SYLLABUS

(With effect from 2022-23)

Bachelor Degree
In

Electronics & Communication Engineering

III & IV Semester

Out Come Based Education
With
Choice Based Credit System

[National Education Policy Scheme]

P.E.S. College of Engineering, Mandya - 571 401, Karnataka
[An Autonomous Institution affiliated to VTU, Belagavi,
Grant – in – Aid Institution (Government of Karnataka),
Accredited by NBA (All UG Programs), NAAC and Approved by AICTE, New Delhi]

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VISION

"PESCE shall be a leading institution imparting quality Engineering and Management education developing creative and socially responsible professionals."

MISSION

- *Provide state of the art infrastructure, motivate the faculty to be proficient in their field of specialization and adopt best teaching-learning practices.*
- *Impart engineering and managerial skills through competent and committed faculty using outcome based educational curriculum.*
- *Inculcate professional ethics, leadership qualities and entrepreneurial skills to meet the societal needs.*
- *Promote research, product development and industry-institution interaction.*

QUALITY POLICY

Highly committed in providing quality, concurrent technical education and continuously striving to meet expectations of stake holders.

CORE VALUES

***P**rofessionalism*
***E**mpathy*
***S**ynergy*
***C**ommitment*
***E**thics*

Department of Electronics and Communication Engineering

The department of Electronics and Communication Engineering was incepted in 1967 with an undergraduate program in Electronics and Communication Engineering. Initially, the program had an intake of 60 students, which increased to 120 in 2012, and further increased to 180 in 2019. Almost 200 students graduate every year, and the long journey of 50 years has seen satisfactory contributions to society, the nation, and the world. The alumni of this department have a strong global presence, making their alma mater proud in every sector they represent.

The department started its PG program in 2012 in the specializations of VLSI design and embedded systems. Equipped with well qualified and dedicated faculty, the department has a focus on VLSI design, embedded systems, and image processing. The quality of teaching and training has yielded a high growth rate of placement at various organizations. The large number of candidates pursuing research programs (M.Sc. and Ph.D.) is a true testimonial to the research potential of the department. The department is recognized as a research centre by VTU, and Mysore University offers a part-time and full-time Ph.D. Program.

Vision

The department of E & C would endeavour to create a pool of Engineers who would be extremely competent technically, ethically strong also fulfil their obligation in terms of social responsibility.

Mission

- M1: Adopt the best pedagogical methods and provide the best facility, infrastructure and an ambience Conducive to imbibe technical knowledge and practicing ethics.
- M2: Group and individual exercises to inculcate habit of analytical and strategic thinking to help the Students to develop creative thinking and instil team skills
- M3: MoUs and Sponsored projects with industry and R & D organizations for collaborative learning
- M4: Enabling and encouraging students for continuing education and moulding them for life-long Learning process

Program Educational Objectives (PEOs)

- **PEO1:** Graduates to exhibit knowledge in mathematics, engineering fundamentals applied to Electronics and Communication Engineering for professional achievement in industry, research and academia
- **PEO2:** Graduates to identify, analyse and apply engineering concepts for design of Electronics and Communication Engineering systems and demonstrate multidisciplinary expertise to handle societal needs and meet contemporary requirements
- **PEO3:** Graduates to perform with leadership qualities, team spirit, management skills, attitude and ethics need for successful career, sustained learning and entrepreneurship.

Program Outcomes (POs)

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

Program Specific Outcomes (PSOs)

Electronics and Communication Engineering Graduates will be able to

- **PSO1:** An ability to understand the basic concepts in Electronics and Communication Engineering and to apply them in the design and implementation of Electronics and Communication Systems.
- **PSO2:** An ability to solve complex problems in Electronics and Communication Engineering, using latest hardware and software tools, along with analytical skills to arrive at appropriate solutions.

Bachelor of Engineering (III –Semester)										
Sl. No.	**Course Code**	**Course Title**	**Teaching Department**	**Hrs / Week**			**Credits**	**Examination Marks**		
				L	**T**	**P**		**CIE**	**SEE**	**Total**
1	P22MA301	Engineering Mathematics – III	MA	2	2	-	3	50	50	100
2	P22EC302	Linear Integrated Circuits	EC	3	-	-	3	50	50	100
3	P22EC303	Circuit Theory	EC	3	-	-	3	50	50	100
4	P22EC304	Digital Logic design	EC	3	-	2	4	50	50	100
5	P22EC305	Signals and Systems	EC	3	-	2	4	50	50	100
6	P22ECL306	Linear Integrated Circuits Laboratory	EC	-	-	2	1	50	50	100
7	P22HSMC307	Employability Enhancement Skills - III	HSMC	-	2	-	1	50	50	100
8	P22BFE308	Biology For Engineers	EC	2	-	-	2	50	50	100
9	P22NSS308	National Service Scheme (NSS)	NSS coordinator	-	-	2	0	100	-	100
	P22PED308	Physical Education (PE) (Sports and Athletics)	PED							
	P22YOG308	Yoga	YOGA							
Total							**21**			
10	P22MDIP301	Additional Mathematics – I	MA	2	2	-	0	100	-	100
11	P22HDIP307	Additional Employability Enhancement Skills - I	HSMC	-	2	-	0	100	-	100

Bachelor of Engineering (IV –Semester)										
Sl. No.	**Course Code**	**Course Title**	**Teaching Department**	**Hrs / Week**			**Credits**	**Examination Marks**		
				L	**T**	**P**		**CIE**	**SEE**	**Total**
1	P22MA401	Engineering Mathematics – IV	MA	2	2	-	3	50	50	100
2	P22EC402	Analog and Digital Communication	EC	3	-	-	3	50	50	100
3	P22EC403	Electromagnetic field theory	EC	3	-	-	3	50	50	100
4	P22EC404	Digital Design Using Verilog HDL	EC	3	-	2	4	50	50	100
5	P22EC405	Microcontroller	EC	3	-	2	4	50	50	100
6	P22ECL406	Analog and Digital Communication Laboratory	EC	-	-	2	1	50	50	100
7	P22HSMC407	Employability Enhancement Skills - IV	HSMC	-	2	-	1	50	50	100
8	P22INT408	Internship – I	EC	-	-	-	2	-	100	100
9	P22NSS409	National Service Scheme (NSS)	NSS coordinator	-	-	2	0	100	-	100
	P22PED409	Physical Education (PE) (Sports and Athletics)	PED							
	P22YOG409	Yoga	YOGA							
Total							**21**			
10	P22MDIP401	Basic Engineering Mathematics - II	MA	2	2	-	0	100	-	100
11	P22HDIP408	Employability Enhancement Skills – II	HSMC	-	2	-	0	100	-	100

L –Lecture, T – Tutorial, P- Practical/ Drawing, CIE: Continuous Internal Evaluation, SEE: Semester End Examination

Course Title	**TRANSFORMS AND SERIES**						
Course Code	**P22MA301**						
Category	**COMMON TO ALL STREAMS**						
Scheme and Credits	Theory/Practical/Integrated					Total teaching hours	Credits
	L	T	P	SS	Total		
	02	02	00	00	03	40	03
CIE Marks: 50	**SEE Marks: 50**		**Total Max. marks=100**		**Duration of SEE: 03 Hours**		

Course Learning Objectives:	
1	**Understand** the concept of infinite series; learn and apply Fourier series to represent periodical physical phenomena in engineering analysis.
2	To facilitate students to study, analyse and apply various transforms to solve engineering problems.

Unit	**Syllabus content**	**No. of hours**	
		Theory	**Tutorial**
I	**Infinite Series:** Introduction, convergence, divergence and oscillation of a series, Tests for convergence – Comparison test, Ratio test, Cauchy's root test Raabe's test, (All tests without proof)- Problems.	06	02
	Self-study component: Integral Test, Alternating series, Leibnitz's theorem – absolute and conditional convergence.		
II	**Fourier Series:** Introduction, periodic function, even and odd functions, Dirichlet's conditions, Euler's formula for Fourier series (no proof). Fourier series for functions of arbitrary period of the form 2L (all particular cases) – problems, analysis- Illustrative examples from engineering field. Half Range Fourier series- Construction of Half range cosine and sine series and problems. Practical harmonic analysis- Illustrative examples from engineering field.	06	02
	Self study: Complex Fourier series.		
III	**Laplace Transforms:** Definition – Transforms of elementary functions. Properties of Laplace Transforms- linearity, Change of scale, shifting, Transform of Derivative and Integrals, Transform of a function multiplied by t^n and division t (no proof)-Problems, Transforms of periodic function, unit step function (All results without proof)-Problems only. **Inverse Laplace Transforms**: Evaluation of inverse transforms by standard methods. Convolution theorem - Problems only.	06	02
	Self-study component- Transform of Unit impulse function. Solution of ODE by Laplace method and L-R-C circuits.		
IV	**Fourier Transforms**: **Complex Fourier Transform**: Infinite Fourier transforms and Inverse Fourier transforms. Properties of Fourier Transforms- linearity Change of scale, shifting and modulation (no proof)-Problems, Fourier sine and cosine transforms and Inverse Fourier cosine and sine transforms with properties-Problems Convolution theorem and Parseval's identity for Fourier Transform (no proof)-problems.	06	02
	Self study: Fourier integrals- Complex forms of Fourier integral.		

V	**Z-Transforms**: Definition. Some standard Z-transforms. Properties-linearity, Damping, Shifting, multiplication by *n*, initial and final value theorem-problems. Evaluation of Inverse Z- transforms- problems. **Application to Difference Equations**: Solutions of linear difference equations using Z- transforms.	06	02
	Self study: Convolution theorem and problems, two sided Z-transforms.		

COURSE OUTCOMES: On completion of the course, student should be able to:	
CO1:	**Understand** the fundamental concepts of infinite series, transforms of functions.
CO2:	**Apply** series and transform techniques to obtain series expansion, discrete and continuous transformation of various mathematical functions.
CO3:	**Analyze** various signals using series expansions and differential, integral and difference equations using transforms.
CO4:	**Evaluate** indefinite integrals, differential equations and difference equations subject to initial conditions using transforms and develop series for a discontinuous function.

TEACHING - LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos

TEXT BOOKS

1. B.S. Grewal, Higher Engineering Mathematics (44th Edition 2018), Khanna Publishers, New Delhi.
2. E. Kreysizig, Advanced Engineering Mathematics, John Wiley and sons, 10th Ed. (Reprint) 2016.

REFERENCE BOOKS

1. V. Ramana: Higher Engineering Mathematics, McGraw –Hill Education, 11th Ed.,
2. H. C. Taneja, Advanced Engineering Mathematics, Volume I & II, I.K. International Publishing House Pvt. Ltd., New Delhi.
3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications,Reprint, 2010.

