communication systems will be helpful for understanding advanced antenna designs.

Course Objectives:

1	Get an idea regarding various types of arrays
2	Achieve the knowledge regarding aperture antenna with ground plane effects
3	Get the brief knowledge. of smart antenna concept

Course Outcomes:

COs	At the end of the successful completion of the course, the students will be able to
CO1	Analyselinear antenna arrays, including array factor, pattern multiplication, directivity, nonuniform excitation, and mutual coupling effects
CO2	Explain the principles and design of aperture antennas using field equivalence, radiation integrals, Fourier transform methods, and diffraction theory.
CO3	Describe the concepts and performance benefits of smart antennas, including beamforming, diversity techniques, and applications in cellular and MANET systems.
CO4	Design and analysecompact microstrip antennas for single-band, dual-band, broadband, and circularly polarized applications.
CO5	Evaluate techniques for compact broadband microstrip antennas, including stacked patches, slot loading, and reactive loading methods.
CO6	Analyse and design compact dual-frequency and dual-polarized microstrip antennas for modern wireless communication systems.

Course Description:

This course provides an in-depth study of antenna theory and design for modern wireless communication systems. Students learn array antennas, including linear arrays, pattern multiplication, directivity, and mutual impedance. Aperture antennas are covered through Huygens' principle, radiation equations, Babinet's principle, Fourier analysis, and diffraction effects. The course explores smart antennas, beamforming, diversity combining, and applications in MANETs and Rayleigh-fading channels. Detailed coverage of compact microstrip antennas includes broadband, dual-frequency, dual-polarized, circularly polarized designs, and techniques such as shorted patches, meandered patches, planar inverted-L, slot-loading, and chip-based enhancements. Emphasis is placed on design, simulation, and practical performance evaluation of antennas for high-frequency applications.

Course Content		
Unit-1	**Array Antenna**	**4 Hours**
Array factor for linear array, uniformly equally spaced linear array, Pattern multiplication, directivity of uniformly excited equally spaced linear array, Nonuniformly excited equally spaced linear array, mutual impedance.		
Unit-2	**Aperture Antenna**	**7 Hours**
Field equivalence Principle: Huygens Principle, radiation equations, directivity, rectangular apertures, circular apertures, design considerations, Babinets' Principle, Fourier transforms in aperture antenna theory, Ground plane Edge effect: The geometrical theory of diffraction.		
Unit-3	**Smart Antenna**	**8 Hours**
Smart antenna analogy, cellular Radio system evolution, signal propagation, smart antenna benefits, smart antenna drawbacks, antenna, antenna beamforming, mobile Ad hoc Networks (MANETs), smart antenna system: design, simulation and Results, Beamforming, diversity combining, Rayleigh-fading and Trellis-coded modulation, other geometries.		
Unit-4	**Compact Microstrip Antenna**	**7 Hours**
Compact Microstrip Antennas ,Compact Broadband Microstrip Antennas, Compact Dual-Frequency Microstrip Antennas, Compact Dual-Polarized Microstrip Antennas, Compact Circularly Polarized Microstrip Antennas, Compact Microstrip Antennas with Enhanced Gain, Broadband Microstrip Antennas, Broadband Dual- Frequency and Dual-Polarized Microstrip Antennas, Broadband and Dual- Band Circularly Polarized Microstrip Antennas Use of a Shorted Patch with a Thin Dielectric Substrate, Use of a Meandered Patch, Use of a Meandered Ground Plane, Use of a Planar Inverted-L Patch,Use of an Inverted U Shaped or Folded Patch.		
Unit-5	**Compact Broadband Microstrip Antennas**	**6 Hours**
Use of a Shorted Patch with a Thick Air Substrate, Use of Stacked Shorted Patches, Use of Chip-Resistor and Chip-Capacitor Loading Technique, Use of a Slot-Loading Technique, Use of a Slotted Ground.		
Unit-6	**Compact Dual-Frequency and Dual-Polarized Microstrip Antennas**	**8 Hours**
Some Recent Advances in Regular-Size Dual-Frequency Designs, Compact Dual-Frequency Operation with Same Polarization Planes, Compact Dual-Frequency Operation, Dual-Band or Triple-Band PIFA, Compact Dual-Polarized Designs.		

Learning Resources:

Reference Books

1	Antenna Theory and design, Stutzmen, warren L, wiley, 3rd edition,1981
2	Broad band Microstrip Antenna by Girishkumar, K.P. Ray Artech House, Inc. 2003
3	Compact And broadband microstrip Antennas by kin-Lu Wong A Wiley-Interscience Publication John Wiley & Sons, Inc. 2002

4	Antenna Theory analysis And Design by Constantine A. Balanis 3rdEdition. A John Wiley & Sons, Inc., Publication 2005.
5	Microstrip antenna design handbook, Ramesh Garg, Prakash Bhatia, Inderbahl, Artech house, Boston, London
6	Antenna engineering handbook, Richard c. Johnson, MGH

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering				
Course Code: 2501PETCLC106P Course Name: Lab Course				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Practicals:	**04 Hours/Week**	**02**	**ISA:**	**25 Marks**
			POE:	**25 Marks**

Prerequisites:

The prerequisite for the Probability and Random Processes course includes a solid foundation in mathematics, particularly calculus, linear algebra, and basic statistics. Students should also understand signals and systems, including linear system behaviour and Fourier analysis. Additionally, a basic knowledge of engineering fundamentals, especially in electronics or communication systems, is helpful to apply probability concepts to real-world signal processing problems.

Course Objectives:

1	To acquire basic understanding of MATLAB implantation.
2	To acquire complete knowledge of probability.
3	To make students understand and learn about Experimental design of processes.

Course Outcomes:

COs	**At the end of the successful completion of the course, the students will be able to**
CO1	Understand and apply the basic concepts of probability, including conditional probability, Bayes' theorem, and independence of events.
CO2	Analyse and compute probabilities using standard distributions such as Gaussian, Poisson, and uniform distributions.
CO3	Formulate and evaluate joint, marginal, and conditional probability density functions for multiple random variables.
CO4	Understand the properties of random processes and compute autocorrelation and cross-correlation functions for stationary and non-stationary signals.
CO5	Apply the concepts of power spectral density to characterize random signals in the frequency domain.
CO6	Develop practical skills in modelling random phenomena using experiments such as dice experiments, Bernoulli trials, and simulations, relevant for engineering applications in communications and signal processing.

Course Description:

This course introduces the fundamentals of probability theory and random processes for engineering applications. Students study probability calculations, classical distributions such as Gaussian, Poisson, and uniform, as well as joint probability density functions. Practical experiments include dice experiments, Bernoulli trials, and relative frequency approaches. The course also covers random process analysis, including autocorrelation, cross-correlation functions, and power spectral density, providing essential tools for signal processing, communications, and statistical modelling in engineering systems.

Course Content

1	Probability Calculation	4 Hours
2	Gaussian Distribution Function	4 Hours
3	Dice Experiment. Relative Frequency Approach	4 Hours
4	Uniform Probability Density Function	4 Hours
5	Gaussian Joint Probability Density Function	4 Hours
6	Poisson Probability Density Function	4 Hours
7	Power Spectral Density	4 Hours
8	Autocorrelation Function	4 Hours
9	Cross correlation Function	4 Hours
10	Bernoulli Trials	4 Hours

Learning Resources:

Reference Books

1	Kandaswamy- Queing Theory

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering				
Course Code: 2501PETCSW107T Course Name: Seminar-I				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Practical:	**02 Hours/Week**	**01**	**ISA:**	**50 Marks**

Course Objectives:

1	To Identify, understand and discuss current, real-world issues.
2	To Distinguish and integrate differing forms of knowledge and academic disciplinary approaches (e.g. humanities and sciences) with that of the students' own academic discipline (e.g., in agriculture, architecture, art, business, economics, education, engineering, natural resources, etc.) and apply a multidisciplinary strategy to address current, real-world issues.
3	To Improve oral and written communication skills.
4	To Improve presentation skills

Course Outcomes: At the end of the successful completion of the course, the students will be able to

CO1	**Identify and select a relevant research problem** in the domain of Design Engineering through an extensive literature survey.
CO2	**Review, analyze, and synthesize research literature** from journals, conferences, and technical reports to understand the state of the art.
CO3	**Prepare a comprehensive technical report** (25–30 pages) in **IEEE format**, demonstrating proper structuring, citation, and academic writing skills.
CO4	**Develop effective oral presentation skills** by delivering a well-organized seminar and communicating technical concepts clearly.
CO5	**Demonstrate critical thinking and depth of understanding** of the chosen topic during discussion and question–answer sessions.
CO6	**Exhibit professional and academic discipline** through active participation, regular attendance, and constructive engagement in peer seminars.

Course Description:

Seminar-I should be based on the literature survey on any topic relevant to Design Engineering (should be helpful for selecting a probable title of the dissertation). Each student has to prepare awriteupofabout25-30pagesof—A4 size sheets and submit it in IEEE format in duplicate as the term work. The student has to deliver a seminar talk in front of the faculty of the department and his classmates. The concerned faculty should assess the students based on the quality of work carried out, preparation and understanding of the candidates. Some marks should be reserved for the Attendance of a student in the seminars of other students.