ONLINE RESOURCES

1. http://www.nptel.ac.in
2. https://en.wikipedia.org
3. https://ocw.mit.edu/courses/18-03sc-differential-equations-fall-2011/
4. https://ocw.mit.edu/courses/18-06sc-linear-algebra-fall-2011/
5. https://math.hmc.edu/calculus/hmc-mathematics-calculus-online-tutorials/differential-equations/first-order-differential-equations/

QUESTION PAPER PATTERN (SEE)	
PART-A	PART-B
One question from each unit carrying two	Answer any **TWO** sub questions for maximum 18 marks

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**2**										
CO2	**2**	**3**										
CO3	**3**	**2**										
CO4	**2**	**3**										

Strength of correlation: Low-1, Medium- 2, High-3

Linear Integrated Circuits

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – III

Course Code:	**P22EC302**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3 : 0 : 0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Understand the basic operation of Op–Amp and its operation as DC and AC amplifiers.
- Understand the various applications of Op-Amp like inverting amplifier, non–inverting amplifier, voltage follower, summing amplifier and difference amplifier.
- Understand the voltage sources, current sources, current amplifiers, Circuit stability and Frequency compensation methods.
- Understand the operation of Op Amp based differentiating, integrating and Schmitt trigger circuits.
- Know the applications of 555 timer such as monostable, astable multivibrators and use of Op–Amps in signal generators, filters and DC voltage regulators.
- Explaining the operation of ADC, DAC and PLL.

UNIT – I	**8 Hours**

Operational Amplifier Fundamentals: IC Operational amplifiers, Op–Amp parameters – Input, output and supply voltages, Offset voltages and currents, Slew rate and frequency limitation. **Op–Amps as DC Amplifiers**– Biasing Op–Amps, Direct coupled –Voltage Follower, Direct–Coupled Non–inverting Amplifiers, Direct–Coupled Inverting amplifiers, Summing amplifiers, Difference amplifier.

Op–Amps as AC Amplifiers: Capacitor coupled Voltage Follower, Capacitor Coupled Non–inverting Amplifier, Capacitor Coupled Inverting Amplifier, Capacitor Coupled Difference amplifier.

Text 1: 1.1, 2.3, 2.4, 2.6, 3.1, 3.2, 3.3, 3.4, 3.6, 3.7, 4.1, 4.3, 4.5, 4.7.

Self-study component:	1. Study of instrumentation amplifier. 2. Study of High Input Impedance Capacitor Coupled Voltage Follower.

UNIT – II	**8 Hours**

Op–Amps Frequency Response and Compensation: Op-Amp Circuit Stability, Frequency Compensation Methods, Circuit Stability Precautions.

OP–AMP Applications: Voltage Sources, Current Sources and Current Sinks, Current Amplifiers, Voltage Level Detectors, Inverting Schmitt Trigger Circuit, Differentiating Circuit, Integrating Circuit.

Text 1:5.1, 5.2, 5.6, 7.1, 7.2, 7.3, 8.2, 8.3, 8.6, 8.7.

Self-study component:	**1.** Study of Log and Anti-log amplifiers. **2.** Study of Circuit Band width and Slew rate.

UNIT – III	**8 Hours**

Signal Processing Circuits: Precision Half–Wave Rectifiers: Saturating Precision Rectifier and Non saturating Precision Rectifier, Precision Full–Wave Rectifiers: Half wave and summing circuit, Limiting circuits: Peak Clipper and precision clipper, Clamping circuits, Peak detectors: Precision rectifier peak detector, Sample and Hold Circuits, Astable Multivibrator using Op-Amp,

Text 1: 9.1, 9.2. 9.3 (Mentioned topics only), 9.4, 9.5 (Mentioned topics only), 9.6, 10.1, 10.3.

Self-study component:	**1.** Study Mono stable Multivibrator using Op-Amp. **2.** Study of Dead Zone Circuit

UNIT – IV	**8 Hours**

Signal Generators: 555 Timer Monostable, 555 Timer Astable, Phase Shift Oscillators, Colpitts and Hartley Oscillators, **Active Filters –**Filter types and characteristics, First order active filter, Second Order active filters.
DC Voltage Regulators: Voltage Regulator Basics, Op–Amp Series Voltage Regulator, Adjustable Output Regulators, IC linear Voltage Regulators: 723 IC regulator and LM 317 IC regulator.
Text 1:10.6, 10.7, 11.1, 11.2, 12.1, 12.2, 12.3, 13.1, 13.2, 13.3, 13.5(Mentioned topics only)

Self-study component:	**1.** Study of Band pass and Band reject filter using Op-amp. 2. Study of LM337 IC regulator and IC Function Generator (IC8038).

UNIT – V	**8 Hours**

DAC and ADC: Analog/Digital Conversion Basics, Digital-To-Analog Conversion, Parallel ADC, ADC Counting Methods: Dual-Slope Integrator ADC, Digital Ramp ADC(Mentioned topics only).
PLL: Basic PLL System, PLL Components, PLL Performance Factors, Integrated Circuit PLL
Text1: 15.1, 15.2, 15.3, 15.4 (Mentioned topics only), 16.1, 16.2, 16.3, 16.5

Self-study component:	1. Study of Linear Ramp ADC. 2. Study of applications of PLL

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Program Outcome Addressed (PO #) with BTL**
CO1	**Understand** the knowledge of basic circuit concepts to describe the operation and characteristics of 741 Op- Amp, 555 Timer, PLL and voltage regulator	Understand	PO1(L2)
CO2	**Illustrate** the working of op-amp applications, voltage regulators, Data converters and PLL system	Applying	PO1 (L3)
CO3	**Analyze** the circuit stability and Frequency compensation methods, applications of op-amp, 555 Timer, volte regulator and PLL system.	Analyze	PO2 (L4)
CO4	**Design** the op-amp applications circuits and PLL systems for a given specification	Creating	PO3 (L6)

Text Book(s):

1. **"Operational Amplifiers and Linear IC's"**, David A. Bell, 3rd edition, Oxford university Press, 2011.ISBN-13: 978-0-19-569613-4 ISBN-10: 0-19-569613-1

Reference Book(s):

1. **"Linear Integrated Circuits",** D. Roy Choudhury and Shail B. Jain, 2nd edition, Reprint 2006, New Age International. ISBN-10: 8122430988: ISBN-13: 978-8122430981
2. **"Op – Amps and Linear Integrated Circuits",**Ramakant A. Gayakwad, 4th edition, PHI

Web and Video link(s):

1. Analog Electronic Circuit- https://youtu.be/pkIxCmaxWFg
2. Differential and Operational Amplifiers- https://youtu.be/LS8ne40mSTE

E-Books/Resources:

1. https://www2.mvcc.edu/users/faculty/jfiore/OpAmps/OperationalAmplifiersAndLinearICs_3E.pdf
2. https://books.google.co.in/books?id=aByz9D63wC&printsec=frontcover#v=onepage&q&f=false
3. https://drive.google.com/u/0/uc?id=1cK8mBJXxeFyNENRFYzSuqLCHWsqyRzzp&export=download

D. Course Articulation Matrix (CAM)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
#1	3												2	
#2	3												3	
#3		2												2
#4			2											

Circuit Theory [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – III			
Course Code:	**P22EC303**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3 : 0 : 0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Understand electrical circuits, their sources and transformations and also their analysis and solutions through node analysis and mesh analysis methods, various network theorems (ac and dc) to analyze complex circuits.
- Analyze the transient conditions that may occur in electrical networks by solving necessary differential equations.
- Provide explanation of Laplace transform and its application in solving circuit problems.
- Determine transient response of electrical circuits by Laplace transform method.
- Examine the behaviour of two-port networks and learn about few special two-port networks.
- Demonstrate that the graph theory concept eases the solution method for solving networks with a large number of nodes and branches.
- Discuss the various properties and synthesis methods for different one-port networks

UNIT – I	**8 Hours**

Introduction to Network Theorems: Mesh Analysis, Node Analysis, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem, Reciprocity Theorem.
Text: 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8

Self-study component:	Source Transformation, Star Delta Transformation, Millman's Theorem, Substitution Theorem.

UNIT – II	**8 Hours**

Introduction to Resonance: Series Resonance, Parallel Resonance
Introduction to Transient Analysis: Initial Conditions, Resistor-Inductor Circuit, Resistor-Capacitor Circuit, Resistor-Inductor- Capacitor Circuit.
Text: 5.1, 5.2, 5.3, 10.1, 10.2, 10.3, 10.4, 10.5

Self-study component:	Comparison of Series and Parallel Resonance Circuits, Behaviour of Pure Resistor in an ac Circuit, Behaviour of Pure Inductor in an ac Circuit, Behaviour of Pure Capacitor in an ac Circuit.

UNIT – III	**8 Hours**

Introduction to Laplace Transforms and its Applications: Laplace transforms of Periodic Functions, Waveform Synthesis, The Transformed Circuit, Resistor-Inductor Circuit, Resistor-Capacitor Circuit, Resistor-Inductor- Capacitor Circuit, Response of RL Circuit to Various Functions, Response of RC Circuit to Various Functions.
Text: 11.1, 11.5, 11.6, 11.10, 11.11, 11.12, 11.13, 11.14, 11.15

Self-study component:	Write programs in MATLAB/PYTHON to synthesis the waveforms

UNIT – IV	**8 Hours**

Introduction to Network Topology: Graph of a Network, Definitions Associated with a Graph, Incidence Matrix, Loop Matrix or Circuit Matrix, Cutset Matrix,
Introduction to Two-Port Networks: Open-Circuit Impedance Parameters (Z Parameters), Short-Circuit Admittance Parameters (Y Parameters), Transmission Parameters (ABCD Parameters), Hybrid Parameters (h parameters).
Text: 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 13.1, 13.2, 13.3, 13.4, 13.6

Self-study component:	Duality, Inter-relationships between the Parameters.

UNIT – V	**8 Hours**

Introduction to Network Synthesis: Hurwitz Polynomials, Positive Real Functions, Elementary Synthesis Concepts, Realization of LC Functions, Realization of RC Functions.
Text: 16.1, 16.2, 16.3, 16.4, 16.5, 16.6, 16.7

Self-study component:	Passive Filters, Realization of RL Functions

Course Outcomes: On completion of this course, students are able to:

COs	Course Outcomes with *Action verbs* for the Course topics	Bloom's Taxonomy Level	Program Outcome Addressed (PO #) with BTL
CO1	**Apply** the fundamental concepts of electrical networks to compute the value of the specified parameter.	Apply	PO1(L3)
CO2	**Analyze** the linear circuits in time and frequency domain and provide a concise summary of the results.	Analyze	PO2(L4)
CO3	**Develop** a network to synthesize the given mathematical function.	Develop	PO3 (L5)
CO4	**Simulate** the network using appropriate tools to verify and conclude the performance specification.	Conclude	PO5, PO9,PO10, (L6)

Text Book(s):

1. Network Analysis and Synthesis, Ravish R Singh, McGraw Hill Education (India) Private Limited. ISBN: 978-1259062957

Reference Book(s):

1. Network analysis, 3E, M. E. Van Valkenburg and T.S. Rathore, Pearson Education. ISBN: 978-9353433123
2. Engineering Circuit Analysis, 9E, William H. Hayt Jr., Jack E. Kemmerly, Jamie D. Phillips, Steven M. Durbin, McGraw Hill Education (India) Private Limited. ISBN: 978-9390185139
3. Problems and Solutions in Engineering Circuit Analysis, William Hayt, Jack Kemmerly, McGraw Hill Education (India) Private Limited. ISBN: 978-0071333030

Web and Video link(s):

https://archive.nptel.ac.in/courses/108/105/108105159/
Network Analysis by Prof. Tapas Kumar Bhattacharya, IIT Kharagpur

E-Books/Resources:

D. Course Articulation Matrix (CAM)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
#1	3												2	
#2		2											3	
#3			2											2
#4					1				1	1				2

Digital Logic Design [As per Choice Based Credit System (CBCS) & OBE Scheme] **SEMESTER – III**			
Course Code:	**P22EC304**	**Credits:**	**04**
Teaching Hours/Week (L:T:P):	**3 : 0 : 2**	**CIE Marks:**	**50**
Total Theory Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Discuss the simplification techniques such as K–map, QM method and VEM technique.
- Design and implement the combinational logic circuits.
- Analyze the sequential elements and sequential circuits.
- Design and implement the sequential logic circuits.
- Develop digital circuits/systems applying finite state machine approach.
- Discuss the structure of Computer architecture, ROM, PLA and FPGA with logic implementation.

UNIT – I	**8 Hours**

Simplification Methods and NAND/NOR Implementation: The Map Method, Two-Variable, Three-Variable and Four Variable K-Maps, NAND and NOR Implementation, Don't – Care Conditions, Determination of Prime-Implicants.
Combinational Logic: Design Procedure, Binary Parallel Adder, Magnitude Comparator, Encoders, Decoders, Multiplexers, Demultiplexers.
Text 1: 3.1-3.3, 3.6, 3.8-3.10, 4.2, 5.2, 5.4-5.6

Self-study component:	Tabulation Method, Logic Synthesis and optimization, Decoders in RAM.
Practical Topics:	1.Discrete Gate Implementation (i) Logic circuit realization using basic gates. (ii) Logic circuit realization using universal gates. 2.(i) Realization of parallel adder/subtractor using 7483 chip (ii) Demonstration of BCD to Excess–3 code conversion and vice versa.

UNIT – II	**8 Hours**

Sequential Logic: Introduction, Flip-Flops, Triggering of Flip-Flops.
Registers and Counters: Introduction, Registers, Shift Registers, Ripple Counters, Synchronous-counters.
Text 1: 6.1-6.3, 7.1-7.5

Self-study component:	Setup and hold time issues, flip-flop versus latches, Delay elements, Watchdog timer.
Practical Topics:	1. (i) Realization of Boolean expression/Combinational Logic. (ii) Application of the IC's – MUX–74153 and DEMUX – 74139 for half and full adders for 3 – bit binary to gray and BCD to Excess–3 code converters. 2. Realization of 2– bit comparator using gates and basic operational study of Priority encoder using 74147.

UNIT – III	8 Hours

State Machines: State Tables and Graph, General Models of Sequential Circuits, Design of a Sequence detector, Guidelines for Construction of State Graphs, Elimination of Redundant States, Equivalent States, Equivalent Sequential Circuits, Reducing incompletely Specified State Tables, Derivation of Flip-Flop Input Equations.
Text 2: 13.3-13.4, 14.1-14.3, 15.1,15.2, 15.4-15.6

Self-study component:	Digital Camera Controller State Machine. Bluetooth Controller.
Practical Topics:	1. Design 2/3 bit synchronous counters using Flip–Flops. 2. Design 2/3 bit asynchronous counters using Flip–Flops.

UNIT – IV	8 Hours

Programmable Logic and Storage Devices: Read-Only Memory (ROM), ROM Based Implementation of Combinational Logic, Programmable Logic Array (PLA), Programmability of PLD's, CPLD's, XILINX XC9500 CPLD's, XILINX FPGA Field Programmable Gate Array (FPGA), XILINX Spartan XL FPGA 's.
Text 3: 5.7-5.8

Self-study component:	Architecture and programming examples of FPGA's.
Practical Topics:	1. Design the Ring counters and Johnson counter. 2. Demonstration of FPGA.

UNIT – V	8 Hours

Computer Architecture and Memory: The Memory unit, Examples of Random-access Memories. Introduction, Processor Organization, Arithmetic Logic Unit, Design of Arithmetic Circuit, Design of Logic Circuit, Design of Arithmetic Logic Unit, Status Register, Design of Shifter, Processor Unit, Design of Accumulator.
Text 1: 7.7-7.8, 9.1-9.10

Self-study component:	Intel 4004, 8085 processors, ARM Machine and AMD's Processors.
Practical Topics:	1. Demonstration of 7489, 16 by 4 random access memory. 2. Realization of Shift operations using 7495.

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Program Outcome Addressed (PO #) with BTL**
CO1	Apply K-Map to simplify the Boolean functions and minimize logic circuits.	Apply	PO1(L3)
CO2	Analyze the combinational and sequential logic circuit for logic function and/or timing diagram.	Analyze	PO2(L4)
CO3	Develop and/or implement logic circuits for the given requirements/specifications using gates/flip-flops/MSI IC's/ROM/RAM/PLA/FPGA.	Create	PO3(L6)
CO4	Use knowledge of digital logic design and IC data to investigate the given logic design or logic system.	Investigate	PO4(L5)
CO5	Implement, test and verify logic circuit for given requirements and record/document the details.	Analysis and Create	PO3, PO9, PO10 (L4, L6)

Text Book(s):

1. M.Morris Mano, "Digital Logic and Computer Design",Pearson, 2020.ISBN: 978-93-325-4252-5.
2. Charles H Roth Jr, Larry L. Kinney, "Fundamentals of Logic Design",7 th Edition, Thomson Learning, 2019.ISBN-13: 978-81-315-2615-6.
3. Michael D. Ciletti, "Advanced Digital Design with the Verilog HDL", 2 nd Edition, Pearson, 2011. ISBN-13: 9780133002546

Reference Book(s):

1. John.M Yarbrough, "Digital logic applications and Design", Pearson, Thomson Learning,2006.ISBN: 981-240-62-1.

Web and Video link(s):

1.https://nptel.ac.in/courses/108106177 -Course by Neeraj Goel, IIT Ropar.

2. https://nptel.ac.in/courses/106105185 - Course by Indranil Sengupta, IIT Kharagpur.

3. https://ocw.mit.edu/courses/6-004-computation-structures-spring- 2017/pages/syllabus/ - Chris Terman, Massachusetts Institute of Technology.

E-Books/Resources:

Course Articulation Matrix (CAM)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
#1	3												3	
#2		2												2
#3			3											
#4				1										
#5			3						1	2				

Signals and Systems [As per Choice Based Credit System (CBCS) & OBE Scheme] **SEMESTER – III**			
Course Code:	**P22EC305**	**Credits:**	**04**
Teaching Hours/Week (L:T:P):	**3:0:2**	**CIE Marks:**	**50**
Total Theory Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Classify the signals and understand different operations on signals.
- Recognize the basic signals (both continuous- time and discrete-time) like impulse, unit step, ramp, sinusoids and exponentials, represented both in frequency and time domains.
- Characterize LTI system using impulse response and linear constant coefficient differential equations.
- Represent all types of signals (CT/DT, periodic/non-periodic) in terms of complex
- Define relationship between Z transform and Fourier transform.
- Implement the systems (any order) in Direct-form-I and Direct-form-II

UNIT – I	**8 Hours**

Continuous time and discrete time signals, transformations of the independent variable, exponential and sinusoidal signals, the unit impulse and unit step functions, Continuous-time and discrete-time systems, basic system properties.

Text1: 1.1,1.2,1.3,1.4, 1.6

Self-study component:	More problems on the periodicity, energy and power a signal.
Practical Topics:	1. Develop a MATLAB code to generate the CTS and DTS a. Periodic Signals b. Exponential Signals c. Sinusoidal Signals 2. Develop a MATLAB code to generate the CTS and DTS a. Exponentially Damped Sinusoidal Signals b. Step, Impulse and Ramp functions c. User defined functions

UNIT – II	**8 Hours**

Linear Time Invariant Systems: Discrete-time LTI systems- The Convolution sum, Continuous-time LTI systems- The Convolution integrals, properties of linear time-invariant systems, Causal LTI systems described by differential and difference equations,

Text1: 2.1 to 2.4.3

Self-study component:	1. Examples on the causality, time invariant and linearity of the system 2. Block diagram representation of systems (Direct form-I and Direct form-II)
Practical Topics:	1. Write a MATLAB code to simulate difference equation. 2. Write a MATLAB code to find the frequency response of LTI systems described by differential or difference equations. 3. Write a MATLAB code to perform convolution of signals.

UNIT – III	8 Hours
Fourier Representation of Continuous-time (CT) Signals: Fourier series representation of continuous-time periodic signals, Properties of continuous –Time Fourier Series. CT Non-Periodic Signals: Representation of Aperiodic signals: The continuous time Fourier transform, Properties of continuous- time Fourier Transform, Convolution property. **Text1:** 3.3, 3.5, 4.1,4.3,4.3.1,4.3.5,4.3.7, 4.4	
Self-study component:	1. Examples on the convolution of two discrete time signals and Fourier transform of the signal. 2. Properties of continuous- time Fourier Transform . 3. The fourier transform for periodic signals
Practical Topics:	1. Write a MATLAB code to generate Amplitude Modulated signal. 2. Write a MATLAB code to find the DTFS of the given signal.

UNIT – IV	8 Hours
Discretization of CT signals and Fourier Representation of Discrete-Time (DT) Signals **Sampling of CT Signals**- Representation Of continuous-Time signals by its samples: The sampling theorem, **Fourier Representation for DT Non Periodic Signals**: Representation of Aperiodic signals: The discrete- Time fourier Transform, Properties of the Discrete- Time Fourier transforms, Multiplication Property. **Text1:**7.1, 5.1, 5.3, 5.5	
Self-study component:	The Convolution property
Practical Topics:	1. Write a MATLAB code to find Poles and Zeros of LTI systems. 2. Write a MATLAB code to generate sampled signal of a discrete and Continuous-time signal.