Course Content

Activity	Description	Expected Output

Topic Selection & Approval	Choose a topic relevant to Design/Engineering domain and get faculty approval.	Approved seminar topic.
Literature Review	Study at least 15–20 recent research papers from journals (IEEE, Elsevier, Springer).	Comprehensive review summary.
Seminar Report Preparation	Prepare a 25–30 page report in IEEE format covering objectives, methods, findings, and future scope.	Hard and soft copies of report.
Seminar Presentation	Present the seminar before faculty and peers using visual aids (slides, charts, etc.).	Oral presentation & Q&A.
Peer Attendance & Evaluation	Students must attend other seminars and actively participate.	Attendance & interaction marks.

Learning Resources:

Text Book	
1	M. Ashraf Rizvi – Effective Technical Communication, McGraw Hill Education India, 2nd Edition.
2	R.C. Sharma & Krishna Mohan – Business Correspondence and Report Writing, Tata McGraw Hill, 5th Edition.
3	C.R. Kothari – Research Methodology: Methods and Techniques, New Age International Publishers, 4th Edition.
Reference Books	
1	S.P. Dhanavel – English and Communication Skills for Students of Science and Engineering, Orient BlackSwan, 2014.
2	Justin Zobel – Writing for Computer Science, Springer India, 3rd Edition.
3	Robert A. Day & Barbara Gastel – How to Write and Publish a Scientific Paper, Cambridge University Press, 8th Edition.
SWAYAM Courses	
1	NPTEL – Technical Communication for Scientists and Engineers (IIT Bombay).
2	NPTEL – Research Writing and Presentation Skills (IIT Madras).
3	SWAYAM – Communication Skills for Researchers (UGC).
Tools	
1	Access online tools such as Mendeley, Zotero, or LaTeX (Overleaf) for reference management and writing.
2	Practice oral presentation using PowerPoint or Google Slides with peer feedback.

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering				
Course Code:2501PETCPCC201 Course Name: Computer Vision				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites: Students should have basic knowledge of **signals and systems**, **digital image processing fundamentals**, and **linear algebra**. Familiarity with **probability concepts** and **programming basics** will be helpful for understanding pattern recognition and neural networks.

Course Objectives:

1	Study wavelets for image processing.
2	Provide basics for CBIR systems.
3	Provide logical base for Feature Extraction

Course Outcomes:

COs	At the end of the successful completion of the course, the students will be able to
CO1	Explain the principles of **wavelets and multiresolution analysis**, including image pyramids, sub band coding, and discrete wavelet transforms.
CO2	Apply **1D and 2D discrete wavelet transforms** and wavelet packet techniques for efficient image representation and analysis.
CO3	Represent and describe **image shapes and regions** using boundary- and region-based representation and descriptor techniques.
CO4	Analyze and apply **pattern recognition techniques**, including minimum distance, correlation-based, Bayesian, and nearest neighbour classifiers.
CO5	Explain and implement **image mining and content-based image retrieval (CBIR)** systems using color, texture, and shape features.

Course Description:

This course provides a comprehensive study of **wavelets and multi-resolution processing**, introducing key concepts such as image pyramids, sub-band coding, Haar transforms, and both 1D and 2D discrete wavelet transforms (DWT), along with fast wavelet transforms and wavelet packets. It covers **image representation and description** techniques including boundary following algorithms, chain codes, polygonal approximation, skeletonization, and regional/relational descriptors for effective feature extraction. The course also explores **pattern recognition and classification methods**, including minimum distance classifiers, correlation-based matching, Bayes classifiers, and nearest neighbor classifiers. Students will learn **image mining and content-based image retrieval (CBIR)**, focusing on color, texture, and shape features, multidimensional indexing, and video mining techniques. Finally, the course introduces **artificial neural networks** for human recognition systems, covering different ANN models, learning, and perception methods for practical applications in image analysis, recognition, and intelligent systems.

Course Content		
Unit-1	**Wavelets and Multi resolution Processing**	**7 Hours**
Background: Image Pyramids, Sub band Coding, Haar Transform, Multi resolution Expansion: Series Expansion, Scaling Function, Wavelet Function Discrete Wavelet Transform in one Dimension, and DWT in 2 Dimensions. Fast wavelet Transform, wavelet packets		
Unit-2	**Representation and Description:**	**7 Hours**
Representation: Boundary Following Algorithm, Chain Codes, Polygonal Approximation, Signatures, Boundary segments, Skeletons. Descriptors: Boundary descriptors; Regional descriptors; Relational descriptors		
Unit-3	**Pattern Recognition:**	**6 Hours**
Overview of pattern recognition; Patterns and pattern Classes		
Unit-4	**Classifier:**	**7 Hours**
Matching: Minimum distance classifier, Matching by Correlation, Matching shape numbers, String matching statistical classifier: Bayes classifier, Nearest Neighbor classifier.		
Unit-5	**Image Mining and Content-Based Image Retrieval:**	**6 Hours**
Introduction, Image Mining, Image Features for Retrieval and Mining: Color Features, Texture Features, Shape features, Topology, Multidimensional Indexing Simple CBIR System, Video mining		
Unit-6	**Artificial neural networks:**	**7 Hours**
Human Recognition system; Artificial neural networks; Different models of Artificial neural networks; Perception and learning;		

Learning Resources:	
Text Book	
1	Digital Image processing and Pattern Recognition by Malay K. Pakhira PHI
2	Digital Image processing by Rafael C. Gonzalez and Richard E. Woods Pearson Education
3	Image Processing Principles and Applications, Tinku Acharya, Ajoy K. Ray, Wiley, 2005
Reference Books	
1	Fundamentals of Digital Image processing, by A. K. Jain PHI
2	Digital image processing and analysis by B. Chanda, D. Dutta Mujumdar PHI

Tatyasaheb Kore Institute of Engineering and Technology F.Y.M. Tech Electronics & Telecommunication Engineering		
Course Code: 2501PETCPCC201T Course Name: Computer Vision Tutorial		
Teaching Scheme	**Credit**	**Evaluation Scheme**
Tutorial/Practical: 02 Hours/Week	**01**	**ISA: 25 Marks**

Prerequisites, if any: Students should have a fundamental understanding of **linear algebra** (vectors, matrices), **probability and statistics**, and **signals and systems** concepts. Basic knowledge of **digital image processing**, including pixel representation and filtering, along with familiarity with **programming in MATLAB or Python**, is essential. An introductory understanding of **machine learning concepts** will be helpful for studying feature extraction, object recognition, and convolutional neural networks used in computer vision applications.

Course Objectives: The objective of the course is to

1) To introduce the **fundamental concepts and techniques of computer vision**, including image formation, representation, and enhancement.
2) To develop the ability to **analyze and implement feature detection, segmentation, and object recognition algorithms** for real-world vision problems.
3) To provide foundational knowledge of **machine learning and deep learning approaches**, particularly CNNs, for advanced computer vision applications such as face recognition, autonomous vehicles, and medical imaging.

Course Outcomes: After successful completion of the course, student will be able to

CO1	**Explain the fundamentals of computer vision**, including image formation, camera models, and image representation techniques.
CO2	**Apply image enhancement and filtering techniques** in spatial and frequency domains to improve image quality.
CO3	**Implement edge detection and image segmentation algorithms** for extracting meaningful regions and boundaries from images.
CO4	**Detect and extract robust image features** using corner detection, SIFT, and SURF techniques.
CO5	**Analyze and apply object recognition and pattern classification methods**, including basic machine learning techniques.
CO6	**Understand and utilize convolutional neural networks (CNNs)** for solving advanced computer vision problems in real-world applications.

Course Description:

Course Content

Sr. No.	Topic of Practical / Experiment / Tutorial	Assigned Hours
1	Introduction to Computer Vision and its applications	02
2	Image formation and camera models in computer vision	02

3	Image representation, sampling and quantization	02
4	Image histogram analysis and histogram equalization	02
5	Image filtering techniques: spatial and frequency domain filtering	02
6	Edge detection techniques: Sobel, Prewitt and Canny operators	02
7	Image segmentation using thresholding techniques	02
8	Region-based segmentation and region growing algorithms	02
9	Feature detection techniques: corner detection and Harris detector	02
10	Feature extraction using SIFT and SURF algorithms	02
11	Object recognition and pattern classification techniques	02
12	Introduction to machine learning methods in computer vision	02
13	Study of convolutional neural networks (CNN) for vision applications	02
14	Applications of computer vision in face recognition systems	02
15	Applications of computer vision in autonomous vehicles and medical imaging	02

Learning Resources:

Text Books

1) **Richard Szeliski**, *Computer Vision: Algorithms and Applications*, Springer.
2) **E. R. Davies**, *Computer Vision: Principles, Algorithms and Applications*, Academic Press.

Reference Books:

1) **Rafael C. Gonzalez and Richard E. Woods**, *Digital Image Processing*, Pearson.
2) **Simon J.D. Prince**, *Computer Vision: Models, Learning and Inference*, Cambridge University Press.

MOOC / NPTEL/YouTube Links:

1) NPTEL Course: *Computer Vision* – IIT Madras
2) NPTEL Course: *Digital Image Processing* – IIT Kharagpur
3) OpenCV Tutorials (YouTube / OpenCV official channel)

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering				
Course Code: 2501PETCPCC202 Course Name: Adhoc & wireless Sensor networks				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites: Students should have basic knowledge of **computer networks**, **wireless communication fundamentals**, and **data communication protocols**. Familiarity with **TCP/IP concepts** and **basic probability and mobility models** will help in understanding ad hoc and sensor networks.

Course Objectives:

1	Explain the constraints of physical layer that affect the design and performance of Adhoc network
2	Discuss the operations and performance of various MAC layer protocols proposed for Adhoc networks.
3	Discuss the operations and performance of various routing protocols proposed for ad hoc networks.

Course Outcomes: At the end of the successful completion of the course, the students will be able to

CO1	Explain the **fundamentals, characteristics, mobility models, and applications of ad hoc networks** in indoor and outdoor wireless environments
CO2	Analyze **medium access control protocols** for ad hoc networks, including contention-based schemes and IEEE 802.11/802.15 standards.
CO3	Compare and evaluate **routing protocols for ad hoc networks**, including proactive, reactive, hybrid, multicast, energy-aware, and QoS-aware routing.
CO4	Describe the **architecture, components, and operational challenges of wireless sensor networks**, including node hardware and energy consumption.
CO5	Analyze **cross-layer design approaches** and integration of ad hoc networks with Mobile IP and 4G wireless systems.
CO6	Explain **sensor network platforms and development tools**, including sensor node hardware, operating systems, simulators, and programming models.

Course Description:

This course introduces the fundamentals of **ad hoc networks**, including their definition, characteristics, applications, and the modeling of wireless channels and mobility for both indoor and outdoor environments. It covers **medium access control (MAC) protocols** with design issues, contention-based and reservation-based mechanisms, scheduling algorithms, and relevant IEEE standards such as 802.11, 802.15, and HIPERLAN. The course also explores **network protocols**, including routing strategies (proactive, reactive, hybrid, energy-aware, and QoS-aware), unicast and multicast algorithms, and hierarchical routing. Students will study **wireless sensor networks (WSNs)**, focusing on challenges, enabling technologies, single-node architecture, energy consumption, operating systems, and execution environments. Additionally, the course emphasizes **cross-layer design and integration** of ad hoc networks with 4G systems, parameter optimization, and practical integration with Mobile IP networks. Finally, it introduces **sensor network platforms and tools**, including Berkeley motes, node-level programming, simulators, and state-centric programming for effective WSN deployment and experimentation.

Course Content		
Unit-1	**Introduction to Adhoc networks**	**6 Hours**
Definition, characteristics features, applications. Characteristics of Wireless channel, Adhoc Mobility Models, Indoor and outdoor models		
Unit-2	**Medium Access Protocols:**	**7 Hours**
MAC Protocols: design issues, goals and classification, Contention based protocols- with reservation, scheduling algorithms, protocols using antennas, IEEE standards: 802.11a, 802.11b, 802.1g, 802.15, HIPERLAN		
Unit-3	**Network Protocols:**	**6 Hours**
Routing Protocols: Design issues, goals and classification. Proactive Vs reactive routing, Unicast routing algorithms, Multicast routing algorithms, hybrid routing algorithm, Energy aware routing algorithm, Hierarchical Routing, QoS aware routing.		
Unit-4	**Overview of Wireless Sensor Networks:**	**7 Hours**
Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks, Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems and Execution Environments.		
Unit-5	**Cross Layer Design and Integration of Adhoc for 4G:**	**6 Hours**
Cross layer Design: Need for cross layer design, cross layer optimization, parameter optimization techniques, Cross layer cautionary perspective, Integration of Adhoc with Mobile IP networks.		
Unit-6	**Sensor Network Platforms and Tools:**	**7 Hours**
Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming.		

Learning Resources:	
Text Book	
1	Ad hoc Wireless Networks Architectures and protocols, Da C. Siva Ram Murthy and B.S. Manoj, 2nd edition, Pearson Education. 2007
2	Adhoc Networking, Charles E. Perkins, Addison − Wesley, 2nd edition, 2000
Reference Books	
1	Mobile Adhoc networking, Stefano Basagni, Marco Conti, Silvia Giordano and Ivan, 2nd edition, 2000
2	The handbook of Adhoc wireless networks, Mohammad Ilyas, CRC press,2002.

Tatyasaheb Kore Institute of Engineering and Technology
F.Y. M. Tech Electronics & Telecommunication Engineering

Course Code: 2501PETCPCC202T Course Name: Adhoc & wireless Sensor networks Tutorial

Teaching Scheme	Credit	Evaluation Scheme
Tutorial/Practical: 02 Hours/Week	**01**	**ISA: 25 Marks**

Prerequisites, if any: Students should have a basic understanding of **computer networks**, including the OSI/TCP-IP models and common routing concepts. Familiarity with **wireless communication fundamentals**, such as radio propagation, fading, and interference, is essential. Knowledge of **data link layer protocols**, **probability concepts**, and **algorithm basics** will help in understanding MAC design, routing, and scheduling. Prior exposure to **embedded systems or sensor networks** is beneficial for comprehending node architecture, energy-aware routing, and sensor platform challenges.

Course Objectives: The objective of the course is to

1) To understand the **fundamental principles and characteristics of ad hoc and wireless sensor networks**, including wireless channels and mobility models.
2) To analyze and design **MAC, routing, and QoS-aware protocols** suitable for dynamic and resource-constrained wireless networks.
3) To develop insights into **energy-efficient, cross-layer, and sensor platform–based solutions** for reliable communication in ad hoc and sensor networks.

Course Outcomes: After successful completion of the course, student will be able to

CO1	**Explain the architecture, characteristics, and applications of ad hoc and wireless sensor networks**, including wireless channel behavior.
CO2	**Analyze mobility models and indoor/outdoor propagation effects** on network performance.
CO3	**Design and evaluate MAC protocols**, including contention-based and scheduling algorithms, for wireless networks.
CO4	**Compare and apply routing protocols**, including energy-aware and QoS-based routing techniques.
CO5	**Understand sensor node architecture and platform constraints**, addressing challenges such as energy, scalability, and reliability.
CO6	**Apply cross-layer design principles** to optimize performance in ad hoc and sensor network environments.

Course Description:

Course Content

Sr. No.	Topic of Practical / Experiment / Tutorial	Assigned Hours
1	Adhoc Networks	02
2	Wireless Characteristics	02

3	Mobility Models	02
4	Indoor Propagation	02
5	Outdoor Propagation	02
6	MAC Design	02
7	Contention Protocols	02
8	Scheduling Algorithms	02
9	Routing Protocols	02
10	Energy Routing	02
11	QoS Routing	02
12	Sensor Challenges	02
13	Node Architecture	02
14	Cross-Layer	02
15	Sensor Platforms	02

Learning Resources:

Text Books

1) **Ad Hoc Wireless Networks: Architectures and Protocols-***C. Siva Ram Murthy, B. S. Manoj*
2) **Wireless Sensor Networks: An Information Processing Approach** *Feng Zhao, Leonidas Guibas*

Reference Books:

1) **Ad Hoc and Sensor Networks: Theory and Applications** *Carlos de Morais Cordeiro, Dharma P. Agrawal*
2) **Wireless Communications & Networking** *Tanenbaum / Rappaport (depending on edition)*

MOOC / NPTEL/YouTube Links:

1) **Wireless Ad Hoc and Sensor Networks** – NPTEL Course by **Prof. Sudip Misra, IIT Kharagpur** *Course Page:* https://onlinecourses.nptel.ac.in/noc26_cs51/preview
2) **Wireless Ad Hoc and Sensor Networks (Archived)** – older session *Archived Content:* https://archive.nptel.ac.in/courses/106105160/

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering				
Course Code: 2501PETCPE2031 Course Name: Cryptography and Network Security				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites: Students should have basic knowledge of **computer networks**, **data communication protocols**, and **discrete mathematics**. Familiarity with **number theory**, **operating systems fundamentals**, and **programming basics** will help in understanding cryptography and network security concepts.

Course Objectives:

1	Understand Block Cipher and DES principles
2	Understand Symmetric Encryption Methods
3	Identify network security threat

Course Outcomes: At the end of the successful completion of the course, the students will be able to

CO1	Explain the **fundamental concepts of network security**, including security services, mechanisms, attack models, and the OSI security architecture.
CO2	Analyze **classical and modern symmetric encryption techniques**, including DES, block cipher principles, modes of operation, and cryptanalysis methods.
CO3	Evaluate **contemporary symmetric ciphers** and key management techniques to ensure confidentiality, secure key distribution, and random number generation.
CO4	Explain the principles of **public key cryptography**, including RSA and Diffie–Hellman key exchange, and their role in secure communication.
CO5	Apply **message authentication and hash functions**, including MACs, digital signatures, and authentication protocols, to ensure data integrity and non-repudiation.
CO6	Analyze **security applications and system-level security mechanisms**, including Kerberos, IPsec, SSL/TLS, firewalls, intrusion detection systems, and malware protection.

Course Description:

This course provides a comprehensive understanding of **network security principles, mechanisms, and potential attacks**, including the OSI security architecture and classical encryption methods such as symmetric ciphers, substitution, transposition techniques, rotor machines, and steganography. It explores **block ciphers and modern symmetric encryption** including DES, Triple DES, Blowfish, and RC5, along with key management, traffic confidentiality, and secure encryption practices. Students also learn **public key cryptography** concepts, RSA, Diffie-Hellman key exchange, and message authentication using hash functions, digital signatures, and MACs. The course covers practical **authentication and security applications**, including Kerberos, X.509, email security protocols (PGP, S/MIME), IP security, and secure web communications through SSL/TLS. Finally, it addresses **system security concerns**, such as intrusion detection, malware, viruses, firewall design, and trusted systems, equipping students to design, analyze, and implement robust security solutions in modern networked environments.