UNIT – V	8 Hours
Z–Transforms: The Z – transform, the region of convergence for the Z-transform. The inverse Z-transform, properties of Z – transforms, System function algebra and block diagram representations, The Unilateral Z transform. **Text1:** 10.1,10.2,10.3,10.5,10.8,10.9	
Self-study component:	1. Find Z transform of the unit impulse, unit step, cosine signals and find the z transform using differentiation property 2. Analysis and characterization of LTI systems using Z-transforms.
Practical Topics:	1. Write a MATLAB code to find Z-transform and inverse of the Z-transform. 2. 2. Solve a given difference equation/system of linear equations [Z-transform].

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Program Outcome Addressed (PO #) with BTL**
CO1	Apply the basic knowledge of mathematics for signals and systems analysis	Apply	PO1(L1)
CO2	Analyze concepts of signals and systems in time and Frequency domain.	Analyze	PO2 (L4)

CO3	Analyze and investigate fundamental concepts of signals and systems to solve complex engineering problems.	Evaluate	PO3 (L4),PO4(L3)
CO4	Demonstrate the knowledge of concepts of signals and systems either in team or individually to address engineering problems using modern engineering tools	Creating	PO5, PO9, PO10

Text Book(s):

1. **"Signals and Systems",**V.Oppenheim, Alan Willsky and A.Hamid Nawab, Pearson education asia/PHI, 2nd edition, 2006. ISBN: 9789332550230, 9332550239
2. **"Signals and Systems",** Simon Haykin and Barry Van Veen, 2nd Edition John Wiley & Sons, 2nd edition 2008. ISBN:9788126512652, 8126512652

Reference Book(s):

1. **"Signals and systems",** H.P.Hsu, R.Ranjan, Schaum's outlines, TMH, 2006. ISBN:9780070669185, 007066918X
2. **"Signals and Systems",** A NagoorKani, McGraw Hill 2010 . ISBN: 9780070151390, 0070151393.
3. **"Fundamentals of Signals and Systems",** Michael J Roberts, Govind Sharma, McGraw Hill 2010. ISBN: 0070702217, 9780070702219.

Web and Video link(s):

- **https://www.youtube.com/watch?v=up55tuwestg&list=PLWPirh4EWFpHr_1ZCkuF9To YUrmujv9Aa**
- **https://www.youtube.com/watch?v=I_ZcZF-EWj8&list=PLWPirh4EWFpHr_1ZCkuF9ToYUrmujv9Aa&index=3**
- **https://www.youtube.com/watch?v=0nZYen9w_eo&list=PLyqSpQzTE6M8KJ-XQ1m2vl3nd2ZUqKEN8**
- **https://www.youtube.com/watch?v=uEIVDGbaE5c**

E-Books/Resources:

- **https://link.springer.com/book/10.1007/978-3-031-02545-7?page=2#book-header "Fundamentals of Signals & Systems" , Benoit Boulet, Charles River Media 2006, ISBN:1-58450-381-5, eISBN: 1-58450-660-1.**
- **https://mlichouri.files.wordpress.com/2013/10/fundamentals-of-signals-and-systems.pdf.**

D. Course Articulation Matrix (CAM)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
#1	3												3	
#2		3												3
#3			3	2										
#4					2				1	1				

Linear Integrated Circuit Laboratory

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – III

Course Code:	**P22ECL306**	**Credits:**	**01**
Teaching Hours/Week (L:T:P):	**0-0-2**	**CIE Marks:**	**50**
Contact Period:	**Lecture :2 Hr, Exam: 2Hr.**	**SEE Marks:**	**50**

Prerequisite: Basic Electronics and Basic Electricals**.**

Course Learning Objectives (CLOs)

This course aims to

1. Provide the basic knowledge of how to use CRO, signal generator, bread board, power supply, ammeter, voltmeter and how to rig-up the circuits.
2. Analyze the characteristics of MOSFET, Op-amp.
3. Design Inverting and Non-inverting amplifiers, Summing, Subtracting and Schmitt trigger circuit using Op-Amp.
4. Demonstrate the working of Integrator, Differentiating circuit, precision half wave and full wave rectifier using 741 IC
5. Design the RC phase shift oscillators using Op-amp.
6. Understanding the working DAC using Op-Amp and Voltage regulator using LM 317 IC regulator

Course Content

1. MOSFET drain and transfer characteristics
2. Op-amp RC phase shift oscillator.
3. Determining the Characteristic parameters of Op-Amp 741 IC,
4. Design of Inverting and Non-inverting amplifier using 741 IC
5. Op-amp as adder, subtractor and voltage follower
6. Op-amp as Integrator and Differentiator circuit
7. Precision half wave and full wave rectifier using 741 IC.
8. Design of Schmitt trigger and zero crossing detection using 741 IC
9. 4 bit R-2R DAC using Op-amp 741 IC
10. Voltage regulator using LM 317 IC regulator.

Open ended experiments

1. Conduct an experiment for the voltage level monitor to energize the LED when Vcc exceeds 16V. Use zener diode and 471 op-amp with single power supply
2. Conduct an experiment to sum two sinusoidal signals of peak amplitude 4v and clip the output level to 5v.
3. Conduct an experiment to clip negative half cycle at 2 V and invert the signal. Assume 5V p-p sinusoidal input signal.

Course Outcome (CO)

CO #	Course Outcome	Bloom Taxonomy Levels	Program Outcome Addressed (PO #) with BTL
CO1	**Apply** the knowledge of basic circuit concepts to experiment for understanding the basic operation and characteristics of 741 IC and MOSFET	Understand	PO1(L2)
CO2	**Conduct** experiments to demonstrate concepts related to application of op-amps.	Analyze	PO2 (L4)
CO3	**Design** the inverting and non-inverting amplifier, Schmitt trigger circuit, oscillator and voltage regulator for a given specification.	Creating	PO3 (L6)
CO4	**Investigate** to analyze and design the open ended experiment for a given specification.	Evaluating	PO4 (L5)
CO5	**Ability** to work effectively in a team to analyze and conduct an experiment for a given problem statement	Analyze	PO9 (L4)

Course Articulation Matrix (CAM)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
#1	1												1	
#2		3												3
#3			2											
#4				1										
#5									2					

BIOLOGY FOR ENGINEERS
[As per Choice Based Credit System (CBCS) & OBE Scheme]
SEMESTER – III

Course Code	**P22BFE308**	**CIE Marks**	**50**
Teaching Hours/Week (L: T:P: S)	**2:0:0:0**	**SEE Marks**	**50**
Credits	**02**	**Total Marks**	**100**

Course objectives:

- To familiarize the students with the basic biological concepts and their engineering applications.
- To enable the students with an understanding of biodesign principles to create novel devices and structures.
- To provide the students an appreciation of how biological systems can be re-designed as substitute products fornatural systems.
- To motivate the students develop the interdisciplinary vision of biological engineering.

Understanding Design Thinking

Definition of design - Design Vs Engineering Design– Difference between Design and Engineering Design– The General Design process Model – Design to Design thinking - Time line of Design thinking.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- ✓ Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflectiveand questioning /inquiry-based teaching.
- ✓ Instructions with interactions in classroom lectures (physical/hybrid).
- ✓ Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
- ✓ Flipped classroom sessions (~10% of the classes).
- ✓ Industrial visits, Guests talks and competitions for learning beyond the syllabus.
- ✓ Students' participation through audio-video based content creation for the syllabus (as assignments).
- ✓ Use of gamification tools (in both physical/hybrid classes) for creative learning outcomes.

Students' seminars (in solo or group) /oral presentations.

Module-1 **(5 Hours)**

BIOMOLECULES AND THEIR APPLICATIONS (QUALITATIVE):

Carbohydrates (cellulose-based water filters, PHA and PLA as bioplastics), Nucleic acids (DNA Vaccine for Rabies and RNA vaccines for Covid19, Forensics – DNA fingerprinting), Proteins (Proteins as food – whey protein and meat analogs, Plant based proteins), lipids (biodiesel, cleaning agents/detergents), Enzymes (glucose-oxidase in biosensors, lignolytic enzyme in bio-bleaching).

Module-2 **(5 Hours)**

HUMAN ORGAN SYSTEMS AND BIO DESIGNS - 1 (QUALITATIVE):

Brain as a CPU system (architecture, CNS and Peripheral Nervous System, signal transmission, EEG, Robotic arms for prosthetics. Engineering solutions for Parkinson's disease).Eye as a Camera system (architecture of rod and cone cells, optical corrections, cataract, lens materials, bionic eye).Heart as a pump system (architecture, electrical signalling - ECG monitoring and heart related issues, reasons for blockages of blood vessels, design of stents, pace makers, defibrillators).

Module-3	(5 Hours)

HUMAN ORGAN SYSTEMS AND BIO-DESIGNS - 2 (QUALITATIVE):

Lungs as purification system (architecture, gas exchange mechanisms, spirometry, abnormal lung physiology - COPD, Ventilators, Heart-lung machine).Kidney as a filtration system (architecture, mechanism of filtration, CKD, dialysis systems). Muscular and Skeletal Systems as scaffolds (architecture, mechanisms, bioengineering solutions for muscular dystrophy and osteoporosis).

Module-4	(5 Hours)

NATURE-BIOINSPIRED MATERIALS AND MECHANISMS (QUALITATIVE):

Echolocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf). Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Plant burrs (Velcro), Shark skin (Friction reducing swim suits), Kingfisher beak (Bullet train). Human Blood substitutes - hemoglobin-based oxygen carriers (HBOCs) and perflourocarbons (PFCs).

Module-5	(5 Hours)

TRENDS IN BIOENGINEERING (QUALITATIVE):

Bioprinting techniques and materials, 3D printing of ear, bone and skin. 3D printed foods. Electrical tongue and electrical nose in food science, DNA origami and Biocomputing, Bioimaging and Artificial Intelligence for disease diagnosis. Self- healing Bioconcrete (based on bacillus spores, calcium lactate nutrients and biomineralization processes) and

Bioremediation and Biomining via microbial surface adsorption (removal of heavy metals like Lead, Cadmium, Mercury, Arsenic).

Course outcomes (Course Skill Set)
At the end of the course the student will be able to:

- Elucidate the basic biological concepts via relevant industrial applications and case studies.
- Evaluate the principles of design and development, for exploring novel bioengineering projects.
- Corroborate the concepts of biomimetics for specific requirements.
- Think critically towards exploring innovative biobased solutions for socially relevant problems.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for**20 Marks** (**duration 01 hours**)

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 2 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module.