Course Content		
Unit-1	**Overview:**	**6 Hours**
Services, Mechanisms, and attacks, The OSI Security Architecture, A model for network security, Classical Encryption Techniques: Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Rotor Machines, and Steganography.		
Unit-2	**Block Ciphers and the Data Encryption Standard:**	**7 Hours**
Simplified DES, Block Cipher Principles, The Data Encryption Standard, The Strength of DES, Differential Linear Cryptanalysis, Block Cipher Design Principles, Block Cipher Modes of Operation.		
Unit-3	**Contemporary symmetric Ciphers:**	**6 Hours**
Triple DES, Blowfish, RC5, Characteristics of Advanced Symmetric Block Ciphers, confidentially using symmetric Encryption: Placement of Encryption Function, Traffic Confidentiality, Key Distribution, and Random Number Generation.		
Unit-4	**Public Key Cryptography and RSA:**	**7 Hours**
Principles of Public Key cryptosystems, The RSA Algorithm, Key Management, other Public Key Cryptosystems key Management, Diffle-Hellman Key exchange.		
Unit-5	**Message Authentication and hash functions:**	**6 Hours**
Authentication Requirements, Authentication Function, Message Authentication Codes, Hash Functions, Security of Hash Functions and MACs. **Hash Algorithms:** MD5 Message Digest Algorithm, Secure Hash Algorithm. Digital signatures and Authentication protocols: Digital signatures, Authentication protocols and Digital signature Standard.		
Unit-6	**Authentication Applications:, Web Security:**	**7 Hours**
Kerberos, X. 509 Authentication Service. Electronic Mail Security: Pretty Good Privacy, S/MIME, IP Security Overview, IP Security Architecture, Authentications, Header, Encapsulating Security Payload, Combining Security Associations, Key Management. **Web Security:** Web Security Considerations, Secure socket layer and Transport layer security. Secure electronic transaction. System Security: Intruders, Intrusion detection, password management. Malicious Software, Viruses, Viruses and Related Threats, Firewalls: Firewall Design Principles, Trusted systems.		
Learning Resources:		
Text Book		
1	Willam Stallings, Cryptography and Network Security, Third Edition, Pearson Education	
2	Network Algorithmic: An Interdisciplinary Approach to Designing Fast Networked Devices George Varghese (Morgan Kaufmann Series in Networking	
Reference Books		

1	Willam Stallings, Cryptography and Network Security, Third Edition, Pearson Education
2	Network Algorithmic: An Interdisciplinary Approach to Designing Fast Networked Devices George Varghese (Morgan Kaufmann Series in Networking
3	Atul Kahate, Cryptography and Network Security, Tata McGraw-Hill, 2003

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering				
Course Code: 2501PETCPE2032 Course Name: Multi Rate System				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites: Students should have a solid foundation in **signals and systems** and **digital signal processing**, including **Fourier and Z-transform techniques**. Familiarity with **linear algebra** and **basic probability concepts** will be helpful for understanding Multirate and filter bank designs.

Course Objectives:

1	To provide basic concepts of Multirate systems
2	To give inputs regarding details of Multirate filter banks and their types.
3	To provide concepts of Multidimensional Multirate Systems

Course Outcomes:

COs	**At the end of the successful completion of the course, the students will be able to**
CO1	Explain the **fundamentals of Multi rate signal processing**, including interpolation, decimation, polyphase representation, and multistage implementations.
CO2	Analyze and design **maximally decimated and perfect reconstruction filter banks**, including QMF banks, aliasing effects, and trans multiplexers.
CO3	Apply **para-unitary filter bank concepts** to design lossless and perfect reconstruction systems for transform coding applications.
CO4	Design and analyze **linear-phase and cosine-modulated perfect reconstruction filter banks** using lattice and polyphase structures.
CO5	Explain the principles of **multidimensional Multi rate systems**, including sampling, alias-free decimation, and Multi rate filter design.
CO6	Apply **Multi rate signal processing techniques** to real-world applications such as speech and audio coding, image and video coding, communication systems, and sensor signal processing.

Course Description:

This course introduces the fundamentals of **multirate signal processing**, including basic multirate operations, interconnection of building blocks, polyphase representations, and multistage implementations. Students study **multirate filter banks** such as maximally decimated QMF banks, M-channel filter banks, and perfect reconstruction systems, including para-unitary and linear phase FIR filter banks, as well as cosine-modulated filter banks and their efficient polyphase structures. The course also covers **multidimensional multirate systems**, addressing sampling, alias-free decimation, cascade connections, and multirate filter design. Practical **applications** include FSK modems, DAB, ADSL, asynchronous sampling rate conversion, speech and audio coding, image and video coding, wavelet-based room acoustics simulation, and sensor signal processing, equipping students to design and implement advanced multirate systems across communication and signal processing applications.

Course Content		
Unit-1	**Fundamentals of Multi-rate Systems:**	**6 Hours**
Basic multi-rate operations, interconnection of building blocks, polyphase representation, multistage implementation.		
Unit-2	**Multirate Filter Banks:**	**6 Hours**
Maximally decimated filter banks: Errors created in the QMF bank, alias-free QMF system, power symmetric QMF banks, M-channel filter banks, poly-phase representation, perfect reconstruction systems, alias-free filter banks, tree structured filter banks, trans multiplexers.		
Unit-3	**Para-unitary Perfect Reconstruction Filter Banks:**	**6 Hours**
Lossless transfer matrices, filter bank properties induced by paraunitariness, two channel Para-unitary lattices, M- channel FIR Para-unitary QMF banks, transform coding.		
Unit-4	**Linear Phase Perfect Reconstruction QMF Banks**	**6 Hours**
Necessary conditions, lattice structures for linear phase FIR PR QMF banks, formal synthesis of linear phase FIR PR QMF lattice. Cosine Modulated Filter Banks: Pseudo-QMF bank and its design, efficient polyphase structures, properties of cosine matrices, cosine modulated perfect reconstruction systems.		
Unit-5	**Multidimensional Multirate Systems:**	**6 Hours**
Introduction, Multidimensional signals and their sampling, minimum sampling density, Multirate fundamentals, Alias free decimation. Cascade connections, Multirate filter design. Special filters and filter banks.		
Unit-6	**Applications:**	**6 Hours**
FSK Modems, OMC data transmission, DAB and ADSL, Asynchronous conversion of sampling rates, Speech and audio coding, Image and video coding, Simulation of room acoustics using Wavelets, Multirate techniques with sensors.		
Learning Resources:		
Text Book		
1	P. Vaidyanathan, "Multirate Systems and Filter Banks,"Pearson Education (Asia) Third impression,2010.	
2	N. J. Fliege, "Multirate Digital Signal Processing," John Wiley & Sons,USA, 2000.engineeringand network design, oliver heckmann john wiley & sonsltd,	
Reference Books		
1	P. Vaidyanathan, "Multirate Systems and Filter Banks,"Pearson Education (Asia) Third impression,2010.	
2	N. J. Fliege, "Multirate Digital Signal Processing," John Wiley & Sons, USA, 2000 engineering and network design, Oliver Heckmann John Wiley & Sos ltd.	

3	Ljiljana Milic, “Multirate Filtering for Digital Signal Processing: MATLAB Applications (Premier Reference Source)”.
4	R. E. Crochiere, L.R. Rabiner, "Multirate Digital Signal Processing,” Prentice Hall.
5	Gilbert Strang and Truong Nguyen, "Wavelets and Filter Banks," Wellesley-Cambridge Press.

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering				
Course Code: 2501PETCPE2033 Course Name: Advanced Light Wave Communication				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites: Students should have basic knowledge of **optical physics**, **electromagnetic theory**, and **analogue/digital communication systems**. Familiarity with **semiconductor devices** and **signals and systems** will help in understanding optical communication system design.

Course Objectives:

1	To expose the students to the basics of signal propagation through optical fibre impairments, components and devices and system design. fibres,
2	To provide an in-depth understanding needed to perform fibre-optic communication system engineering calculations, identify system trade-offs, and apply this knowledge to modern fiber optic systems.
3	To design and evaluate WDM/DWDM-based long-haul optical communication systems, considering system performance parameters such as BER, regeneration, and reliability.

Course Outcomes:

COs	**At the end of the successful completion of the course, the students will be able to**
CO1	Explain the **fundamentals of guided optical communication**, including optical fiber types, cable structures, transmission losses, and fiber selection for high-speed systems.
CO2	Analyze **attenuation mechanisms** such as absorption and scattering, and apply loss considerations in the design of high-bandwidth optical links.
CO3	Describe the **construction, operating principles, and performance characteristics of optical sources**, including LEDs, lasers, EDFAs, and soliton-based systems.
CO4	Evaluate **optical detectors and receiver design**, including detector sensitivity calculations and suitability for 980 nm, 1.3 μm, and 1.55 μm wavelength systems.
CO5	Explain and analyze **optical multiplexing techniques**, including WDM and DWDM systems, and the design of optical multiplexers and demultiplexers.
CO6	Design and evaluate **long-haul high-bandwidth optical transmission systems**, considering power budget, BER, regeneration, interfacing, and system reliability.