The SEE question paper will be set for 100 marks and marks scored will be proportionately reduced to 50 marks

Suggested Learning Resources:

- Human Physiology, Stuart Fox, Krista Rompolski, McGraw-Hill eBook. 16th Edition, 2022
- Biology for Engineers, Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012.
- Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011
- Biomedical Instrumentation, Leslie Cromwell, Prentice Hall 2011.
- Biology for Engineers, Sohini Singh and Tanu Allen, Vayu Education of India, New Delhi, 2014.
- Biomimetics: Nature-Based Innovation, Yoseph Bar-Cohen, 1st edition, 2012, CRC Press.
- Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, D. Floreano and C. Mattiussi, MIT Press, 2008.
- Bioremediation of heavy metals: bacterial participation, by C R Sunilkumar, N Geetha A C Udayashankar Lambert Academic Publishing, 2019.
- 3D Bioprinting: Fundamentals, Principles and Applications by Ibrahim Ozbolat, Academic Press, 2016.
- Electronic Noses and Tongues in Food Science, Maria Rodriguez Mende, Academic Press, 2016
- Blood Substitutes, Robert Winslow, Elsevier, 2005

Web links and Video Lectures (e-Resources):

- VTU EDUSAT / SWAYAM / NPTEL / MOOCS / Coursera / MIT-open learning resource
- https://nptel.ac.in/courses/121106008
- https://freevideolectures.com/course/4877/nptel-biology-engineers-other-non-biologists
- https://ocw.mit.edu/courses/20-020-introduction-to-biological-engineering-design-spring-2009
- https://ocw.mit.edu/courses/20-010j-introduction-to-bioengineering-be-010j-spring-2006
- https://www.coursera.org/courses?query=biology
- https://onlinecourses.nptel.ac.in/noc19_ge31/preview
- https://www.classcentral.com/subject/biology
- https://www.futurelearn.com/courses/biology-basic-concepts

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Group Discussion of Case studies
- Model Making and seminar/poster presentations
- Design of novel device/equipment like Cellulose-based water filters, Filtration system mimicking the kidney, Bioremediation unit for E-waste management, AI and ML based Bioimaging,

Course Title :ADDITIONAL MATHEMATICS-I (P21MATDIP301) **SEMESTER – III (Lateral Entry: Common to all branches)**		
Course Code: P22MATDIP301		**CIE Marks:50**
Credits: L:T:P:S: 3:1:0:0		
No of lecture hours per week: 04 :L=2,T=2		

Course Learning Objectives**: The mandatory learning course** P21MATDIP31 **viz.,** Additional Mathematics-I **aims to provide basic concepts of complex trigonometry, vector algebra, differential & integral calculus, vector differentiation and various methods of solving first order differential equations.**

UNIT – I	**12 Hours**

Complex Trigonometry: Complex Numbers: Definitions & properties. Modulus and amplitude of a complex number, Argand's diagram, De-Moivre's theorem (without proof).
Vector Algebra: Scalar and vectors. Vectors addition and subtraction. Multiplication of vectors (Dot and Cross products). Scalar and vector triple products-simple problems

Self-study component:	De-Moivre's theorem (without proof). Roots of complex number - Simple problems.

UNIT – II	**10 Hours**

Differential Calculus: Polar curves –angle between the radius vector and the tangent pedal equation-Problems. Taylors series and Maclaurin's series expansions- Illustrative examples.
Partial Differentiation: Elimentary problems. Euler's theorem for homogeneous functions of two variables. Total derivatives-differentiation of composite and implicit function**.**

Self-study component:	Review of successive differentiation. Formulae for n^{th} derivatives of standard functions- Liebnitz's theorem (without proof). Application to Jacobians, errors & approximations.

UNIT – III	**10 Hours**

Integral Calculus: reduction formulae for $sin^n x$, $cos^n x$, and $sin^m x cos^m x$ and evaluation of these with standard limits-Examples. Applications of integration to area, length of a given curve, volume and surface area of solids of revolution.

Self-study component:	Differentiation under integral sign (Integrals with constants limits)-Simple problems.

UNIT – IV	**10 Hours**

Vector Differentiation: Differentiation of vector functions. Velocity and acceleration of a particle moving on a space curve. Scalar and vector point functions. Gradient, Divergence, Curl and Laplacian (Definitions only).

Self-study component:	Solenoidal and irrotational vector fields-Problems.

UNIT – V	**10 Hours**

Ordinary differential equations (ODE's): Introduction-solutions of first order and first degree differential equations: homogeneous, exact, linear differential equations of order one and equations reducible to above types.

Self-study component:	Applications of first order and first degree ODE's - Orthogonal trajectories of Cartesian and polar curves. Newton's law of cooling, R-L circuits- Simple illustrative examples from engineering field.

Course Outcomes: After the successful completion of the course, the students are able to	
CO1	Demonstrate the fundamental concepts –in complex numbers and vector algebra to analyze the problems arising in related area of engineering field.
CO2	Identify – partial derivatives to calculate rate of change of multivariate functions
CO3	Apply - the acquired knowledge of integration and differentiation to evaluate double and triple integrals to compute length surface area and volume of solids of revolution and indentify velocity, acceleration of a particle moving in a space
CO4	Find analytical solutions by solving first order ODE's which arising in different branches of engineering.

Text Book:

B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, New Delhi, 43rd Ed., 2015.

Reference books:

1. E. Kreyszig: Advanced Engineering Mathematics, John Wiley & Sons, 10th Ed., 2015.
2. N.P.Bali and Manish Goyal: Engineering Mathematics, Laxmi Publishers,7th Ed., 2007.

Course Title	MATHEMATICAL AND NUMERICAL TECHNIQUE **(COMMON TO EC,EE, CS, IS)**						
Course Code	**P22MA401B**						
Category	**Mathematics for EC,EE, CS, IS**						
Scheme and Credits	Theory/Practical/Integrated					Total teaching hours	Credits
	L	T	P	SS	Total		
	02	02	0	00	04	40	04
CIE Marks: 50	**SEE Marks: 50**		**Total Max. marks=100**		**Duration of SEE: 03 Hours**		

Course Learning Objectives:	
1	**Familiarize** the importance of calculus associated with one variable and two variables.
2	**Analyze** Engineering problems by applying Ordinary Differential Equations
3	**Develop** the knowledge of Linear Algebra to solve system of equation by using matrices

Unit	**Syllabus content**	**No. of hours**	
		Theory	**Tutorial**
I	**Calculus of complex functions**: Introduction to complex variables. Definitions- limit, continuity, differentiability and Analytic functions of f(z) : Cauchy- Riemann equations in Cartesian and polar forms (no proof)-Harmonic function and Problems. Applications to flow problems. Construction of analytic functions when $u \text{ or } v \text{ or } u \pm v$ are given- Milne-Thomson method. Conformal transformations: Introduction. Discussion of transformations for $W = z^2, W = e^z, W = z + {}^1/_z \text{ where } z \neq 0$	06	02
	Self-Study: Derivation of Cauchy- Riemann equation in Cartesian and polar form		
II	**Complex integration:** Bilinear Transformations- Problems, line integrals of complex function. Cauchy's theorem, Cauchy's integral formula. Taylor's and Laurent's series (Statements only)- illustrative examples. Singularities, poles and residues with examples, Cauchy's Residues Theorem (statement only)- Illustrative examples.	06	02
	Self-Study:– Contour integration Type-I & Type-II problems		
III	**Statistical Methods:** **Statistics:** Brief review of measures of central tendency and dispersion. Moments, skewness and kurtosis. **Curve Fitting:** Curve fitting by the method of least squares, fitting the curves of the forms $= ax + b$, $y = ab^x$ and $y = ax^2 + bx + c$. **Correlation and regression**: Karl Pearson's coefficient of correlation and rank correlation- problems, Regression analysis, lines of regression and problems.	06	02
	Self-Study: **Self-Study**: Fit a curve of the form $y = ax + b, y = a + bx + cx^2$		

IV	**Probability and Distribution:** **Random variables and Probability Distributions:** Review of random variables. Discrete andcontinuous random variables-problems. Binomial, Poisson, Exponential and Normal distributions (with usual notation of mean and variance)-:problems. **Joint Probability Distributions :** Introduction,Joint probability and Joint distribution of discrete random variables and continuous random variables	06	02
	Self-study: Geometric and Gamma distributions- problems.		
V	**Stochastic Processess and sampling theory**: **Markov Chains**: Markov chains, Classification of Stochastic processes, Probability vector, Stochastic matrix, Regular stochastic matrix, Transition probabilities and Transition probability matrix. **Testing of Hypothesis**: Sampling distributions-introduction. Standard error, Type-I and Type-II errors. Testing of hypothesis and confidence intervals for means. Student's t –distribution and Chi-square distribution as a test of goodness of fit - Illustrative examples only.	06	02
	Self-study: Classification of Stochastic process, Bernoulli Process, Poisson Process.		

COURSE OUTCOMES: On completion of the course, student should be able to:	
CO1:	**Understand** fundamental concepts in calculus of complex functions, statistics, probability and special functions.
CO2:	Apply tools taught to analyze transformations arising in engineering field and evaluate complex integrals and draw statistical inferences.
CO3:	**Analyze** problems in engineering field by employing special functions, complex functions and statistical methods.
CO4:	**Evaluate** integrals of complex functions, regression and correlation coefficient, probability of a discrete and continuous variable, series solution of special differential equations.

TEACHING - LEARNING PROCESS: Chalk and Talk, power point presentation, animations, videos

TEXT BOOKS

1. B.S. Grewal, Higher Engineering Mathematics (44th Edition 2018), Khanna Publishers, New Delhi.
2. E. Kreysizig, Advanced Engineering Mathematics, John Wiley and sons, 10th Ed. (Reprint) 2016.

REFERENCE BOOKS .

1. V. Ramana: Higher Engineering Mathematics, McGraw –Hill Education,11th Ed..
2. H. C. Taneja, Advanced Engineering Mathematics, Volume I & II, I.K. International PublishingHouse Pvt. Ltd., New Delhi.
3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications,Reprint, 2010.