Course Description:

This course provides a comprehensive introduction to **guided optical communication systems**, starting with the fundamentals of optical fibers, types of fibers and cables, and transmission losses due to absorption and scattering. It covers **optical sources** including LEDs and lasers, their working principles, optical amplifiers like EDFA, and system design considerations for LAN and WAN applications, including power budget calculations. The course also addresses **optical detectors**, their characteristics, spectral response, and receiver design for different wavelength systems. Students learn **multiplexing techniques** such as WDM and DWDM, including the design of multiplexers and demultiplexers using angular dispersive devices, thin-film filters, and planar waveguides. Finally, the course explores the design of **long-haul high-bandwidth transmission systems**, focusing on outage,

bit error rate, cross-connects, interface considerations, regenerator spacing, and practical deployment challenges, equipping students to design and analyze high-speed optical communication networks.		
Course Content		
Unit-1	**Introduction to guided optical communication:**	**5 Hours**
Optical Fibers, types of fibers & optical Cables, Study of losses during transmission through viz. Attenuation by Absorption & Scattering, Consideration of losses in designing of High Speed / High bandwidth optical communication systems, Selection of fibre for such systems.		
Unit-2	**Optical Sources:**	**8 Hours**
Types of LEDs used in optical communication, their construction & operating principle, Types of Lasers. Principle of working of Lasers, solid state & injection Lasers, Optical amplifiers, EDFA, Soliton Systems & design of system required in LAN & WAN type of applications. Calculations of Power budgets and feasibility of system design for above optical sources.		
Unit-3	**Optical Detectors:**	**6 Hours**
Introduction & study of type of detectors characteristics. Spectral spread and availability of detectors for 980 nm, 1.3 µm & 1.55 µm λ systems. Calculation of detector sensitivity and design considerations of suitable receivers for LAN, WAN applications.		
Unit-4	**Multiplexing Components**	**7 Hours**
Concepts of WDM, DWDM system design parameters, Optical multiplex / Demultiplex design considerations- Angular dispersive devices.		
Unit-5	**Techniques:**	**7 Hours**
Dielectric thin film filter type devices, Hybrid & planer wave guide devices, Active WDM devices, Wavelength non selective devices, System application.		
Unit-6	**Long Haul High Band Width Tx System:**	**6 Hours**
Designing systems for long haul high band width consideration-Outage, Bit error rate, Cross connect, Low & high-speed interphases, Multiplex / Demultiplex consideration, Regenerator spacing, Degeneration & Allowances, Application consideration.		
Learning Resources:		
Text Book		
1	Optical Communication Systems by John Gowar (PHI)	
2	Optical Fiber Communication by Gerd Keiser (MGH)	
Reference Books		
1	Optical Fiber Communication by Gerd Keiser (MGH)	
2	Optical Fiber Communication Principles & Practice by John M. Senior (PHI pub.1996.)	

<table>
<tr><th colspan="5">Tatyasaheb Kore Institute of Engineering and Technology
F.Y. M. Tech Electronics & Telecommunication Engineering</th></tr>
<tr><th colspan="5">Course Code: 2501PETCPE2041 Course Name: Advanced Microwave circuit Design</th></tr>
<tr><td colspan="2">Teaching Scheme</td><td>Credit</td><td colspan="2">Evaluation Scheme</td></tr>
<tr><td>Lectures:</td><td>03 Hours/Week</td><td>03</td><td>ISE:</td><td>40 Marks</td></tr>
<tr><td></td><td></td><td></td><td>ESE:</td><td>60 Marks</td></tr>
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Prerequisites: Students should have basic knowledge of **electromagnetic theory**, **analog electronics**, and **signals and systems**. Familiarity with **transmission lines**, **network theory**, and **semiconductor devices** is desirable for understanding RF and microwave circuit design.

Course Objectives:

1	Analyze transmission line circuits at RF and microwave frequencies.
2	Design impedance matching in transmission line networks
3	Perform Scattering parameter analysis of RF networks

Course Outcomes:

COs	At the end of the successful completion of the course, the students will be able to
CO1	Explain the **importance of RF design** and analyze RF behavior of passive components, transmission lines, and impedance matching using the Smith chart.
CO2	Apply **microwave network analysis techniques**, including scattering parameters and interconnecting networks, for RF circuit characterization.
CO3	Design and analyze **RF filters**, including resonator-based and coupled filter configurations, to meet given frequency specifications.
CO4	Design and evaluate **RF transistor amplifiers**, including biasing, matching, stability, gain, noise figure, and broadband multistage performance
CO5	Explain the **principles and design of RF oscillators and mixers**, including high-frequency oscillator configurations and mixer characteristics.
CO6	Describe the **materials, fabrication technologies, and applications of microwave integrated circuits (MICs and MMICs)** used in modern RF systems.

Course Description:

This course provides a detailed study of **radio frequency (RF) and microwave engineering**, emphasizing the design and analysis of RF components and circuits. Students learn the fundamentals of **RF behavior of passive components**, chip components, and circuit board considerations, along with **transmission line analysis** using stripline, microstrip line, and Smith Chart techniques. The course covers **microwave network analysis**, including interconnecting networks, scattering parameters, and impedance matching with discrete and microstrip components. Key topics include **RF filter design** with resonators, coupled filters, and special filter configurations, as well as **RF transistor amplifier design**, focusing on active component modeling, matching, biasing, stability, noise, and multistage high-power amplifiers. The curriculum also addresses **oscillator and mixer design**, exploring high-frequency configurations, and concludes with **microwave integrated circuits (MICs)**, covering hybrid and monolithic IC fabrication, amplifiers, oscillators, mixers, frequency dividers, modulators, switches, phase shifters, multipliers, and up-converters, providing a strong foundation for practical RF and microwave system design.

Course Content		
Unit-1	**Introduction:**	**7 Hours**
Importance of Radio frequency design, RF behavior of passive components, Chip components and circuit board consideration. Transmission line Analysis: Strip line & micro strip line, Smith Chart		
Unit-2	**Microwave Network Analysis:**	**7 Hours**
Interconnecting Networks, Network properties & applications, scattering parameters, impedance matching using discrete components, micro strip line matching networks, biasing networks.		
Unit-3	**RF Filter Design:**	**7 Hours**
Basic resonator &Filter configurations, special filter realizations,Filter implementation, Coupled filters.		
Unit-4	**RF Transistor Amplifier Design:**	**7 Hours**
Active RF components, Active RF component modeling, Matching and biasing network, Characteristics of amplifiers, Amplifier power relations, Stability considerations, Constant gain, Noise figure circles, Constant VSWR circles, Broadband High power & Multistage Amplifiers.		
Unit-5	**Oscillator and Mixture Design:**	**7 Hours**
Basic Oscillator Model, High frequency Oscillator configuration, Basic characteristics of Mixers & mixer design.		
Unit-6	**Microwave Integrated Circuits:**	**7 Hours**
Materials &basic fabrications technologies of Hybrid ICs & monolithic ICs, Examples of IC Fabrication flow, MICs- amplifiers, Oscillators, Mixers, Frequency dividers, Digital modulators, Switches, Phase shifters, Multipliers & Up-converters.		
Learning Resources:		

Text Book	
1	Reinhold Ludwig and Pavel Bretshko Circuit Design Theory & Applications", Pearson Education.
2	D. M. Pozar, "Microwave Engineering", John Wiley & sons
Reference Books	
1	Yoshihiro Konishi, "Microwave Integrated Circuits" BSP Books Pvt. Ltd
2	Samuel Y Liao, "Microwave Devices & Circuits", Prentice Hall of India, 2006

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering					
Course Code: 2501PETCPE2042Course Name: SDR & Cognitive Radio Technology					
Teaching Scheme		**Credit**	**Evaluation Scheme**		
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**	
			ESE:	**60 Marks**	

Prerequisites: Students should have basic knowledge of **wireless communication systems**, **digital signal processing**, and **RF/microwave fundamentals**. Familiarity with **computer networks**, **embedded systems**, and **antenna basics** will help in understanding SDR and cognitive radio concepts.

Course Objectives:

1	Understand concept of SDR and Cognitive radios.
2	Know COBRA, SCA, JTRS
3	Understand concept of smart antenna

Course Outcomes:

COs	**At the end of the successful completion of the course, the students will be able to**
CO1	Explain the **concepts, evolution, and benefits of Software Defined Radio (SDR)**, including ideal SDR architecture, end-to-end communication, and global frequency band plans.
CO2	Describe the **Software Communications Architecture (SCA)**, including functional view, core framework, real-time operating systems, CORBA, and JTRS compliance.
CO3	Analyze **RF front-end and baseband signal processing architectures** used in SDR systems, including intelligent radios and adaptive techniques.
CO4	Explain the integration of **smart antennas, phased array antennas, and adaptive beamforming** in SDR-based wireless systems.
CO5	Evaluate **low-cost SDR platforms**, their system requirements, architectures, and convergence of military and commercial communication systems.
CO6	Explain the **principles and architecture of Cognitive Radio**, including spectrum awareness, adaptive transmission, smart antenna integration, and future trends in cognitive wireless systems.

Course Description:

This course introduces the fundamental concepts, architectures, and applications of **Software Defined Radio (SDR)** and **Cognitive Radio (CR)** systems. Students study the **history, evolution, and benefits of SDR**, exploring the SDR Forum standards, ideal SDR architecture, end-to-end SDR communication, and global frequency band plans. The curriculum covers **SDR system design**, including RF design, baseband signal processing, smart and adaptive antennas, phased array antennas, and the integration of SDR principles with antenna systems. Emphasis is given to **low-cost SDR platforms**, their system architecture, and convergence between military and commercial applications, as well as emerging trends in SDR.The course also introduces **Cognitive Radio**

concepts, including its history, advantages, forums, and ideal architectures for dynamic spectrum management and end-to-end communication. Students learn the design and implementation of **CR-based platforms**, cognitive RF systems, adaptive signal processing, and smart antenna architectures, highlighting the application of cognitive principles in modern wireless communication systems. Practical aspects of SDR and CR integration into intelligent radio systems are emphasized to prepare students for research and industry applications in next-generation wireless networks.		
Course Content		
Unit-1	**SDR concepts & history**	**4 Hours**
Benefits of SDR, SDR Forum, Ideal SDR architecture, SDR Based End-to-End Communication, Worldwide frequency band plans, Aim and requirements of the SCA.		
Unit-2	**Architecture Overview**	**7 Hours**
Functional View, Networking Overview, Core Framework, Real Time Operating Systems, Common Object Request Broker Architecture (CORBA), SCA and JTRS compliance.		
Unit-3	**Radio Frequency design**	**7 Hours**
Baseband Signal Processing, Radios with intelligence, Smart antennas, Adaptive techniques, Phased array antennas, Applying SDR principles to antenna systems, Smart antenna architectures.		
Unit-4	**Low Cost SDR Platform**	**7 Hours**
Requirements and system architecture, Convergence between military and commercial systems, The Future for Software Defined Radio.		
Unit-5	**Cognitive radio concepts & history**	**7 Hours**
Benefits of Cognitive radio, Cognitive radio Forum. Ideal Cognitive radio architecture, Cognitive radio Based End-to-End Communication, Worldwide frequency band plans. Low Cost Cognitive Radio Platform, Requirements and system architecture, Convergence between military and commercial.		
Unit-6	**Radio Frequency design,**	**4 Hours**
Baseband Signal Processing, Radios with intelligence, Smart antennas, Adaptive techniques, Phased array antennas, Applying Cognitive radio principles to antenna systems, Smart antenna architectures.		
Learning Resources:		
Text Book		
1	Dillinger, Madani, Alonistioti (Eds.): Software Defined Radio, Architectures, Systems and Functions, Wiley 2003	
2	Software Defined Radio for 3G, 2002, by Paul Burns.	
Reference Books		
1	Tafazolli (Ed.): Technologies for the Wireless Future, Wiley 2005.	
2	Bard, Kovarik: Software Defined Radio, The Software Communications Architecture, Wiley 2007	

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering					
Course Code: 2501PETCPE2043 Course Name: Industry Automation & Process Control					
Teaching Scheme		**Credit**	**Evaluation Scheme**		
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**	
			ESE:	**60 Marks**	

Prerequisites: Students should have prior knowledge of engineering mathematics, including differential equations and Laplace transforms, along with fundamentals of control systems. A basic understanding of electrical and electronics engineering concepts such as sensors, actuators, signal conditioning, and digital logic is required. Familiarity with industrial processes and introductory instrumentation concepts will help in understanding automation strategies and advanced control techniques.

Course Objectives:

1	Explain the General function of Industrial Automation, List basic Devices in Automated Systems, Distinguish Different Controllers Employed in Automated Systems.
2	Identify Practical Programmable Logic Controller Applications, Know the History of the PLC, Demonstrate Basic PLC Skills
3	To study basics fuzzy logic and control for industrial atomization

Course Outcomes:

COs	**At the end of the successful completion of the course, the students will be able to**
CO1	Explain the characteristics of industrial processes by analyzing process variables, degrees of freedom, dynamic behavior, and classification of processes such as self/non-self regulating, interacting/non-interacting, and linear/nonlinear systems.
CO2	Analyze liquid, gas, flow, and thermal processes using concepts of resistance, capacitance, dead time, oscillation, and damping for appropriate selection of control actions.
CO3	Describe the evolution of instrumentation and control systems and evaluate automation strategies using PLC, DCS, SCADA, and hybrid systems with respect to performance, safety, and industrial benefits.
CO4	Apply intelligent control techniques including model-based controllers, predictive controllers, fuzzy logic, neuro-fuzzy systems, and ANN controllers to improve dynamic performance of industrial processes.
CO5	Explain the architecture, configuration, programming, and database functions of Distributed Control Systems (DCS) and assess their role in enterprise-level automation and ERP integration.
CO6	Design and implement automation solutions using PLCs for discrete process control and evaluate automation practices in industries such as power, water treatment, food processing, pharmaceuticals, cement, sugar, automobile, and building automation.

Course Description:

This course provides a comprehensive understanding of **process dynamics, control strategies, and industrial automation systems**. Students learn about process characteristics, types of processes, control actions, and process variables, along with the evolution and application of automation tools like **PLC, DCS, and SCADA**. The course also covers **intelligent controllers** (fuzzy logic, model

predictive control, and neural network-based controllers), distributed control systems, PLC design and programming, and their application across industries such as power, water treatment, food, pharmaceuticals, and manufacturing. Emphasis is placed on both theoretical concepts and practical implementation in real-world industrial automation.		
Course Content		
Unit-1	**Process characteristics:**	**6 Hours**
Incentives or process control, Process Variables types and selection criteria, process degree of freedom, The period of Oscillation and Damping, Characteristics of physical System: Resistance, Capacitive and Combination of both. Elements of Process Dynamics, Types of processes- Dead time, Single / multi-capacity, self- Regulating / non-self-regulating, Interacting / non-interacting, Linear / nonlinear, and Selection of control action for them. Study of Liquid Processes, Gas Processes, Flow Processes, Thermal Processes in respect to above concepts.		
Unit-2	**Control Systems and Automation Strategy:**	**6 Hours**
Evolution of instrumentation and control, Role of automation in industries, Benefits of automation, Introduction to automation tools PLC, DCS, SCADA, Hybrid DCS/PLC, Automation strategy evolution, Control system audit, performance criteria, Safety Systems.		
Unit-3	**Intelligent Controllers:**	**6 Hours**
Stepan analysis method for finding first, second and multiple time constant and dead time**.** Model Based controllers: Internal Model control, Smith predictor, optimal controller, Model Predictive controller, Dynamic matrix controller (DMC). Self-Tuning Controller. Fuzzy logic systems and Fuzzy controllers, Introduction, Basic Concepts of Fuzzy Logic, Fuzzy Sets, Fuzzy Relation, Fuzzy Graphs, and Fuzzy Arithmetic, Fuzzy If- Then Rules, Fuzzy Logic Applications, Neuro-Fuzzy Artificial Neural networks and ANN controller.		
Unit-4	**Distributed Control Systems:**	**6 Hours**
DCS introduction, functions, advantages and limitations, DC Susan automation Tool to support Enterprise Resources Planning, DCS Architecture of different makes, specific at ions, configuration and programming, functions including database.		
Unit-5	**Programmable logic controllers (PLC):**	**6 Hours**
Introduction, architecture, definition of discrete state process control, PLCVs PC, PLCVs DCS, relay diagram, ladder diagram, ladder diagram examples, relay sequencers, timers/counters, PLC design, Study of at least one industrial PLC.		
Unit-6	**Automation for following industries– Power**	**8 Hours**
Water and Waste Water Treatment, Food and Beverages, Cement, Pharmaceuticals, Sugar, Automobile and Building Automation.		
Learning Resources:		
Text Book		

1	Donald Eckman–Automatic Process Control, Wiley Eastern Limited
2	Thomas E Marlin-Process Control- Design in processes and Control Systems for Dynamic Performance, McGraw- Hill International Editions
Reference Books	
1	Process control Systems-F. G. Shinskey, TMH
2	Programmable Logic Controllers: Principles and Applications- Webb & Reis PHI

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering				
Course Code: 2501PETCOE2051 Course Name: Advanced Operating Systems				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites: Students should have a basic understanding of computer organization and architecture, including CPU operation, memory hierarchy, and I/O concepts. Prior knowledge of data structures, algorithms, and programming in a high-level language such as C/C++ or Java is essential. Familiarity with basic concepts of digital logic and computer networks will be helpful for understanding process management, scheduling, and security aspects of operating systems.

Course Objectives:

1	Understand the Concept of hardware interface and OS Interface
2	Understand parallel System along with Multiprocessor
3	Understand IPC patterns

Course Outcomes:

COs	**At the end of the successful completion of the course, the students will be able to**
CO1	Explain the fundamental concepts, objectives, and classifications of operating systems, including batch, multiprogramming, time-sharing, real-time, and distributed systems.
CO2	Describe the internal structure and design approaches of operating systems such as monolithic, layered, virtual machine, and kernel-based architectures.
CO3	Analyze process management concepts including process states, process control blocks, inter-process relationships, and thread implementation using POSIX threads.
CO4	Apply process synchronization techniques to solve concurrency problems using critical sections, semaphores, monitors, and classical synchronization problems.
CO5	Evaluate uniprocessor, multiprocessor, and real-time CPU scheduling algorithms and assess their performance characteristics.
CO6	Identify computer security threats and attacks, and explain protection mechanisms including authentication, access control, intrusion detection, and malware defense techniques.