ONLINE RESOURCES

1. **http://www.nptel.ac.in**
2. **https://en.wikipedia.org**
3. **https://ocw.mit.edu/courses/18-03sc-differential-equations-fall-2011/**
4. **https://ocw.mit.edu/courses/18-06sc-linear-algebra-fall-2011/**
5. **https://math.hmc.edu/calculus/hmc-mathematics-calculus-online-tutorials/differential-equations/first-order-differential-equations/**

QUESTION PAPER PATTERN (SEE)	
PART-A	PART-B
One question from each unit carrying two	Answer any **TWO** sub questions for maximum 18 marks

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**2**	**2**										
CO2	**2**	**3**										
CO3	**3**	**2**										
CO4	**2**	**3**										
Strength of correlation: Low-1, Medium- 2, High-3												

Analog and Digital Communication

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – IV

Course Code:	**P22EC402**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3 : 0 : 0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Analyze the elements of communication system provide basic knowledge of Modulation, generation, detection and application of Amplitude and Angle modulation of signal in time domain and frequency domain.
- Explain the aspects of sampling of signal in digital communication, the model of digital communication system and outline the use of correlation.
- Explain quantization process, quantities and commanding of signals in PCM system.
- Describe the principle of DM, ADM, DPCM systems.
- Describe and contrast various aspects of different digital coherent and non-coherent modulation schemes such as ASK, PSK, QPSK, DPSK and MSK.
- Analyze different coding schemes adopted in PAM signaling and explain the causes for the occurrence of ISI and advantages of pulse shaping and correlation coding.

UNIT – I	**8 Hours**

AMPLITUDE MODULATIONS AND DEMODULATIONS: Baseband versus carrier communications, Double-sideband amplitude modulation, Amplitude modulation, bandwidth-efficient amplitude modulations, Amplitude modulations: Vestigial sideband (VSB),Local carrier synchronization.

Text 1: 3.1-3.6

Self-study component:	Single side band modulation**,** Frequency Division Multiplexing **(FDM),** Phase locked loop.

UNIT – II	**8 Hours**

ANGLE MODULATION AND DEMODULATION: Nonlinear modulation, bandwidth of angle-modulated waves, generating FM waves, demodulation of FM signals, effects of nonlinear distortion and interference, super heterodyne analog AM/FM receivers.

Text 1: 4.1-4.7

Self-study component:	FM broadcasting system, QAM.

UNIT – III	**8 Hours**

SAMPLING: Sampling theorem, Signal Reconstruction from Uniform Samples, Practical Issues in Signal Sampling and Reconstruction, Maximum Information Rate: Two Pieces of Information per Second per Hertz, Non ideal Practical Sampling Analysis, Some Applications of the Sampling theorem, Pulse Code Modulation (PCM),Advantages of Digital Communication, Quantizing, Principle of Progressive Taxation: Non uniform Quantization, Transmission Bandwidth and the Output SNR, Digital Telephony: PCM in T1carrier systems.

Text 1:5.1-5.3

Self-study component:	Random Variables, Mat lab/Octave code for Sampling and Reconstruction of Low pass Signals

UNIT – IV	**8 Hours**

ANALOG-TO-DIGITAL CONVERSION: Digital Multiplexing, Differential Pulse Code Modulation (DPCM), Adaptive Differential PCM (ADPCM), Delta Modulation.

PRINCIPLES OF DIGITAL DATA TRANSMISSION: Digital communication systems, Line coding, Pulse shaping, Scrambling, Digital receivers and regenerative repeaters.

Text 1: 5.4-5.7, 8.1-8.5

Self-study component:	Adaptive delta modulation**,** Video Compression

UNIT – V	**8 Hours**

DIGITAL COMMUNICATION SYSTEM: Eye diagrams, PAM: M-ary baseband signaling for higher data rate, Digital carrier systems, M-ary digital carrier modulation, Optimum linear detector for binary polar signaling, general binary signaling, coherent receivers for digital carrier modulations, Signal space analysis of optimum detection.

Text 1:8.6-8.9, 9.1-9.4

Self-study component:	Noise in Communication systems.

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Program Outcome Addressed (PO #) with BTL**
CO1	Apply the basic knowledge of mathematics for Formulation and analysis of Analog and Digital communication system.	Understand and Apply	PO1(L2), PO2(L3)
CO2	Identify and Analyze performance of different modulation schemes and coherent receivers, including their effects on signal integrity and system efficiency in real-world scenarios.	Apply	PO1(L3), PO2(L3)
CO3	Design and assess digital communication techniques, such as pulse shaping, coding, and modulation, to enhance signal transmission efficiency, reduce distortion, and mitigate errors in analog and digital communication systems	Analyze	PO2(L3), PO3(L4)
CO4	Evaluate the process of analog-to-digital conversion, including sampling, quantization, and encoding, to optimize signal transmission quality and minimize noise in digital communication systems	Analyze	PO2(L3)

Text Book(s):

1. **"Modern Digital and Analog Communication Systems",** B.P. Lathi .Zhi Ding,Hari M.Gupta 4th Edition ISBN-13:978-0-19-947628-2, ISBN-10:0-19-947628-4.

Reference Book(s):

1. **"An Introduction to analog and digital communications",** Simon Haykin, John Wiley and Sons, Inc.2013, ISBN:9788126536535.
2. **"Digital Communication",** P. Ramakrishna Rao, TATA cGraw Hill, 2011, ISBN:9780070707764.
3. **"Principles of Electronic Communication Systems",** Louis E. Frenzel, Jr. TATA McGraw Hill ,Fourth Edition, ISBN : 978-0-07-337385-0

Web and Video link(s):

1. **Analog Communication: https://archive.nptel.ac.in/courses/117/105/117105143/**
2. **Digital Communication: https://nptel.ac.in/courses/117105077**
3. **Modern Digital Communication Techniques: https://onlinecourses.nptel.ac.in/noc22_ee118/preview**

E-Books/Resources:

1. **https://www.skylineuniversity.ac.ae/pdf/computer/An%20Introduction%20to%20Digital%20Multimedia.pdf**
2. **https://edisciplinas.usp.br/pluginfile.php/5251120/mod_resource/content/1/B.%20P.%20Lathi%2C%20Zhi%20Ding%20%20Modern%20Digital%20and%20Analog%20Communication%20SystemsOxford%20University%20Press%20%282009%29.pdf**

D. Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
#1	2	1											2	1
#2	3	1											3	1
#3		2	1											2
#4		2												2

Electromagnetic Field Theory

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – IV

Course Code:	**P22EC403**	**Credits:**	**03**
Teaching Hours/Week (L:T:P):	**3:0:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Provide the basic knowledge of electromagnetic fields and waves of radio communication.
- Describe the basic laws, properties and equations of static electric field using 3– dimensional vector method.
- Understand the basic laws, properties and equations of static magnetic field using 3 – dimensional vector method.
- Analyse the concepts of magnetic forces and inductance.
- Extend the Maxwell's equations to time varying electromagnetic waves.
- llustrate the properties of electromagnetic waves.

UNIT – I	**8 Hours**

Electrostatic Fields Part1: Coulomb's law and Field intensity, Electric fields due to Continuous charge distributions- line charge, surface charge, Electric Flux density, divergence of a vector and divergence theorem, Gauss law, Application of Gauss's Law: Point charge, Infinite Line charge.

Text 1: 3.6,4.2 to 4.6.

Self-study component:	1. Vectors and Co-ordinate Systems: Cartesian Coordinates, Cylindrical Coordinates, Spherical Coordinates. 2. Applications of Gauss law

UNIT – II	**8 Hours**

Electrostatic Fields Part 2: Electric potential, Del operator, gradient of a scalar, Relationship between E and V, An Electric Dipole and Flux lines.

Electric Fields in material Space: Convection and Conduction current, Continuity equations and Relaxation time, Boundary conditions.

Electrostatic Boundary–value Problems: Poisson's and Laplace's equations, Uniqueness Theorem

Text1:3.4, 3.5, 4.7 to 4.9, 5.3, 5.8, 5.9, 6.2 to 6.3.

Self-study component:	1. Energy density in electrostatic fields 2. Resistance and Capacitance

UNIT – III	**8 Hours**

Magnetostatics Fields: Biot– Savart's law, Ampere's circuital law, applications of Ampere's law, magnetic flux density, Curl of a vector and Stroke theorem, Maxwell's equations for static fields, Magnetic scalar and vector potentials.

Magnetic Forces: Forces due to magnetic fields, A magnetic dipole, magnetic boundary conditions.

Text 1:7.2-7.7, 3.7, 8.2, 8.4, 8.7

Self-study component:	**1.** Magnetic torque and moment. 2. Inductors and inductance.

UNIT – IV	**8 Hours**

forces, displacement current, Maxwell's equations in final forms, Time Varying Potential.

Electromagnetic Wave Propagation: Introduction, Waves in general, Wave propagation in Lossy dielectrics, Plane waves in free space, Wave Polarization, Power and Poynting Vector.

Text 1:9.2-9.6, 10.2, 10.3, 10.5,10.7, 10.8

Self-study component:	1. Plane waves in Losses dielectrics and Good Conductors. 2. Reflection of plane wave in normal incidence.

UNIT – V	**8 Hours**

Basics of Wave Propagation: Introduction, Definition and Broad Categorization, Basic Definition, Guided Waves, Unguided Waves, Different modes of wave propagation.
Ground Wave Propagation: Introduction, Space Wave and Surface Wave, Transition between Surface and Space Wave, Tilt of Wave Front due to Ground Losses.
Space Wave Propagation: Introduction, Field Strength Relation, Effects of Imperfect Earth, Effects of Curvature of Earth, Effects of Interference Zone, Shadowing Effect of Hills and Buildings.
Sky Wave Propagation: Introduction, Structural Details of the Ionosphere, Refraction and Reflection of Sky Waves by Ionosphere, Ray Path, Critical Frequency, MUF, LUF of,Virtual Height and Skip Distance, Relation between MUF and the Skip Distance.
Text 2:22.1-22.2, 22.5**,** 23.1, 23.3 to 23.5, 24.1 to 24.6, 25.1, 25.2, 25.4, 25.5, 25.6.

Self-study component:	1. Scattering Phenomena, Tropospheric Propagation, Fading, Path Loss Calculations. 2. Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC).

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	**Apply** the knowledge of physics and vector calculus to compute parameters of static Electric and Magnetic fields.	Apply	PO1(L3)
CO2	**Analyze** Electric and Magnetic fields to solve boundary value problems	Analyze	PO2(L4)
CO3	**Evaluate the pa** time-varying electromagnetic fields and waves as governed by Maxwell's equations.	Evaluate	PO3 (L5)
CO4	**Design** solutions for applications in electric and electronic circuits and communication systems	Design	PO5, PO9,PO10, (L6)

Text Book(s):

1. **"Principles of Electromagnetics"** Matthew N.O. Sadiku, S.V Kulkarni Oxford University Press 6th edition, 2018.ISBN-13: 978-0-19-946185-1, ISBN-10:0-19-946185-6
2. **"Antennas and Wave Propagation",** John D Kraus, Ronald J Marhefka and Ahmed S Khan, Tata McGraw Hill, 4th Edition, 2015.ISBN: 9780070671553.