Course Description:

This course introduces the **fundamentals of operating systems**, covering their classification, structure, and core functions. Topics include **process and thread management, synchronization techniques, scheduling algorithms for uniprocessor and multiprocessor systems, and real-time scheduling**. Additionally, the course addresses **computer security principles**, exploring threats, attacks, authentication, access control, intrusion detection, and malware defense, providing students with both theoretical knowledge and practical understanding of OS operation and secure computing.

Course Content

Unit-1	**Overview of Operating Systems:**	**6 Hours**
Classes of operating systems, Efficiency systems performance, and User service, Batch Processing		

system, Multiprogramming systems, Time sharing systems, Real-time operating systems, Distributed operating systems.		
Unit-2	**Structure of Operating Systems:**	**6 Hours**
Operations of an OS, Structure of an operating systems, Operating systems with monolithic structure, Layered design of operating systems, Virtual machine operating systems, Kernel-Based operating systems.		
Unit-3	**Process Management and Threads:**	**6 Hours**
Processes and programs, Relationship between processes and programs, Child Processes, Implementing Processes Process context and the process control block, Threads, POSIX Threads.		
Unit-4	**Process Synchronization:**	**8 Hours**
Race conditions, Critical Sections, Synchronization Approaches, Looping versus blocking, Classic Process synchronization, Semaphores, Monitors.		
Unit-5	**Uniprocessor Scheduling and Multiprocessor & Real Time Scheduling:**	**6 Hours**
Type of scheduling, Scheduling Algorithms, Multiprocessor Scheduling, Real time scheduling.		
Unit-6	**Computer security Threats and Techniques:**	**6 Hours**
Computer security Concepts, Threats Attacks & Assets, Intruders, Malicious Software Overview, Viruses Worms &Bots, Root kits, Authentication, Access Control, Intrusion Detection, Malware Defence, Dealing with Buffer overflow Attacks.		

Learning Resources:	
Text Book	
1	Operating Systems Internals and design principles – William Stallings.
2	Operating Systems- Dhananjay M. Dhamdhere.
Reference Books	
1	Operating System by John Crowley
2	Operating System by William Stallings

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering				
Course Code: 2501PETCOE2052 Course Name: Cyber Security				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites: Students should have a basic understanding of **computer networks, operating systems, and internet technologies**. Familiarity with **programming fundamentals**, **data communication concepts**, and basic knowledge of **information security principles** will help in understanding cybercrime mechanisms, risk assessment, and legal perspectives in cybersecurity.

Course Objectives:

1	Understand the Concept of Cyber security.
2	Understand Cyber offenses & Cybercrimes.
3	Understand Tools and Methods Used in Cybercrime

Course Outcomes:

COs	**At the end of the successful completion of the course, the students will be able to**
CO1	Understand the fundamentals of cyber security, cybercrime evolution, classifications, and the global and Indian legal perspectives including the IT Act 2000.
CO2	Identify various cyber offenses and attack methodologies such as social engineering, cyber stalking, botnets, mobile and wireless security threats, and credit card frauds.
CO3	Analyze common tools and techniques used in cybercrime including phishing, malware, network attacks, web application attacks, and identity theft mechanisms.
CO4	Apply security risk assessment and risk analysis techniques by understanding risk terminology, regulations, and qualitative and quantitative assessment methods.
CO5	Explain the concepts and methodologies of Vulnerability Assessment and Penetration Testing (VAPT) for networks and web applications, including discovery, exploitation, and reporting phases.
CO6	Interpret cyber security laws and legal frameworks related to cyberspace, e-commerce, cybercrime, digital evidence, intellectual property, and emerging global cyber law trends.

Course Description:

This course provides a comprehensive overview of **cybersecurity fundamentals**, including the definition, origins, and classification of cybercrimes, with a focus on both **global perspectives and Indian regulations (ITA 2000)**. It explores **cyber offenses, attack planning, social engineering, mobile and cloud security challenges**, and the tools and methods used by cybercriminals, such as phishing, malware, SQL injection, and DDoS attacks. Students also learn about **security risk assessment, vulnerability assessment, penetration testing (VAPT)**, and gain an understanding of **cyber laws, legal frameworks, and regulatory aspects** related to e-commerce, intellectual property, electronic banking, and cybercrime mitigation.

Course Content

Unit-1	**Introduction to Cyber Security:**	**6 Hours**
Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.		
Unit-2	**Cyber offenses & Cybercrimes:**	**6 Hours**
How criminal plan the attacks, Social Engg, Cyber stalking, Cybercafé and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices.		
Unit-3	**Tools and Methods Used in Cybercrime:**	**6 Hours**
Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Identity Theft (ID Theft).		
Unit-4	**Security Risk Assessment and Risk Analysis:**	**6 Hours**
Risk Terminology, Laws, Mandates, and Regulations, Risk Assessment Best Practices, The Goals and Objectives of a Risk Assessment, Best Practices for Quantitative and Qualitative Risk Assessment.		
Unit-5	**Vulnerability Assessment and Penetration Testing (VAPT):**	**6 Hours**
VAPT An Overview, Goals and Objectives of a Risk and Vulnerability Assessment, Vulnerability Assessment Phases-Discovery, Exploitation/Analysis, Reporting Penetration Testing Phases-Discover/Map, Penetrate Perimeter, Attack Resources, Network and Web VAPT		
Unit-6	**Cyber Security Laws and Legal Perspectives:**	**8 Hours**
The Concept of Cyber space E-Commerce, The Contract Aspects in Cyber Law, The Security Aspect of Cyber Law, The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law, The Criminal Aspect in Cyber Law, Global Trends in Cyber Law, Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking, The Need for an Indian Cyber Law.		
Learning Resources:		

Text Book	
1	Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi.
2	The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
Reference Books	
1	The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
2	Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering				
Course Code: 2501PETCOE2053Course Name: Artificial Intelligence and Machine Learning				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Lectures:	**03 Hours/Week**	**03**	**ISE:**	**40 Marks**
			ESE:	**60 Marks**

Prerequisites: Students should have a solid understanding of **basic programming (Python preferred)**, **linear algebra, probability, and statistics**, and **fundamentals of data structures and algorithms**. Familiarity with **basic concepts of computer science and data analysis** will help in implementing and understanding AI and ML models effectively.

Course Objectives:

1	To introduce the fundamental concepts and principles of Artificial Intelligence (AI) and Machine Learning (ML)
2	To develop competency in data preprocessing and feature engineering techniques
3	To enable learners to understand and apply various machine learning algorithms

Course Outcomes:

COs	**At the end of the successful completion of the course, the students will be able to**
CO1	Understand the fundamentals of Artificial Intelligence (AI) and Machine Learning (ML), including supervised, unsupervised, and reinforcement learning, and their real-world applications.
CO2	Preprocess and analyze data using techniques such as feature selection, scaling, normalization, and dimensionality reduction methods like PCA, Sparse PCA, and Kernel PCA.
CO3	Apply regression techniques including linear, polynomial, and logistic regression for prediction and classification problems, and implement optimization algorithms like stochastic gradient descent.
CO4	Design and implement classification models using Naïve Bayes and Support Vector Machines (SVM), including linear, kernel-based, and support vector regression approaches.
CO5	Design and implement classification models using Naïve Bayes and Support Vector Machines (SVM), including linear, kernel-based, and support vector regression approaches.
CO6	Develop and evaluate decision tree models and ensemble learning methods such as Random Forest, AdaBoost, and Gradient Boosting for supervised learning tasks.

Course Description:

This course introduces students to the fundamentals of **Artificial Intelligence (AI) and Machine Learning (ML)**, covering supervised, unsupervised, and reinforcement learning along with statistical and information-theoretic foundations. It emphasizes **data preprocessing, feature selection, dimensionality reduction (PCA, Kernel PCA, Sparse PCA), and regression techniques**, including linear, polynomial, and logistic regression with optimization methods like stochastic gradient descent. Students also explore **classification algorithms (Naïve Bayes, SVM), decision trees, ensemble methods, clustering techniques (K-means, DBSCAN, hierarchical), and recommendation systems**, with practical implementation using **Scikit-learn** and hands-on applications for predictive modeling and pattern recognition.