Reference Book(s):

1. **"Electromagnetics with Application"**, John Kraus and Daniel .A. Fleischer, McGraw Hill, 5th edition 1999.ISBN: 9780071164290
2. **"Electromagnetics",** Joseph A Edminister, Adapted by: Vishnu priye. McGraw–Hill, Revised 2nd edition, 2013.ISBN:9780070353961
3. **"Engineering Electromagnetics"**, William H. Hayt Jr. John A. Buck and M Jaleel Akhtar McGraw–Hill, 8th edition, 2015. ISBN: 9789339203276

Web and Video link(s):

https://archive.nptel.ac.in/courses/108/106/108106073/

E-Books/Resources:

1. Electromagnetic Fields and Energy By Hermann A. Haus | James R. Melcher | 1998 PDF
2. Electromagnetic Field Theory: A Problem Solving Approach By Markus Zahn | 2003 | 752 pages PDF
3. Introduction to Electromagnetic Engineering by Roger F.Harrington – McGraw-Hill, 1958

D. Course Articulation Matrix (CAM)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
#1	3												2	
#2		2											3	
#3			2											2
#4					1				1	1				2

Digital Design Using Verilog HDL [As per Choice Based Credit System (CBCS) & OBE Scheme] **SEMESTER – IV**			
Course Code:	**P22EC404**	**Credits:**	**04**
Teaching Hours/Week (L:T:P):	**3:0:2**	**CIE Marks:**	**50**
Total Theory Teaching Hours:	**40**	**SEE Mrks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Explain the working knowledge of a broad variety of Verilog based topic for global understating of Verilog HDL based design.
- Describe the practical design perspective of Verilog HDL.
- Explain the logical progression of Verilog HDL based topics.
- Explain the basics and some advanced topics such as PLI and logic synthesis.

UNIT – I	**8 Hours**

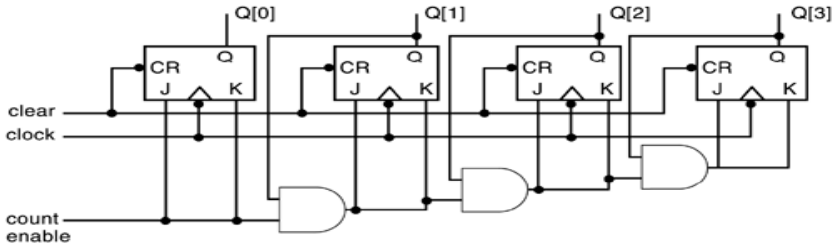
Basic Concepts: Lexical Conventions, Data Types, System Tasks and Compiler Directives.
Modules and Ports: Modules, Ports, Hierarchical Names.
Gate-Level Modeling: Gate Types, Gate Delays.
Dataflow Modeling: Continuous Assignments, Delays, Expressions, Operators, and Operands, Operator Types, Examples.

Self-study component:	Develop a Verilog code and test bench for following question and verify it by using any EDA tool (Xilinx/libero/vivado/ iverilogetc.). 1. Study typical design flow for designing VLSI Circuits. 2. Design 2 to 1 mux using bufif0 and bufif1. 3. Design 4 bit mod 13 counter and display all input and output values in command window.
Practical Components	1. Write Verilog HDL code to realize all the logic gates. 2. Write a Verilog HDL program for the following combinational designs a. Decoder b. Encoder (with and without priority)

UNIT – II	**8 Hours**

Behavioral Modeling: Structured Procedures, Procedural Assignments, Timing Controls, Conditional Statements, Multiway Branching, Loops, Sequential and Parallel Blocks, Generate Blocks. Examples.
Tasks and Functions: Difference between Tasks and Functions, Tasks, Functions.

Self-study component:	1. Design 8-bit ALU Using task or function. 2. Design clock with time period = 80 and duty cycle of 40 % using always & initial statement.
Practical Components	1. Write a Verilog HDL program for the following combinational designs. a. Multiplexer and Demultiplexer b. Code converter. c. Comparator. 2. Write a VERILOG HDL code to describe the functions of a Full Adder, parallel adder and subtractor using three Modeling styles.

UNIT – III	**8 Hours**
Useful Modeling Techniques: Procedural Continuous Assignments, Overriding Parameters, Conditional Compilation and Execution, Time Scales, Useful System Tasks. **Timing and Delays:** Types of Delay Models, Path Delay Modeling, Timing Checks, Delay Back-Annotation. **Switch Level Modeling:** Switching-Modeling Elements, Examples.	
Self-study component:	1. Design 16 to 1 mux using 4 to 1 mux and display all input and output values in command window. 2. Create a design that uses the full adder example above. Use a conditional compilation (`ifdef). Compile the fulladd4 with defparam statements if the text macro DPARAM is defined by the define statement; otherwise, compile the fulladd4 with module instance parameter values. 3. Switch Level Verilog Description for XOR gate.
Practical Components	1. Develop and simulate a VERILOG HDL code for 8-bit booth Multiplier. 2. Develop the VERILOG HDL code for the following flip–flops, SR, D, JK, T and counter
UNIT – IV	**8 Hours**
User Defined Primitives: UDP basics. Combinational UDPs, Sequential UDPs, UDP Table Shorthand Symbols, Guidelines for UDP Design. **Programming Language Interface:** Uses of PLI, Linking and Invocation of PLI Tasks.Internal Data Representation, PLI Library Routines. **Logic Synthesis with Verilog HDL:** What Is Logic Synthesis? Impact of Logic Synthesis, Verilog HDL Synthesis, Synthesis Design Flow.	
Self-study component:	1. Design the 4-bit synchronous counter shown below (Use the UDP jk_ff). 
Practical Components	1. Design and develop VERILOG HDL code for a 4-bit binary serial adder and simulate. 2. Write VERILOG HDL code to display messages on the given seven segment display and LCD and accepting Hex key pad input data. 3. Write VERILOG HDL code to control speed, direction of DC and Stepper motor.

UNIT – V	8 Hours

Logic Synthesis with Verilog HDL: Verification of the Gate-Level Netlist, Modeling Tips for Logic Synthesis, Example of Sequential Circuit Synthesis.

Advanced Verification Techniques: Traditional Verification Flow, Assertion Checking, Formal Verification.

Self-study component:	1. A 1-bit full subtractor has three inputs x, y, and z (previous borrow) and two outputs D(difference) and B(borrow). The logic equations for D and B are as follows: • D = x'y'z + x'yz' + xy'z' + xyz • B = x'y + x'z +yz 2. Write the Verilog RTL description for the full subtractor. Synthesize the full subtractor, using any technology library available to you. Optimize for fastest timing. Apply identical stimulus to the RTL and the gate-level netlist and compare the output.
Practical Components (4 Hours)	1. Write VERILOG HDL code to accept 8 channel Analog signals, Temperature sensors and display the data on LCD panel or seven segment display. 2. Write VERILOG HDL code to generate different waveforms (Sine, Square, Triangle, Ramp etc.,) using DAC change the frequency and amplitude. 3. Write VERILOG HDL code to simulate Elevator operations.

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Level Indicator**
CO1	**Apply** the knowledge of digital fundamentals to understand the basic concepts in Verilog HDL and writing the Verilog model for combinational and sequential circuits.	L2	PO1(L2)
CO2	**Analyze** the given digital circuit and develop Verilog model for given digital circuits.	L4	PO2(L4)
CO3	**Develop** any combinational and sequential circuits and develop Verilog model for the given specifications.	L6	PO3(L6)
CO4	To **verify** the design through synthesis and demonstrate the application using EDA tools.	L3	PO4(L3) PO5(L6),PO9(L3), PO10(L3)

Text Book(s):

1. **"Verilog® HDL, A Guide to Digital Design and Synthesis",** Samir Palnitkar Pearson Education, Second Edition, ISBN 978-81-775-918-4.

Reference Book(s):

1. **"Advanced Digital Design with the Verilog HDL",** Michael DCiletti, PHI, ISBN: 9789332584464, 933258446X**.**
2. **"A Verilog HDL Primer",** J. Bhaskar, BS Publications, ISBN: 9788178000145, 8178000148
3. **"Fundamentals of Digital Logic with Verilog Design",** Stephen brown and ZvonkoVranesic, TMH, ISBN: 9780073380544, 0073380547

Web and Video link(s):

1. https://youtu.be/VS9JzfJ6Oxg
2. https://youtu.be/wiNDn19GpRU

E-Books/Resources:

D. Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
#1	2												2	
#2		3												3
#3			2											
#4				1	2				2	1				

Microcontroller [As per Choice Based Credit System (CBCS) & OBE Scheme] **SEMESTER – IV**			
Course Code:	**P22EC405**	**Credits:**	**04**
Teaching Hours/Week (L:T:P):	**3:0:2**	**CIE Marks:**	**50**
Total Theory Teaching Hours:	**40**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable the students to:

- Provide the basic knowledge of embedded systems.
- Outline the architecture of MSP430.
- Make use of the instruction sets and addressing modes for writing programs.
- Understand working and applications of interrupts.
- Utilize the Low-Power Modes for the Operation of MSP430
- Summarize the operation and utilization of timers.

UNIT – I	**8 Hours**

Embedded Electronic Systems and Microcontrollers: What and where are embedded systems, Approaches to Embedded Systems, Small Microcontrollers, Anatomy of a Typical Small Microcontroller, Memory, and Software.

The Texas Instruments MSP430: The Outside View—Pin-Out, the Inside View—Functional Block Diagram, Memory, Memory Mapped input and output, Clock Generator, Exceptions: Interrupts and Resets.

Text1:1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 2.1, 2.2, 2.3, 2.5, 2.6, 2.7.

Self-study component:	1. Study and understand the application of MSP430 in real time applications. 2. Understand the environmental development to develop programs for microcontroller.
Practical Topics: (6 Hours)	1. Arithmetic operation -Addition, Subtraction, multiplication, division,incrementing, decrementing operations. 2. Data transfer- Block move and exchange, sorting, finding largest and smallest element in an array.

UNIT – II	**8 Hours**

Architecture of the MSP430 Processor: Central Processing Unit, Addressing Modes, Constant Generator and Emulated Instructions, Instruction set, Examples, Reflections on the CPU and Instruction Set, Resets, Clock system.

Text1:5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8.

Self-study component:	1. Light LED's in C and Assembly Language. 2. Access to the microcontroller for programming and debugging along with demonstration boards
Practical Topics:	1. Boolean and logical instructions: AND, OR, XOR, NOT, rotate and swap operations, Conditional CALL and RETURN. Interfacing experiments: 2. Program to blink the LED's using on-chip timer.

UNIT – III	8 Hours
Functions, Interrupts and Low-Power Modes: Functions and Subroutines, What happens when a Subroutine is called?, Storage for Local Variables, Passing Parameters to a Subroutine and Returning a Result, Interrupts, what happens when an interrupt is requested?, Interrupt Service Routines, Issues Associated with Interrupts, Low-Power Modes of Operation. **Text1:** 6.1, 6.2, 6.3, 6.4, 6.6, 6.7, 6.8, 6.9, 6.10.	
Self-study component:	1. Study of assembly language/ c-programming tools with programming exercises. 2. Develop and Implement a assembly level program to Flash LED's with frequency of 1Hz using software delay and subroutine.
Practical Topics:	1. Interfacing an LCD unit to MSP430F2013. 2. Generation of different wave forms using DAC interface.
UNIT – IV	**8 Hours**
Timers: Watchdog Timer, BasicTimer1, Timer_A, Measurement in the Capture Mode, Measurement of time: Press and Release of button, Output in the Continuous Mode, operation of Timer_A in the sampling mode, Timer_B, what Timer where? **Text1:**8.1, 8.2, 8.3, 8.4, 8.4.1, 8.5, 8.8, 8.9, 8.10.	
Self-study component:	1. Study of ouput in the up mode- Edge-Aligned PWM. 2. Design and develop a assembly level program to generate pseudorandom stream of bits using shift register.
Practical Topics:	1. Stepper motor interface and speed control of stepper motor. 2. Measurement of pressure, temperature, weight.
UNIT – V	**8 Hours**
Mixed signal system: Analog input and output: Comparator, Analog-to-Digital Conversion: General Issues, Analog-to-Digital Conversion: Successive Approximation, Operation of a switched capacitor SAR ADC. TheADC10 Successive-Approximation ADC, Basic Operation of the ADC10, ADC conversion Sigma-Delta. **Text1:**9.1, 9.2, 9.3, 9.3.1, 9.4, 9.5, 9.8.	
Self-study component:	1. Study of ADC12 Successive-Approximation ADC. 2. Examine whether direct connection to a MSP430 is sufficient or further connection of the signal is required for conversions of analog signals to digital signals.
Practical Topics:	1. Measurement of time and frequency using timers and interrupts. 2. Temperature monitoring system.

Course Outcomes: On completion of this course, students are able to:

COs	**Course Outcomes** with ***Action verbs*** for the Course topics	**Bloom's Taxonomy Level**	**Program Outcome Addressed (PO #) with BTL**
CO1	Apply the knowledge of logic design to understand the concept of 16-bit Microcontroller (MC), its instruction set, addressing modes and other features.	Understand	PO1(L2)
CO2	Analyze the working of different peripheral components associated with MSP430 MC	Analyze	PO2 (L4)

CO3	Develop logical skills to write programs using MSP430 instruction set and by using 'C' for the given Engineering Problems.	Creating	PO3 (L6)
CO4	Investigate to analyze and write a software code using modern tool for a given specification.	Evaluating	PO4, PO5 (L5)
CO5	Ability to work indusial and in a team effectively to analyze and write a report for a given problem	Analyze	PO9, PO10 (L4)

Text Book(s):

1. **"MSP430 Microcontrollers Basics",** John H. Davies, Newnes (Elsevier Science), 2008, ISBN: 978-0-7506-8276-3

Reference Book(s):

1. ,**"Getting Started with the MSP430 Launchpad",** Adrian Fernandez, Dung Dang**,**Newnes (Elsevier Science), 2013, ISBN: 978-0-124116009
2. **"Programmable Microcontrollers with Applications: MSP430 LaunchPad with CCS and Grace"** Cem Unsalan, H. Deniz Gurhan, McGraw Hill Publications, 2013, ISBN: 978-0071830034.

Web and Video link(s):

https://www.youtube.com/watch?v=l6M7aqN6dmo

E-Books/Resources:

https://www.academia.edu/38330666/MSP430_Microcontroller_Basics_John_H_Davies

D. Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
#1	2												2	
#2		3												3
#3			2											
#4				1	2									
#5									2	1				

Analog and Digital Communication Laboratory

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – IV

Course Code:	**P22ECL406**	**Credits:**	**01**
Teaching Hours/Week (L:T:P):	**0-0-2**	**CIE Marks:**	**50**
Contact Period:	**Lab: 36 Hrs., Exam: 3 Hrs.**	**SEE Marks:**	**50**

Course Learning Objectives (CLOs)

This course aims to:

- Provide the basic practical knowledge of Analog and Digital Fiber Optic links, laser, diode characterization and attenuation.
- Demonstrate the measurement of various parameters of Optical fiber losses, Numerical Aperture and WDM MUX- DEMUX.
- Demonstrate the generation and detection of analog signals using various modulation techniques such as AM, PAM.
- Provide the basic practical knowledge of digital modulation & demodulation.
- Design and Analyze the frequency response of Second order active filters using op-Amp and Astable multi-vibrators.

Course Content

All the following experiments have to be performed using discrete components and modules.

1. Analog and Digital Fibre optic links. Attenuation, Bending loss and Numerical aperture measurement of optical fibre.
2. Characterization of WDM MUX and DEMUX.
3. Time Division Multiplexing of signals (Using PAM Kit).
4. Amplitude Modulation and Detection in time domain and its observation in frequency domain (Use Spectrum Analyser).
5. Demonstration of ASK, FSK, PSK and DPSK modulation and Demodulation.
6. Simulation of QPSK transmitter and receiver taking into account the phase and the frequency offset (Using WICOMM–T Kit).
7. Design an A-stable Multi-vibrator using IC555 Timer.
8. Design Second order active filters for different cut-off frequencies using op-Amp: LPF, HPF and BPF.

Open Ended Experiments:

1. Analyse and Understand the Hysteresis Curve generated using Schmitt Trigger Op-amp Circuit.
2. Determine the Bit Error Rate (BER) and Analyse the Eye Pattern generated in a Digital Transmission using Light Runner.

REFERENCE BOOKS:

1. **"Introduction to Fiber Optic",** A. Ghatak and K. Thygarajan, Cambridge University Press, Cambridge, UK 1988.
2. **"Fiber Optical Communication System",** 3rd edition Govind P. Agrawal, John wiley Sons Inc. 2002.
3. **"Optical Fiber Communication Principles and Systems",** S. Kar, A. Selvarajan and T Sreenivas Tata McGraw Hill Publishing Company Ltd., New Delfi, 2002.
4. **"An Introduction to Analog and Digital Communication System",** Simon Hykin and John Wiley 2004.
5. **"Advanced Digital Communication Laboratory Manual",** Preetha Sharan, R Bhargava Rama Gowda, CBS Publishers & Distributors Pvt. Ltd., First Edition, 2013.

Course Outcomes

CO #	Course Outcome	Bloom's Taxonomy Level	Level indicator Program Outcome
CO1	**Apply** the basic knowledge of communication to determine attenuation, losses and other parameters.	**Apply**	**L3(PO1, PO9,PO10)**
CO2	**Analyze** the operation of different Analog and Digital modulation and demodulation schemes.	**Analyze**	**L4(PO1, PO2, PO9,PO10)**
CO3	**Evaluate** by **applying** basic knowledge of communication theory the working of TDM, WDM-MUX and WDM-DEMUX.	**Evaluate**	**L5(PO2,PO9, PO10)**
CO4	**Design** and **Evaluate** Second Order Active Filters and Multi-vibrator.	**Create**	**L6(PO3, PO9,PO10)**

D. Course Articulation Matrix (CAM)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
#1	2								2	1			2	
#2	2	3							2	1			2	3
#3		2							2	1				2
#4			1						2	1				

Course Title :ADDITIONAL MATHEMATICS-II As per Choice Based Credit System (CBCS) & OBE Scheme] **SEMESTER – IV (Lateral Entry: Common to all branches)**		
Course Code: P22MATDIP401		**CIE Marks:50**
Credits: L:T:P:S: 3:1:0:0		
No of lecture hours per week: 04 :L=2,T=2		

Course Objectives:
The mandatory learning course**: P21MATDIP401**viz., **Additional Mathematics-II** aims to provide essential concepts of linear algebra, introductory concepts of second & higher order differential equations along with various techniques/ methods to solve them, Laplace & inverse Laplace transforms and elementary probability theory.

UNIT – I	**10 Hours**

Linear Algebra: Introduction - Rank of matrix by elementary row operations - Echelon form of a matrix. Consistency of system of linear equations - Gauss elimination method. Gauss-Jordan and LU decomposition methods. Eigen values and Eigen vectors of a square matrix.

Self-study component:	Application of Cayley-Hamilton theorem (without proof) to compute the inverse of a matrix-Examples.

UNIT – II	**14 Hours**

Higher order ODE's: Linear differential equations of second and higher order equations with constant coefficients. Homogeneous /non-homogeneous equations. Inverse differential operators. and variation of parameters. Solution of Cauchy's homogeneous linear equation and Legendre's linear differential equation.

Self-study component:	Method of undetermined coefficients

UNIT – III	**10 Hours**

Multiple Integrals: Double and triple integrals-region of integration. Evaluation of double integrals by change of order of integration.
Vector Integration: Vector Integration: Integration of vector functions. Concept of a line integrals, surface and volume integrals. Green's, Stokes's and Gauss theorems (without proof) problems.

Self-study component:	Orthogonal curvilinear coordinates.

UNIT – IV	**12 Hours**

Laplace transforms: Laplace transforms of elementary functions. Transforms of derivatives and integrals, transforms of periodic function and unit step function-Problems only. Inverse Laplace transforms: Definition of inverse Laplace transforms. Evaluation of Inverse transforms by standard methods.

Self-study component:	Application to solutions of linear differential equations and simultaneous differential equations.

UNIT – V	**6 Hours**

Probability: Introduction. Sample space and events. Axioms of probability. Addition and multiplication theorems. Conditional probability – illustrative examples.

Self-study component:	State and prove Bayes's theorem.

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

CO1	**Apply** matrix theory for solving systems of linear equations in the different areas of linear algebra.
CO2	**Solve** second and higher order differential equations occurring in of electrical circuits, damped/un-damped vibrations.

CO3	**Identify** - the technique of integration to evaluate double and triple integrals by change of variables, and vector integration technique to compute line integral
CO4	**Explore** the basic concepts of elementary probability theory and, apply the same to the problems ofdecision theory.

TEXT BOOKS

B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, New Delhi, 43rd Ed., 2015

REFERENCE BOOKS

1. E. Kreyszig: Advanced Engineering Mathematics, John Wiley & Sons, 10th Ed., 2015.
2. N.P.Bali and Manish Goyal: Engineering Mathematics, Laxmi Publishers,7th Ed., 2007.