Course Content		
Unit-1	**Introduction to Artificial Intelligence and Machine learning: Introduction:**	**7 Hours**
What Is Al and ML? Examples of AI and ML, Applications, Supervised Learning, Un-Supervised Learning and Reinforcement Learning, Important Elements of Machine Learning- Data formats, Learnability, Statistical learning approaches, Elements of information theory		
Unit-2	**Feature Selection:**	**7 Hours**
Scikit- Learn Dataset, creating training and test sets, managing categorical data, Managing missing features, Data scaling and normalization, Feature selection and Filtering, Principle Component Analysis(PCA)- non-negative matrix factorization, Sparse PCA, Kernel PCA. Atom Extraction and Dictionary Learning.		
Unit-3	**Regression:**	**6 Hours**
Linear regression- Linear models, A bi-dimensional example, Linear Regression and higher dimensionality, Polynomial regression, Logistic regression-Linear classification, Logistic regression, Implementation and Optimizations, Stochastic gradient descendent algorithms		
Unit-4	**Naïve Bayes and Support Vector Machine:**	**6 Hours**
Bayes Theorem, Naïve Bayes Classifiers, Naïve Bayes in Scikit-learn- Bernoulli Naïve Bayes, Multinomial Naïve Bayes, and Gaussian Naïve Bayes. Support Vector Machine (SVM)- Linear Support Vector Machines. Scikit- 06. learn implementation, Linear Classification, Kernel based classification, Non- linear Examples. Controlled Support Vector Machines, Support Vector Regression.		
Unit-5	**Decision Trees and Ensemble Learning:**	**5 Hours**
Decision Trees- Impurity measures, Feature Importance. Decision Tree Classification with Scikit learn, Ensemble Learning-Random Forest, AdaBoost, Gradient Tree Boosting, Voting Classifier. Clustering Fundamentals-Basics, K-means: Finding optimal number of clusters, DBSCAN, Spectral Clustering. Evaluation methods based on Ground Truth- Homogeneity, Completeness, Adjusted Rand Index.		
Unit-6	**Clustering Techniques:**	**5 Hours**
Hierarchical Clustering, Expectation maximization clustering. Agglomerative Clustering Dendrograms, Agglomerative clustering in Scikit- learn, Connectivity Constraints. Introduction to Recommendation Systems- Naïve User based systems. Content based Systems, Model free collaborative filtering-singular value decomposition, alternating least squares.		

Learning Resources:

Text Book	
1	Giuseppe Bonaccorso, "Machine Learning Algorithms", Packt Publishing Limited.
2	Josh Patterson, Adam Gibson, "Deep Learning: A Practitioners Approach", O"REILLY

Reference Books	
1	Ethem Alpaydin, "Introduction to Machine Learning", PRENTICE HALL INDIA Publication.
2	Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", Cambridge University Press.

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering				
Course Code: 2501PETCLC206TCourse Name: Laboratory Course				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Practical:	**04 Hours/Week**	**02**	**ISA:**	**25 Marks**

Prerequisites: Students should have a basic understanding of **discrete mathematics**, including modular arithmetic, number theory, and matrix operations. Familiarity with **programming fundamentals** (preferably in Python, C, or Java) and basic concepts of **data structures** will help in implementing classical cryptographic algorithms.

Course Objectives:

1	To acquire basic understanding of MATLAB coding for Ciphers.
2	Toacquirecompleteknowledgeof Security.
3	To make students understand and learn about algorithms of Cryptography.

Course Outcomes:

COs	At the end of the successful completion of the course, the students will be able to
CO1	Understand the principles of classical cryptography, including substitution and transposition techniques, and their role in securing information.
CO2	Implement and analyze basic ciphers such as **Caesar**, **Affine**, and **Polyalphabetic ciphers**, understanding encryption and decryption procedures.
CO3	Develop skills to implement **digraph and key-based ciphers** like **Playfair** and **Auto Key ciphers** for secure communication.
CO4	Apply matrix-based encryption techniques such as the **Hill cipher** and implement **rail fence** and **columnar transposition** methods for data confidentiality.
CO5	Design and execute advanced **columnar transposition techniques** to enhance cryptographic security and analyze their strengths and weaknesses.
CO6	Use the **Euclidean Algorithm** for computing greatest common divisors, modular inverses, and its application in classical and modern encryption schemes.

Course Description:

This course provides hands-on understanding of **classical cryptographic techniques and fundamental algorithms** for secure communication. Students will implement and analyze various ciphers including **Caesar Cipher, Affine Cipher, Playfair Cipher, Polyalphabetic and Auto Key Ciphers, Hill Cipher, Rail Fence Cipher, and Columnar Transposition techniques**. Emphasis is also given to **mathematical foundations like the Euclidean Algorithm** for key generation and modular arithmetic. The course combines theory with practical programming exercises to strengthen skills in encryption, decryption, and cryptanalysis.

Course Content

1	Implement Ceaser Cipher
2	Implement Affine Cipher with equation c=3x+12

3	Implement Playfair Cipher with key l drp
4	Implement polyalphabetic Cipher
5	Implement Auto Key Cipher
6	Implement Hill Cipher
7	Implement Rail fence technique
8	Implement Simple Columnar Transposition Technique
9	Implement Advanced Columnar Transposition technique
10	Implement Euclidean Algorithm

Learning Resources:

Text Book

1	Willam Stallings, Cryptography and Network Security, Third Edition, Pearson Education
2	Network Algorithmic: An Interdisciplinary Approach to Designing Fast Networked Devices George Varghese (Morgan Kaufmann Series in Networking

Reference Books

1	Network Algorithmic: An Interdisciplinary Approach to Designing Fast Networked Devices George Varghese (Morgan Kaufmann Series in Networking
2	Atul Kahate, Cryptography and Network Security, Tata McGraw-Hill, 2003

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering				
Course Code: 2501PETCSW207T Course Name: Seminar II				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Practicals:	**02 Hours/Week**	**01**	**ISA:**	**50 Marks**

Prerequisites: Students should have a basic understanding of **engineering design concepts**, **research methodology**, and **technical writing**. Familiarity with **literature survey techniques**, **IEEE formatting**, and **presentation skills** will help in preparing the seminar report and delivering the talk effectively.

Course Objectives:

1	To Identify, understand and discuss current, real-world issues.
2	To Distinguish and integrate differing forms of knowledge and academic disciplinary approaches (e.g. humanities and sciences) with that of the student 's own academic discipline (e.g. in agriculture, architecture, art, business, economics, education, engineering, natural resources, etc.) and apply multidisciplinary strategy to address current, real-world issues.
3	To Improve oral and written communication skills.

Course Outcomes:

COs	**At the end of the successful completion of the course, the students will be able to**
CO1	Conduct a comprehensive **literature survey** on a topic relevant to design engineering to identify research gaps and formulate objectives for a potential dissertation.
CO2	Develop skills to **organize and present technical information** effectively in a written report using the **IEEE format**.
CO3	Demonstrate the ability to **synthesize information** from multiple sources, critically analyze prior work, and draw meaningful conclusions.
CO4	Enhance **oral communication skills** by delivering a seminar presentation to peers and faculty with clarity and technical accuracy.
CO5	Apply proper **documentation and referencing techniques** to avoid plagiarism and maintain academic integrity in technical writing.
CO6	Develop **professional and collaborative skills** through participation in peer seminars, including evaluating others' work and learning from feedback.

Course Description:

Each student will select an advanced topic closely related to their M.Tech specialization and dissertation area. The seminar will require an in-depth literature review from reputed journals (IEEE, Elsevier, Springer, ACM, etc.), critical analysis of existing research, and formulation of possible research directions. Students must prepare a 30 - 40page seminar report in IEEE format, submit two copies (soft + hard), and present their work before the departmental faculty and peers. Evaluation will consider technical depth, quality of documentation, presentation skills, and peer participation.

Course Content		
Activity	**Description**	**Expected Output**
Topic Selection & Approval	Choose advanced research-oriented topic aligned with dissertation.	Approved seminar topic.
Extended Literature Review	Study at least 20–25 research papers from reputed sources, identify gaps.	Review matrix & summary.
Seminar Report Preparation	Prepare 30 - 40 page detailed report in IEEE format including methodology & research.	Hard and soft copies of report.
Seminar Presentation	Present seminar using professional slides, defend through Q&A.	Oral presentation & Q&A record.
Peer Review Participation	Attend peer seminars, provide constructive feedback, participate in academic discussion.	Peer review marks & participation.

Learning Resources:

Text Book	
1	M. Ashraf Rizvi – Effective Technical Communication, McGraw Hill Education India, 2nd Edition.
2	R.C. Sharma & Krishna Mohan – Business Correspondence and Report Writing, Tata McGraw Hill, 5th Edition.
3	C.R. Kothari – Research Methodology: Methods and Techniques, New Age International Publishers, 4th Edition.

Reference Books	
1	Justin Zobel – Writing for Computer Science, Springer India, 3rd Edition.
2	Robert A. Day & Barbara Gastel – How to Write and Publish a Scientific Paper, Cambridge University Press, 8th Edition.
3	S.P. Dhanavel – English and Communication Skills for Students of Science and Engineering, Orient BlackSwan, 2014.

Tatyasaheb Kore Institute of Engineering and Technology F.Y. M. Tech Electronics & Telecommunication Engineering				
Course Code: 2501PETCCV208P Course Name: Comprehensive Viva				
Teaching Scheme		**Credit**	**Evaluation Scheme**	
Practicals:	**02 Hours/Week**	**01**	**ISA:**	**--**
			POE	**25 Marks**

Prerequisites:

Course Objectives:

1	To verify the continuous assessment and performance of students by external examiner and internal examiner.
2	
3	
4	

Course Outcomes:

COs	**At the end of the successful completion of the course, the students will be able to**
CO1	Verify their knowledge based on the subjects they have studied in Semester-I and Semester-II.
CO2	
CO3	
CO4	
CO5	

Course Description:

The students have to prepare on all subjects which they have studied in Ist and IInd semesters The viva will be conducted by the External/Internal Examiner jointly and their appointments will be made by institute. The in-depth knowledge, preparation and subjects understanding will be assessed by the Examiners.